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MASTER THESIS

“TRADE EFFECTS OF TARIFF REDUCTION: THE CASE OF UKRAINE”

by

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ABSTRACT

This thesis investigates the expected medium-term trade effects of tariff reduction under the Deep and Comprehensive Free Trade Agreement (DCFTA) between the EU and Ukraine. In particular, trade creation and trade diversion effects for pork and poultry are measured using the partial equilibrium model applied by the UNCTAD policy simulation tool SMART. The medium-term import price elasticities and elasticities of substitution required for the SMART model are estimated using the Autoregressive Distributed Lag (ARDL) model. The analysis covers the period from January 2010 to December 2015, using the monthly time series on Ukrainian GDP, imports and import prices of pork and poultry, as well as the calculated tariff equivalents of the tariff quotas on pork and poultry under the DCFTA. The obtained results suggest that the tariff reductions will lead to an annual increase in imports of pork and poultry from the EU to Ukraine by 1.32 to 2.44 ths. tones (3-6% growth compared to the average imports over the period under investigation) and 1.81 to 7.39 ths. tones (3-12% growth), accordingly. The major part of imports increase led by the tariff cuts is expected to result from the trade diversion from the producers outside the EU towards the EU meat exporters.

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LIST OF ABBREVIATIONS AND SYMBOLS

ADF test – augmented Dickey-Fuller Test

AIC – Akaike information criterion

ARDL model – Autoregressive distributed lag model

CES – constant elasticities of substitution

CIS – Commonwealth of Independent States

DCFTA – Deep and Comprehensive Free Trade Area

ECM – error correction model

ECT_t – –error correction term in period *t*

EU – European Union

$\varepsilon_{g,r}$ – own- price elasticity of good *g* imported from region *r*

FTA – free trade area

GDP – gross domestic product

HS – Harmonized system of tariff nomenclature

IEF – Institute for Economics and Forecasting (of the National Academy of Sciences of Ukraine)

KPSS test – Kwiatkowski-Phillips-Schmidt-Schin test

LR – likelihood ratio

MRS – Marginal rate of substitution

$m_{g,r}$– imports of good *g* from region *r*

M_t – ratio of the EU to RoW imports in period *t*

n – consumption of the numeraire good

GE – general equilibrium

PE – partial equilibrium

$p^d_{g,\neq r}$ – domestic price of good *g* imported from the region other than *r*

$p^d_{g,r}$ – domestic price of good *g* imported from region *r*

$p^w_{g,r}$ – world price of good *g* imported from region *r*

P_t – ratio of the EU to RoW import prices in period *t*

RoW – rest of the world

SC – Schwarz information criterion

$\sigma_{g,r,\neq r}$– elasticity of substitution between the varieties of good g imported from different regions

$t_{g,r}$ – tariff on good g imported from region *r*

$TC_{g,r}$ – trade creation effect for good g imported from region *r*

$TD_{g,r}$ – trade diversion effect for good g imported from region *r*

SMART – partial equilibrium modeling tool included in WITS that is used for market analysis

UAH – Ukrainian hryvnia (Ukrainian national currency)

UNCTAD – United Nations Conference of Trade and Development

$u_g(.)$ – subutility function of good g

U – utility function

VAR – vector autoregression

WITS – World Integrated Trade Solution

WTO – the World Trade Organization

y – national income

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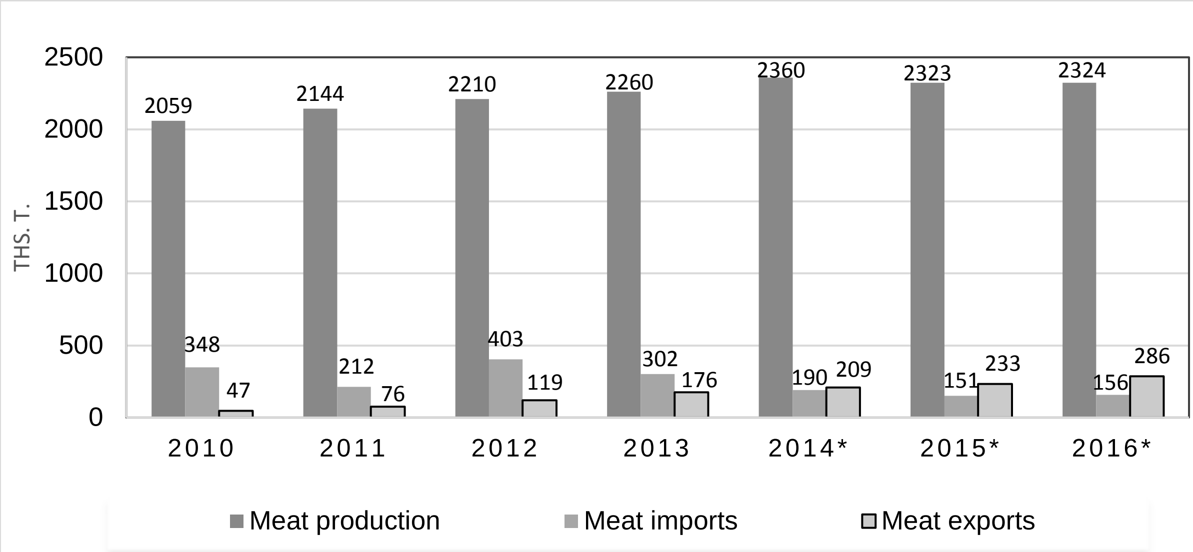
CHAPTER 1. INTRODUCTION

The signing of the Deep and Comprehensive Free Trade Agreement (DCFTA, effective of 1 January 2016), which is part of the Association Agreement between the EU and Ukraine (Title IV: Trade and Trade-Related Matters) has lately been one of the most discussed and disputed issues in the Ukrainian international economic policy. It can be viewed the second major step in Ukraine's integration into the global economy after its accession to the WTO in 2008.

Trade in agricultural products is traditionally one of the most problematic questions in negotiations on free trade areas. In the case of the EU and Ukraine, it is even more complex due to highly asymmetric initial trade conditions between the parties, which had been aggravated after Ukraine's accession to the WTO and rapid reduction of its customs barriers. In particular, while Ukraine mainly applies ad valorem import tariffs, in the EU there is a large set of specific and combined import tariffs, tariff quotas, export subsidies and special agricultural products protective measures, which Ukraine is not entitled to. In general, markets for agricultural products are the most protected ones in the EU. Before the signing of the Agreement, the average weighted import tariff rate for agricultural products in the EU was 16%, the respective value in Ukraine constituted 6.8% (Ryzhenkov 2013, 12). Therefore, the DCFTA is broadly viewed as a means of partially mitigating the existing asymmetry of trade conditions between the parties.

At the same time, there have been many concerns regarding the Agreement. Most of them were related to the trade in meat, which turned out to be the most vulnerable product group (especially pork and poultry) after Ukraine's accession to the WTO (IEF 2014, 19) and the succeeding reduction of tariff and non-tariff barriers. Figure 1 though reveals the fact that even after the first steps of trade liberalization, there is still a substantial potential for Ukraine to extend its international trade in meat. The international component of the meat market in Ukraine is relatively small: the major part of meat production in Ukraine is directed to cover the needs of domestic consumption (imports of meat in 2015, right before the enactment of the DCFTA, constituted around 7% of its consumption, whereas exports of meat comprised roughly 11% of its production level in 2015) (Avercheva 2016, 7). Figure 1 below also implies that meat imports were more affected by the political crisis than its production, following the overall downturn in international trade in Ukraine in 2013-2015 and its gradual stabilization in 2016. At the same time, meat exports continued to grow over this period, turning Ukraine from the net meat importer into the net meat exporter.

Figure 1: Meat Production vs. International Trade in Meat in Ukraine in 2015-2016 (in Slaughter Weight, ths. t.)



* excluding the temporarily occupied territories.
Source of the data: State Statistics Service of Ukraine.

At the same time, Ukraine's membership in the WTO led to significant diversification of the country's international trade. For example, the number of its trading partners in pork grew immediately from 6 (mostly CIS countries) in 2006 to 26 in 2008 (with an 18-fold growth of imports from European countries over the period) (Hess 2009, 16). Moreover, from Figure 2 it can be seen that over the subsequent years the EU has become Ukraine's major trade partner in terms of all the main varieties of meat imported to Ukraine. Poultry and pork have traditionally been the main types of meat traded (and produced, see Appendix A) by Ukraine with fat and edible meat offal starting to play a more significant role in the recent years.

Figure 2: Structure of the Ukrainian Meat Trade in 2010 and 2015, Total and the EU (in Slaughter Weight, thsd.t and %)

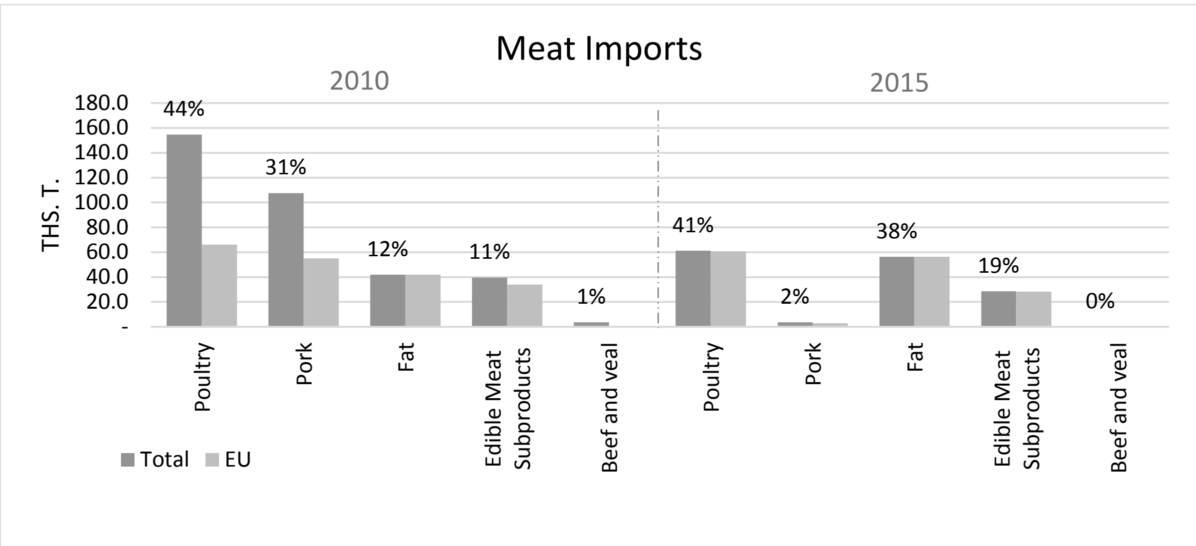
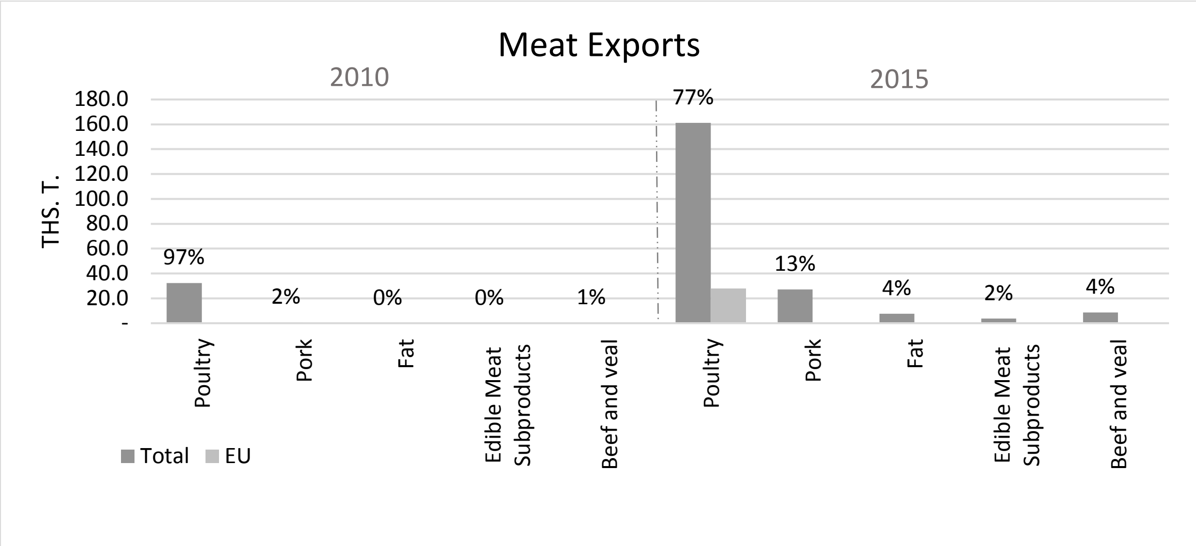


Figure 2 (cont.)



Source of the data: State Statistics Service of Ukraine.

Thus, this thesis aims to evaluate the trade effects of the DCFTA creation on Ukrainian meat markets (namely, pork and poultry), based on the estimated medium-term price import elasticities and elasticities of substitution. In particular, the analysis is focused on calculation of the *trade creation* and *trade diversion* effects from the tariff reduction undertaken by Ukraine under the DCFTA starting from 1 January 2016, based on the UNCTAD SMART partial equilibrium model of international trade. The estimation of the elasticities required for the model is carried out using the Autoregressive Distributed Lag (ARDL) model applied to the monthly data on Ukrainian pork and poultry imports, prices and GDP covering the period from January 2010 to December 2015. Statistical software packages R and EViews are used for the estimations. The tariff equivalents used in the SMART model are computed on the basis of Ukraine's tariff obligations specified in Annex I-A of the Agreement.

This master thesis is structured as follows: Chapter 2 contains a brief literature review of models used to evaluate the effects of international trade liberalization with the focus on advantages and disadvantages of the UNCTAD SMART model in the current context, as well as an analysis of studies applying the ARDL model for elasticities estimation. Chapter 3 explains the theoretical concept of the SMART model and derives hypotheses in terms of the expected results for the series under consideration. Chapter 4 contains the empirical analysis of the data aimed at estimating the medium-term price elasticities and elasticities of substitution, as well as tests the hypotheses derived in the previous chapter. In the following chapter, the trade creation and trade diversion effects are computed based on the estimated elasticities and the calculated tariff equivalents. And finally, the last chapter concludes and indicates the possible avenues for further research.

CHAPTER 2. RELATED LITERATURE

2.1. Partial Equilibrium Models in International Trade Analysis: SMART Set-Up

The idea of free trade having positive impact on the national economies in its more or less modern form dates back to the seminal works of Adam Smith ("The Wealth of Nations" (1776)) and David Ricardo ("On the Principles of Political Economy and Taxation"(1817)). Ever since free trade policies had to compete at different times with the policies of mercantilists, isolationists, protectionists and others (Edwards 1993, 1358).

In the 20th century, during the post-World War II period, the free trade ideas naturally evolved into the theories of economic integration, first set out in the fundamental work of Viner (1950) and further developed by Meade (1955), Lipsey (1960), Balassa (1967) and others. This period of time was marked by the conclusion of regional, as well as multilateral free trade agreements and, in particular, by setting the milestones for the World Trade Organization and the European Community.

To analyze the welfare effects of international trade, either static general equilibrium or partial equilibrium models of trade are usually applied. General equilibrium models capture a change in international trade policy throughout the entire economy, whereas partial equilibrium models are used to evaluate the effects of a shift in international trade in just one market (sector of economy), assuming that other markets remain unaffected by the change (Van den Berg, Lewer 2015, 10). General equilibrium models may be conceptually more preferable than partial equilibrium models, because they allow to take into account numerous simultaneous relationships in the economy. At the same time, their complexity leads to the necessity to make a lot of assumptions, which inevitably affects the quality of the estimates of gains or losses of changes in the trade policy (Van den Berg, Lewer 2015, 11). Hence, it might be useful to adopt a partial equilibrium approach for cases where the trade in a particular good, which does not constitute a substantial part in the country's trade, is analyzed. Since the current analysis is focused on a single industry, that does not account for a large share of Ukraine's economy and trade, and is applied to the disaggregated data, a partial equilibrium approach seems to be more appropriate for achieving the goals of this thesis. It is therefore assumed that the effects of tariff reduction on meat imported from the EU will have a negligible effect on other sectors of the economy.

The partial equilibrium approach to the analysis of international trade has a number of advantages. Firstly, it is actively adopted due to its simplicity: it is much less data-intensive than the general equilibrium approach and traditionally requires only data for the trade flows, trade policy (in this case, the size of the tariff cuts) and some behavioral parameters (most commonly, price elasticities). Secondly, as noted above, it enables the analysis of high level of disaggregation in data and makes it possible to isolate impacts of trade agreements on the most affected commodities (The World Bank 2010[1]), whereas the general equilibrium analysis suffers more heavily from aggregation biases. The partial equilibrium analysis is also believed to be better at providing useful information for policy-makers, for it focuses on the direct impacts of trade policy (Koo et al. 2005, 79).

In this thesis, I use the theoretical framework of SMART, which is a partial equilibrium modeling tool included in the World Integrated Trade Solution (WITS) of the World Bank for market access analysis. It permits to focus on an importing market for a particular good and on its exporting parties, and to evaluate the trade effects of tariff changes (The World Bank 2010[2]). In particular, the case of a small country (with infinitely elastic supply elasticity) is considered. On the demand side, the Armington elasticities of substitution are assumed (that is, goods that are similar up to the 6th HS digit level imported from different import sources are considered to be imperfect substitutes). The model is solved through a two-step optimization procedure of a representative agent, that first chooses the total level of consumption of a particular good and then allocates its costs among different varieties (different importing sources) of this good (The World Bank 2010)[3]. The assessment of trade flows in the SMART model is based on the data on the change in trade flows, policy parameters (tariff cuts) and own-price elasticities and elasticities of substitution of the imported good. The latter ones are the focus of the empirical analysis of this thesis. The analytical set-up of the SMART model is discussed in more detail in Chapter 3. The next subchapter gives an overview of the ARDL approach to estimating the behavioral parameters used in the SMART model for the current analysis, namely, the price elasticities of imports and the elasticities of substitution.

2.2. Application of ARDL Models in Estimating Long- and Short-Run Elasticities

As stated above, the SMART analysis of trade effects is based primarily on import demand responsiveness to price changes, that is, on import price elasticities, as well as on elasticities of substitution of a particular good imported from different regions. The pioneering

[1] Exact link: http://wits.worldbank.org/wits/wits/witshelp/Content/SMART/Rationale%20for%20Partial%20Equilibrium.htm, access: 9 July 2017.
[2] Exact link: http://wits.worldbank.org/wits/wits/witshelp/Content/SMART/SMART%20Theoretical%20Framework1.htm, access: 9 July 2017.
[3] Exact link: http://wits.worldbank.org/wits/wits/witshelp/Content/SMART/Demand%20side%20the%20Armington.htm, access: 9 July 2017.

paper on estimation of trade elasticities is Orcutt (1950), which has been followed by a large number of studies on the determination, use and econometric specification of trade elasticities. Among the most prominent papers are Krenin (1967), Houthakker and Magee (1969), Stern et al. (1976), Goldstein and Khan (1976), Goldstein and Khan (1985), Reinhart (1995). The theoretical model that was offered for the estimation of trade elasticities is an imperfect substitutes model, where imports and exports are viewed as imperfect substitutes for domestic goods. The domestic demand for foreign goods is thus most often determined by the domestic income, prices of foreign goods and prices of goods that compete with foreign goods in the domestic market (although other explanatory variables, that are assumed to affect demand besides income and prices, may be included) (Via 2011, 6-7). The most general specification of the import demand function is as follows (see, for example, Goldstein and Khan 1976, 203):

$$logM_t^d = a_0 + a_1 logP_t + a_2 logY_t + u \quad (1)$$

Where *M* is import demand in period *t*, *P* is ratio of import prices to domestic prices in period *t*, and *Y* is level of national income in constant prices in period *t*. Thanks to the logarithmic form, coefficients a_1 and a_2 directly represent price and income elasticities of import demand (see Appendix D).

Since time series are often subject to a non-stationarity problem and may contain a deterministic or a stochastic trend, the direct application of a traditional OLS to test for the relationships among such series without running preliminary checks could deliver misleading inferences. In particular, in the presence of nonstationary variables, the error term is often highly correlated and traditional diagnostic statistics for evaluation of the validity of the model (such as *t* and *F* statistics) become highly unreliable (i.e., the null hypothesis is rejected too often for a given critical value, which increases the risk of a "spurious" regression (Pfaff 2008 74). In addition, when the endogenous variable contains a stochastic trend, the R^2 tends to be very high (since at computation of the total variation a fixed mean is assumed). The presence of unit root in the series results in violation of constant means and variances of OLS, for they become functions of time, which makes it impossible to make meaningful predictions: any shocks to the data series will lead to a cumulative divergence from the mean (Nkoro and Uko 2016, 68, 74). Including a trend term (in case of trend-stationary data) and differencing the series (in case of difference-stationary data) may solve the problem. However, differencing may lead to the loss of the relevant long run properties of information of the equilibrium relationship between the variables. This information can be retrieved using cointegration methods that enable the detection of stable long-run relationships among non-stationary variables (Pfaff 2008, 75). Considering the above, an Autoregressive Distributed Lag (ARDL) cointegration technique is applied for the estimation of medium-term elasticities required for the analysis of the trade effects within the SMART framework. The text below describes the main characteristics of the ARDL model, as well as its application in studies estimating equilibrium steady relationships between the variables and their short-run dynamics.

In their seminal papers, Pesaran and Shin (1999) and Pesaran et al. (2001) revived the use of the ARDL approach in the presence of difference-stationary data by introducing the bounds test for cointegration that can be used within an ARDL framework (Altinay 2007, 5832). Before that, the model was traditionally applied to analyze long-run relations among (trend-) stationary data. To deal with the series integrated of the first order, a number of procedures have been developed (Engle and Granger (1987), Johansen (1991), Phillips (1991), Phillips and Hansen approaches (1990)), which, however, require that all the data are integrated of the same order (Pesaran and Shin 1999, 371).

The ARDL model has been thereon used to test the existence of a level relationship between a dependent variable and a set of regressors, when it is not known with certainty whether the underlying regressors are trend- or first-difference stationary or mutually cointegrated (Pesaran et al 2001, 289). It is a general dynamic specification that employs the lags of the regressand and the lagged and contemporaneous values of regressors, for direct estimation of short-run effects and indirect evaluation of the long-run equilibrium relationship (Altinay 2007, 5832). It involves a two-step procedure: first the existence of a long-run relationship among all the variables is checked using the bounds test, and, upon confirmation of the cointegration, the long- and short-run coefficients can be estimated with the help of the associated ARDL and error correction models (ECMs) (Altinay 2007, 5832). The model has particularly become popular in the analysis of demand responsiveness to changes in prices and income (especially in the energy sector). Inter alia, it has been applied for the estimation of short- and long-run demand elasticities of aggregated and disaggregated import demand by Abrishami, H and M. Mehrara (2000), Altinay (2007), Emran and Shilpi (2010) Rashid and Razzaq (2010), Tang (2008), of energy demand (including demand for oil, natural gas, electricity) by Bernstein and Reinhard (2011), Cuddington and Dagher (2011), Narayan and Smyth (2005), etc.

Among its advantages, Pesaran et al. (2001) name the fact that the approach overcomes the unit root testing problems (related to the low power of the tests, contradictory results of different tests), since both I(0) and I(1) variables can enter the equation. The model, however, cannot be applied to the I(2) series, therefore, the pretesting for the presence of I(2) data can still be enlightening. The further arguments against unit root tests could be that their power is commonly too low, especially in short time series, and that most of economic data are rarely found to be I(2). Another benefit of the ARDL cointegration approach is its applicability to small samples (which is, for example, not the case for Engle-Granger and Johansen procedures). In addition to the critical bounds calculated by Pesaran et al. (2001), Narayan (2005) provides critical values for samples of a size from 30 to 80 observations. It is also possible to choose different optimal number of lags for different variables (Pahlavani 2005, 7-8). Chapter 4 provides more details on the ARDL technique employed for the purposes of this thesis.

CHAPTER 3. THEORETICAL MODEL

3.1. Theoretical Set-Up of the UNCTAD SMART Model: Small Country Case

The analysis of the trade effects of the tariff reductions resulting from the DCFTA is based on the partial equilibrium SMART model introduced by Jammes and Olarreaga (2005). In particular, for Ukraine, a case of a small country with no influence on world market prices is considered, which implies a perfectly elastic export supply. Therefore, the initial model follows the following assumptions:

- there are *no income effects* for the imported goods;
- *Armington assumption*: same goods imported from different countries are imperfect substitutes in demand (Armington 1969, 159). The current analysis, in particular, is focused on two goods (pork and poultry) imported from two regions (the EU and the "rest of the world" (RoW)); this means that 2x2 = 4 "varieties" of goods are considered, that is, the vector of imports would look like M = ($m_{1,1}, m_{1,2}, m_{2,1}, m_{2,2}$), where $m_g = (m_{g,1}, m_{g,2})$, for g = 1, 2, is a group of imports supplied by the two regions under consideration, which in other words can be described as market for good g;
- *independence of preferences* (except for the numeraire good): consumers' preferences for "varieties" of goods in market m_g are independent of their imports in other markets. Under this assumption, MRS between any two imports of the same good from two different regions must be independent of the quantities of imports of all other goods. This assumption also allows to measure unambiguously the demand for any good g and to collapse the utility function $U = U(m_{1,1}, m_{1,2}, m_{2,1}, m_{2,2}, n)$ to $U = V(m_1, m_2, n)$, where n is a composite numeraire good and $m_g = \phi_g(m_{g,1}, m_{g,2})$, where ϕ_g is linear and homogeneous. As a result, it should be then possible to express the demand for any variety of good $m_{g,r}$, for r = 1,2 as a function of m_g and the relative prices in the g^{th} market, whereas the linearity and homogeneity of ϕ_g ensure that the price for good g p_g is only a function of $p_{g,1}, p_{g,2}$ (Armington 1969, 164-166). The budget constraint can then be written as $y = \sum_g \sum_r p_{g,r} m_{g,r} + n = \sum_g p_g m_g + n$ (where the price of the numeraire good n is set to 1);
- *constant elasticities of substitution* (CES): elasticities of substitution between imports of the same good from different locations are constant (they do not depend on the market shares of the respective goods, which is a restrictive assumption upon the data, but it allows to find a convenient functional form for the analysis);

- *perfectly elastic export supplies* (for Ukraine is considered a small economy that cannot affect the world prices).

The demand structure that satisfies the assumptions of the model can be explained by a quasi-linear additive utility function as suggested by Jammes and Olarreaga (2005):

$$U = \sum_g u_g(m_g) + n \tag{2}$$

where *n* denotes the consumption of the composite numeraire good (which may be also referred to as “money”), m_g is total imports of good g from different countries and $u_g(.)$ is a sub-utility function of good g such that $u_g(.)$ is increasing and concave: $u'_g(.) > 0$ and $u''_g(.) < 0$.

It should be noted here that using microfoundations to express the aggregate behavior suffers from a number of problems. Import demand relationship involves the reactions of rather diverse individuals purchasing rather diverse commodities (Stern 1962, 42). According to different approaches to utility aggregation, the measurability and comparability of utility have to be assumed in order to use the sum of individual utilities as a measure of social welfare. The comparability of utility is based on the assumption that all the consumers have very similar underlying preference orderings, which hardly reflects the reality. Using the concept of a representative individual is complicated by the fact that policy recommendations based on observed past macroeconomic relationships may neglect subsequent behavioral changes by economic agents, which, when added up, would change the macroeconomic relationships themselves (Lucas critique (1976)). The problems of aggregation of individual preferences were summarized in Arrow’s impossibility theorem, which states the failure to successfully generate a social preference ordering from a set of individual preferences. According to the theorem, no ideal social welfare function can be found, no matter how sophisticated the aggregation mechanism (Hindriks and Miles 2013, 442). There have been attempts to deal with the described problems by constructing alternative models, e.g. models with heterogeneous agents, to reflect the behavior of individual agents, which heavily overcomplicates the model. Bearing in mind the deficiencies pointed out above, and being aware that no model can be sophisticated enough to perfectly describe real-world relationships, utility function (2) will still be used to solve for the aggregate demand in the further analysis.

Such functional form ensures that there are no substitution effects across different goods g owing to the additivity of the utility function and that there are no income effects – thanks to the linearity on the composite numeraire good *n*. That is, demand for good g is assumed to be independent of the demand for other goods, and the marginal utility of money is assumed constant and is set to 1 (zero income effect). Such assumptions should be plausible in case that demand for a particular import good is small compared to other goods (Choynowski 2002, 9). Ukraine's import demand functions for each variety of good g and the numeraire good can be obtained by solving the utility maximization problem subject to the budget constraint (see the derivation in Appendix B):

$$m_{g,r} = f\left(p^d_{g,r}; p^d_{g,\neq r}\right), \forall g, r \quad (3)$$

$$n = y - \sum_r \sum_g p^d_{g,r} m_{g,r} \quad (4)$$

where $m_{g,r}$ are imports of good g from region r, $p^d_{g,r}$ is the domestic price of good g imported from region r, $p^d_{g,\neq r}$ is the domestic price of good g the region other than r, y is the national income. Thus the consumption of good g imported from region r depends only on the domestic prices on good g imported from different regions, whereas the consumption of n absorbs all the income effects and is determined by the level of consumption of imported goods m_g. Domestic price of good g from region r is defined in turn as its world price plus the respective tariff protection:

$$p^d_{g,r} = p^w_{g,r}\left(1 + t_{g,r}\right) \quad (5)$$

Based on this analytical setup, the SMART model can be used to evaluate the trade effects (import creation and import diversion) of the tariff reduction resulting from the free trade area creation. The latter are explained in the following two subchapters.

3.2. Trade Creation Effects

Trade creation is the direct increase in imports following a decreased tariff protection imposed on good g from region r (Jammes and Olarreaga 2005, 3). It can be obtained from the definition of the price elasticity of import demand, which is the percentage change in the imported quantity of a commodity following a 1% change in the increase of its price (Koo et al. 2005, 81). Under the assumption of the fixed world prices, the own-price elasticity of demand can be defined as a direct increase in imports due to a tariff reduction (Bacchetta et al. 2012, 147):

$$\varepsilon_{g,r} = \frac{\%\Delta m_{g,r}}{\%\Delta p^d_{g,r}} = \frac{\Delta m_{g,r}/m_{g,r}}{\Delta p^d_{g,r}/p^d_{g,r}} = \frac{dm_{g,r}/m_{g,r}}{dp^d_{g,r}/p^d_{g,r}} < 0 \quad (6)$$

Note that meat is viewed as a normal good, and thus demand for meat and its price are assumed to have an inverse relation, that is why the own-price elasticity of demand is expected to be negative. Therefore, import demand is considered elastic if $\varepsilon_{g,r} < -1$.

Solving for $dm_{g,r}$ and using that $\partial p^d_{g,r} = p^w_{g,r} dt_{g,r}$ yields:

$$TC_{g,r} = p^w_{g,r} dm_{g,r} = p^w_{g,r} \varepsilon_{g,r} m_{g,r} \frac{dp^d_{g,r}}{p^d_{g,r}} = p^w_{g,r} \varepsilon_{g,r} m_{g,r} \frac{dt_{g,r}}{(1+t_{g,r})} \quad (7)$$

The world prices can be set equal to 1 so that $m_{g,r}$ represents both imported quantities and the value of good *g* from region *r*:

$$TC_{g,r} = \varepsilon_{g,r} m_{g,r} \frac{dt_{g,r}}{(1+t_{g,r})} \tag{8}$$

3.3. Trade Diversion Effects

Trade diversion in the case under consideration measures the possible substitution away of imports from a more efficient supplier outside the FTA to a less efficient supplier within the FTA due to the decrease of the domestic prices on good *g* from the EU resulting from the tariff reduction under the DCFTA (Bacchetta et al. 2012, 148). It can be derived from the definition of the elasticity of substitution between imports of good *g* from the EU and the rest of the world, which is the percentage change in relative imports of good *g* resulting from a 1% change in its relative prices (Stern and Zupnick 1962, 57):

$$\sigma_{g,r,\neq r} = \frac{\%\Delta\left(\frac{m_{g,r}}{m_{g,\neq r}}\right)}{\%\Delta\left(\frac{p^d_{g,r}}{p^d_{g,\neq r}}\right)} = \frac{\Delta\left(\frac{m_{g,r}}{m_{g,\neq r}}\right)/\frac{m_{g,r}}{m_{g,\neq r}}}{\Delta\left(\frac{p^d_{g,r}}{p^d_{g,\neq r}}\right)/\frac{p^d_{g,r}}{p^d_{g,\neq r}}} = \frac{d\left(\frac{m_{g,r}}{m_{g,\neq r}}\right)\Big/\frac{m_{g,r}}{m_{g,\neq r}}}{d\left(\frac{p^d_{g,r}}{p^d_{g,\neq r}}\right)\Big/\frac{p^d_{g,r}}{p^d_{g,\neq r}}} < 0 \tag{9}$$

Again, it is expected that the relative demand for a variety of good *g* will increase with the fall of its relative price, which is why the elasticity of substitution should be less than zero. With the world prices normalized at 1, the trade diversion is defined as follows (see the derivation in Appendix C):

$$TD_{g,r} = dm_{g,r} = -dm_{g,\neq r} = \begin{cases} \frac{m_{g,\neq r} m_{g,r}}{m_{g,\neq r}+m_{g,r}} \frac{dt_{g,r}}{(1+t_{g,r})} \sigma_{g,r,\neq r} & if\ -dm_{g,r} \leq m_{g,\neq r} \\ m_{g,\neq r} & if\ -dm_{g,r} > m_{g,\neq r} \end{cases} \tag{10}$$

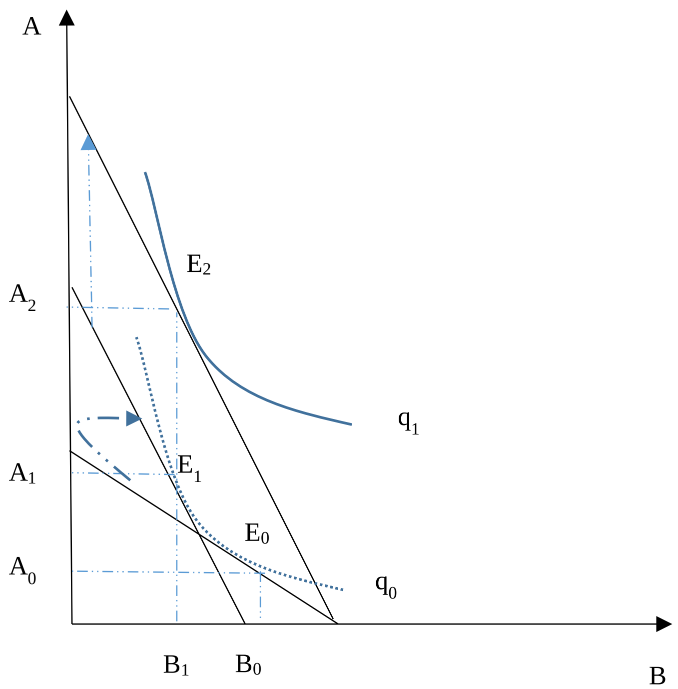
That is, the trade diversion is restricted by the level of the original imports from other countries.

As can be seen in Figure 3, which illustrates the trade effects for good *g*, lowering the tariff for the EU leads to the change of the relative prices of the two varieties of the good and the budget constraint rotates clockwise, allowing the consumers in Ukraine to increase their imports of good *g* from the EU by A_0A_1 at the expense of imports from the rest of the world, which sinks by B_0B_1 (trade diversion). In other words, trade diversion may be characterized as the demand reaction to price changes when the choice is constrained to the initial level of the composite curve q_0.

At the same time, a lower domestic price for good *g* imported from the EU enables consumers to increase their European imports up to A_2 keeping their expenses constant, that is, to reach a higher composite curve q_1 (trade creation) (Bacchetta et al. 2012, 149).

To obtain the total increase in imports of good g from the EU resulting from the preferential tariff reduction for good g under the FTA the sum of the respective trade diversion (A_0A_1) and trade creation (A_1A_2) terms should be calculated (Bacchetta et al. 2012, 149).

Figure 3: Trade Diversion and Trade Creation Effects in SMART



Source: Bacchetta et al. 2012, 149

In the following, the discussed trade effects are assessed using the import demand elasticities and elasticities of substitution estimated by the ARDL model presented in the next chapter.

3.4. Hypotheses Regarding Price Elasticities and Elasticities of Substitution Estimated to Compute the Trade Effects

Price elasticities. Using the notation presented above, the „long-run“ cointegrating regression for estimating the import demand elasticities is specified as follows (see the justification in Appendix D):

$$\ln(m_{g,EU\,t}) = \alpha + \beta_1 \ln(p_{g,EU\,t}) + \beta_2 \ln(p_{g,RoW\,t}) + \beta_3 \ln(GDP_{UA,t}) + \epsilon_t \qquad (11)$$

where $\ln(p_{g,EU})$, $\ln(p_{g,RoW\,t})$ and $\ln(p_{g,RoW\,t})$ are natural logarithms of imports of good g from the EU and of its price in the EU and RoW respectively, and $\ln(GDP_{UA,t})$ is natural logarithm of real GDP in Ukraine in period t. Error term ϵ_t reflects other minor influences and is assumed to be uncorrelated with the explanatory variables. It should be noted that, although the theoretical model described in previous chapters assumes that imports of a variety of good g depends only on prices on good g in different locations, and all the income effects are absorbed by numeraire composite good n, this might not realistically reflect the existing income-demand relationships. Therefore, income term $\ln(GDP_{UA,t})$ is nevertheless included in the equation to account for the macro effect of the income influence on the aggregate demand. It might be the case that income and prices move together, responding jointly to similar underlying forces, then if the income variable is wrongfully excluded, the price coefficient will gain in significance but become biased, and the random disturbance term will then include the excluded income and would necessarily be correlated with the price variable (Stern and Zupnick 1962, 32). It can then be tested if the income effect turns out to be significant in the model:

$$H_1: \beta_3=0, \ H_{1A}: \beta_3 \neq 0 \tag{12}$$

For such a cointegrating relationship to exist, it should be assumed that price elasticities are constant: at any price or consumption level, 1% change in price will be followed by the same percentage change in imports. A number of studies (Orcutt (1950), Liu (1954), Goldstein and Khan (1976), Kindleberger (1973)), however, argue that relative price elasticity of demand is larger for larger price changes than for small price changes, which can be explained, for example, by the fact that the price change should be large enough to overcome the switching costs, or that the adjustment of imports to large price changes is faster than the adjustment to small changes (in this case, long-run elasticities should be independent of the size of the price change, whereas short-run elasticities are functionally related to the price change) (Goldstein and Khan 1976, 201). Therefore, although the log-linear form is convenient for the purposes of the current analysis, the considerations above should be taken into account.

Coefficients $\beta_1 = \varepsilon_{g,EU}$ and $\beta_2 = \varepsilon_{g,\neq EU}$ represent the direct and cross- price elasticities of import demand for good g from the EU, and β_3 is income elasticity of import demand. Due to the logarithmic functional form of equation (11), the elasticities are constrained to be constant (Stern and Zupnick 1962, 58). β_1 is expected to have a negative sign, whereas β_2 and β_3 are expected to be positive. That is, imports of good g from the EU should decline in case it becomes more expensive relative to its close substitutes in other countries. Similarly, when the price for good g in other countries rises, imports from the EU are expected to increase (hence a positive β_2). At the same time, since the analyzed time period covers only 5 years, the long-run (or, in this case, sooner medium-term) price elasticities are not expected to be high in absolute value and are likely to be less than unity. And generally, one would expect that households will increase their consumption when their incomes rise (at least in case of normal goods). Therefore, one can check if the following hypotheses are rejected:

$$H_2: \beta_1 \geq 0, H_{2A}: \beta_1 < 0 \tag{13}$$

$$H_3: \beta_2 \leq 0, H_{3A}: \beta_2 > 0 \tag{14}$$

and, in case H_1 is rejected:

$$H_4: \beta_3 \leq 0, H_{4A}: \beta_3 > 0 \tag{15}$$

However, there is a possibility that β_3 turns out to be negative, if, for example, imports are assumed to be the difference between the consumption and the production, and production is more responsive to changes in income than the consumption. In such situation, imports could fall when the income rises (Goldstein and Khan 1976, 204).

The possible sources of bias (usually, underestimation of the elasticities) in estimating parameters in (11) include:

- *simultaneity problem*: the estimates of elasticities can be biased towards zero due to the positive correlation between the error term (temporary shifts in demand) in the import demand relationship and the price term (price adjustments that take place to ration the available quantity) (Stern and Zupnick 1962, 63). However, under the assumption of the perfectly elastic supplies, the shocks in Ukraine's demand should not affect the word prices for goods from the EU or RoW;
- *multicollinearity* in the explanatory variables (when explanatory variables respond jointly to similar underlying forces: e.g. when income and prices tend to move together over time);
- *problems of aggregation*: use of data aggregates may give undue weight to goods with relatively low elasticities. Although the current analysis uses relatively disaggregated data in terms of tariff lines, the variables are aggregated over countries (the EU and RoW);
- *errors in measurement* (see, for example, Orcutt 1950, 123);
- as a consequence, the estimated price elasticities might be substantially less than unity so that the *Marshall-Lerner condition* might not be met (Stern and Zupnick 1962, 23).

Elasticities of substitution. Elasticities of substitution measure the curvature of the indifference curve, i.e. how easy it is to substitute one variety of good g for another one (Stern and Zupnick 1962, 42). The cointegrating regression for the elasticities of substitution applied in the further analysis has the following form:

$$\ln\left(\frac{m_{g,EU}}{m_{g,RoW}}\right)_t = \mu + \delta \ln\left(\frac{p_{g,EU}}{p_{g,RoW}}\right)_t + \psi_t \quad (16)$$

where $\ln\left(\frac{m_{g,EU}}{m_{g,RoW}}\right)_t$ and $\ln\left(\frac{p_{g,EU}}{p_{g,RoW}}\right)_t$ are natural logarithms of the ratios of imports of good g from the EU to the imports of good g from the rest of the world, and of the price of good g imported from the EU to the price of good g imported from the rest of the world in period t, respectively, ψ_t is the error term.

As in the case of import demand elasticities, elasticities of substitution are assumed to be constant: a 1% change in price ratio is expected to induce the same percentage change in the ratio of the good g imported from different destinations – for any price levels or levels of consumption. Hence, the same considerations as those stated for the import demand elasticities should apply.

Since the goods dealt with are imperfect substitutes, δ is expected to have a high absolute value:

$$H_5: \delta \geq -1, H_{5A}: \delta < -1 \quad (17)$$

In order to fit the analytical model presented in previous subchapter, the above specification imposes some strong assumptions upon the data:

- the algebraic sum of own- and cross price elasticities for the two varieties of good g must be equal (*absence of money illusion* (Stern and Zupnick 1962, 47));
- the *income elasticities for the two varieties must be equal* (since, according to the Armington assumption, the two varieties of good g are alike in all economic respects except that they are not perfect substitutes (Stern and Zupnick 1962, 60- 62)).

The estimation of elasticities of substitution faces problems similar to those listed for the price import demand elasticities. However, the elasticity of substitution relation on the demand side should be more stable than the corresponding demand relation due to the canceling out of the disturbances in the respective demand functions (Stern and Zupnick 1962, 64).

The use of the ARDL specification to analyze the relationships in equations (11) and (16) enables to measure the influences of past changes in the independent (and dependent) variables on the current behavior of imports. The effect of lags is essential in the current setting due to the short time-period units utilized in the analysis (in case of the monthly data the current imports are more likely to be influenced more by the prices in the preceding periods than in the current month for such reasons as lags between orders and shipments, speed of adjustment of imports to the change in prices, etc. (Stern and Zupnick 1962, 15). Such specification, however, causes a new set of potential problems, among which are the scarcity of observations, multicollinearity among the various lagged explanatory variables, and, as a result, large standard errors on the coefficients. However, if the question of interest is the long-run response and not the distribution of the response over time, then the large standard errors on individual coefficients are not that important. The results are then expected to be most meaningfully reported in terms of long-run coefficients and the coefficient of adjustment (Stern and Zupnick 1962, 15).

Assuming that in the short-run the habits are persistent, the demand schedule is expected to be completely inelastic with respect to changes in prices, that is the short-run price elasticities should not be significantly different from zero:

$$H_{60}: {\varepsilon_{g,EU}}^{SR} \neq {\varepsilon_{g,\neq EU}}^{SR} \neq 0;\ H_{6A}:\ {\varepsilon_{g,EU}}^{SR} = {\varepsilon_{g,\neq EU}}^{SR} = 0 \tag{18}$$

In the following chapter, the assumptions derived here will be tested upon the estimation of the ARDL models.

CHAPTER 4. METHODOLOGY

4.1. Specification of the ARDL Model for Estimating Price Elasticities and Elasticities of Substitution for Pork and Poultry Imports

General econometric specification of the import demand for the estimated period is described by Equation (11) which is repeated below:

$$\ln(m_{g,EU\ t}) = \beta_0 + \beta_1 \ln(p_{g,EU\ t}) + \beta_2 \ln(p_{g,RoW\ t}) + \beta_3 \ln(GDP_{UA\ t}) + \epsilon_t$$

where g = (*pork, poultry*), $m_{g,EU\ t}$ is imports of g from the EU in month *t*, $p_{g,EU\ t}$ is the price of g imported from the EU in month *t*, $p_{g,RoW\ t}$ is the price of g imported from the rest of the world in month *t*, $GDP_{UA\ t}$ is Ukraine's GDP in month *t* and ϵ_t is white-noise term.

To simplify the notation, the above equation is rewritten using $\ln(m_{g,EU\ t}) = m_t$, $\ln(p_{g,EU\ t}) = p_{1,t}$, $\ln(p_{g,RoW\ t}) = p_{2,t}$, $\ln(GDP_{UA\ t}) = y_t$:

$$m_t = \beta_0 + \beta_1 p_{1,t} + \beta_2 p_{2,t} + \beta_3 y_t + \epsilon_t \qquad (19)$$

The medium-term elasticities of substitution are estimated from the relationship (16) specified in Subchapter 3.4.:

$$\ln\left(\frac{m_{g,EU}}{m_{g,RoW}}\right)_t = \mu + \delta \ln\left(\frac{p_{g,EU}}{p_{g,RoW}}\right)_t + \psi_t,$$

As earlier, the equation is simplified as follows: $\ln\left(\frac{m_{g,EU}}{m_{g,RoW}}\right)_t = M_t$ $\ln\left(\frac{p_{g,EU}}{p_{g,RoW}}\right)_t = P_t$, yielding:

$$M_t = \mu + \delta P_t + \psi_t \qquad (20)$$

After testing for Granger causality and making sure that no variables are I(2), an unrestricted error correction model[4] can be specified for both models.

For price elasticities:

$$\Delta m_t = c + \phi_1 m_{t-1} + \phi_2 p_{1,t-1} + \phi_3 p_{2,t-1} + \phi_4 y_{t-1}$$
$$+ \sum_{i=1}^{k} \varphi_{1,i} \Delta m_{t-i} + \sum_{i=0}^{l} \varphi_{2,i} \Delta p_{1,t-i} + \sum_{i=0}^{m} \varphi_{3,i} \Delta p_{2,t-i} + \sum_{i=0}^{n} \varphi_{4,i} \Delta y_{t-i} + u_t \qquad (21)$$

For elasticities of substitution:

$$\Delta M_t = s + \theta_1 M_{t-1} + \theta_2 P_{t-1} + \sum_{i=1}^{q} \vartheta_{1,i} \Delta M_{t-i} + \sum_{i=0}^{z} \vartheta_{2,i} \Delta P_{t-i} + \varsigma_t \qquad (22)$$

[4] here, in contrast to the traditional restricted ECM, the lagged residuals, for example, for the imports demand equation, $z_{t-1} = m_{t-1} - \hat{\beta}_0 - \hat{\beta}_1 p_{1,t-1} - \hat{\beta}_2 p_{2,t-1} - \hat{\beta}_3 y_{t-1}$ obtained from estimating equation (19) are replaced with the same lagged levels of the variables, but their coefficients are then not restricted.

where ϕ and θ are long-run multipliers, c and s are drift terms, φ and ϑ are short-run coefficients, and u_t and ς_t are white noise error terms.

The maximum lag lengths k, l, m, n and q, z for the differenced variables are chosen predominantly using Schwarz information criterion (SC), since it is a consistent model-selector and chooses a more parsimonious model, which is reasonable given the small sample size at hand. Attention should also be paid to the significance of the coefficients in the model (to avoid "over-selection" of the maximum lags), at the same time, the residuals should be checked for the absence of serial correlation (in case of which additional lags should be introduced into the model). Since the model has an autoregressive structure, it should be tested if it is dynamically stable, i.e., if all the inverse roots of the characteristic equation of the model lie within the unit circle.

After the unrestricted ECM model is estimated, it is tested whether the long-run multipliers ϕ and θ are all equal to zero (which means the absence of a long-run equilibrium relationship between the variables), against the alternative hypothesis that at least one long-run multiplier is not equal to zero (bounds testing). The following F-tests are therefore carried out:

$$H_{01}: \phi_1 = \phi_2 = \phi_3 = \phi_4 = 0;$$
$$H_{A1}: \phi_1 \neq 0, \text{ or } \phi_2 \neq 0, \text{ or } \phi_3 \neq 0, \text{ or } \phi_4 \neq 0 \quad (23)$$
$$H_{02}: \theta_1 = \theta_2 = 0;$$
$$H_{A2}: \vartheta_1 \neq 0 \text{ or } \vartheta_2 \neq 0 \quad (24)$$

The distribution of the test statistic is non-standard and depends on the order of integration of the variables included in the ARDL (I(0) or I(1)), the number of regressors, presence of an intercept and/ or a trend, as well as on the sample size (Narayan 2005, 1981). Pesaran et al. (2001) provided the bounds on the critical values for the asymptotic distribution of the F-statistic, where the lower bound is based on the assumption that all variables are I(0) and the upper bound – that all of them are I(1). Therefore, if the F-statistic falls bellows the lower bound, the Ho of no cointegration cannot be rejected, and when it exceeds the respective upper bound, the Ho of no cointegration can be rejected, irrespective of the number of unit roots in the single variables (Bernstein and Madlener 2011, 7). In cases when the F-statistic falls within the bounds range the test is inconclusive. However, according to Narayan (2005), the critical values provided by Pesaran et al. (2001) should not be applied to small samples, since they are based on large samples (500 and 1000 observations and 20000 and 40000 replications respectively). Since the series under consideration include 72 observations, it might be reasonable to use the critical values for the F-test provided by Narayan (2005), calculated for small samples (from 30 to 80 observations).

If the results of the bounds testing confirm the existence of a cointegration relationship, the medium-term elasticities can be calculated from the ARDLs in levels.

For price elasticities:

$$m_t = \alpha_c + \sum_{i=1}^{k} \alpha_{1,i}\, m_{t-i} + \sum_{i=0}^{l} \alpha_{2,i}\, p_{1,t-i} + \sum_{i=0}^{m} \alpha_{3,i}\, p_{2,t-i} + \sum_{i=0}^{n} \alpha_{4,i}\, y_{t-i} + w_t \quad (25)$$

For elasticities of substitution:

$$M_t = \gamma_\mu + \sum_{i=1}^{q} \gamma_{1,i}\, M_{t-i} + \sum_{i=0}^{z} \gamma_{2,i}\, P_{t-i} + \varpi_t \quad (26)$$

where w_t and ϖ_t are error terms. As long as it can be assumed that error terms are white noise processes (are stationary independent of the series of independent and dependent variables), the ARDL models can be estimated consistently by OLS (Nkoro and Uko 2016, 77).

From the above equations, the long-run coefficients can be computed as follows:

For (19):

$$\beta_0 = \frac{\alpha_c}{(1-\sum_{i=1}^{k} \alpha_{1,i})} \quad (27a)$$

$$\beta_1 = \frac{\sum_{i=0}^{l} \alpha_{2,i}}{(1-\sum_{i=1}^{k} \alpha_{1,i})} \quad (27b)$$

$$\beta_2 = \frac{\sum_{i=0}^{m} \alpha_{3,i}}{(1-\sum_{i=1}^{k} \alpha_{1,i})} \quad (27c)$$

$$\beta_3 = \frac{\sum_{i=0}^{n} \alpha_{4,i}}{(1-\sum_{i=1}^{k} \alpha_{1,i})} \quad (27d)$$

For (20):

$$\mu = \frac{\gamma_\mu}{(1-\sum_{i=1}^{q} \gamma_{1,i})} \quad (28a)$$

$$\delta = \frac{\sum_{i=0}^{z} \gamma_{2,i}}{(1-\sum_{i=1}^{q} \gamma_{1,i})} \quad (28b)$$

where β_0 and μ are constant terms and β_1, β_2 and β_3 are the long-run coefficients representing the medium-term price, cross-price and income elasticities of demand, respectively, whereas δ characterizes the elasticity of substitution.

The short-run coefficients $\zeta_{j,i}$ (with j = {1,2,3,4}) and $\xi_{h,i}$ (with h={1,2}) are then estimated from the restricted error-correction models:

For (21):

$$\Delta m_t = \zeta_c + \zeta_z z_{t-1} + \sum_{i=1}^{k} \zeta_{1,i} \Delta\, m_{t-i} + \sum_{i=0}^{l} \zeta_{2,i} \Delta\, p_{1,t-i} + \sum_{i=0}^{m} \zeta_{3,i} \Delta\, p_{2,t-i} + \sum_{i=0}^{n} \zeta_{4,i} \Delta\, y_{t-i} + v_t \quad (29)$$

For (22):

$$\Delta M_t = \xi_\mu + \xi_x x_{t-1} + \sum_{i=1}^{q} \xi_{1,i} \Delta\, M_{t-i} + \sum_{i=0}^{z} \xi_{2,i} \Delta\, P_{t-i} + \iota_t \quad (30)$$

where z_{t-1} and x_{t-1} are the lagged error correction terms from estimated long-run equilibrium relationships (19) and (20):

$$z_{t-1} = m_{t-1} - \hat{\beta}_0 - \hat{\beta}_1 p_{1,t-1} - \hat{\beta}_2 p_{2,t-1} - \hat{\beta}_3 y_{t-1}. \quad (31)$$

$$x_{t-1} = M_{t-1} - \hat{\mu} - \hat{\delta} P_t \quad (32)$$

θ_z and ξ_x then characterize the speed of adjustment to their respective long-run equilibria following a shock in demand, and are expected to be negative and significant for the variables to cointegrate.

4.2. Data Description

For the estimation of price import elasticities and elasticities of substitution the monthly data over the period from 2010 to 2015 are used (which covers the years following Ukraine's accession to the WTO and preceding the enactment of the DCFTA). The elasticities are estimated separately for pork and poultry. For the estimation of price elasticities of import demand, the series of import volumes (in kilograms), prices of meat imported from the EU and the RoW (in UAH per kilogram), and Ukraine's GDP (in UAH) are analyzed. Since the initial price series were expressed in USD, they were recalculated in UAH and adjusted by the food CPI, so as to align with the GDP data expressed in UAH. The monthly GDP series was in turn constructed from the quarterly GDP series and the monthly industrial production index (which normally tends to move together with the GDP series). The data on the series were taken from the website of the State Statistics Service of Ukraine[5] and exclude the information on the temporarily occupied territories. The exchange rates for USD/UAH were taken from the official website of the National Bank of Ukraine[6]. For the estimation of elasticities of substitution, the series of imports and price ratios (EU to RoW) were calculated. The series in Figures 4 and 5 are presented in logarithms and therefore represent the data directly used in the further analysis.

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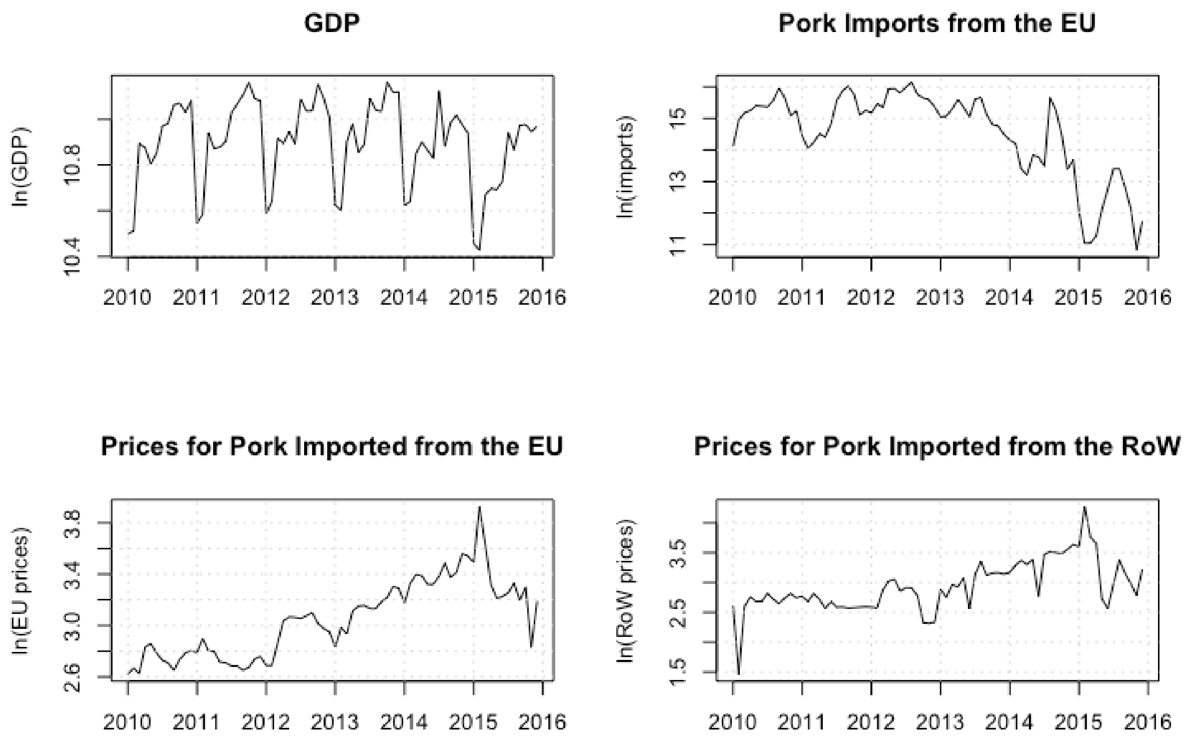
[5] http://ukrstat.gov.ua/, access: 10 July 2017.

[6] https://bank.gov.ua/control/uk/curmetal/detail/currency?period=daily, access: 10 July 2017.

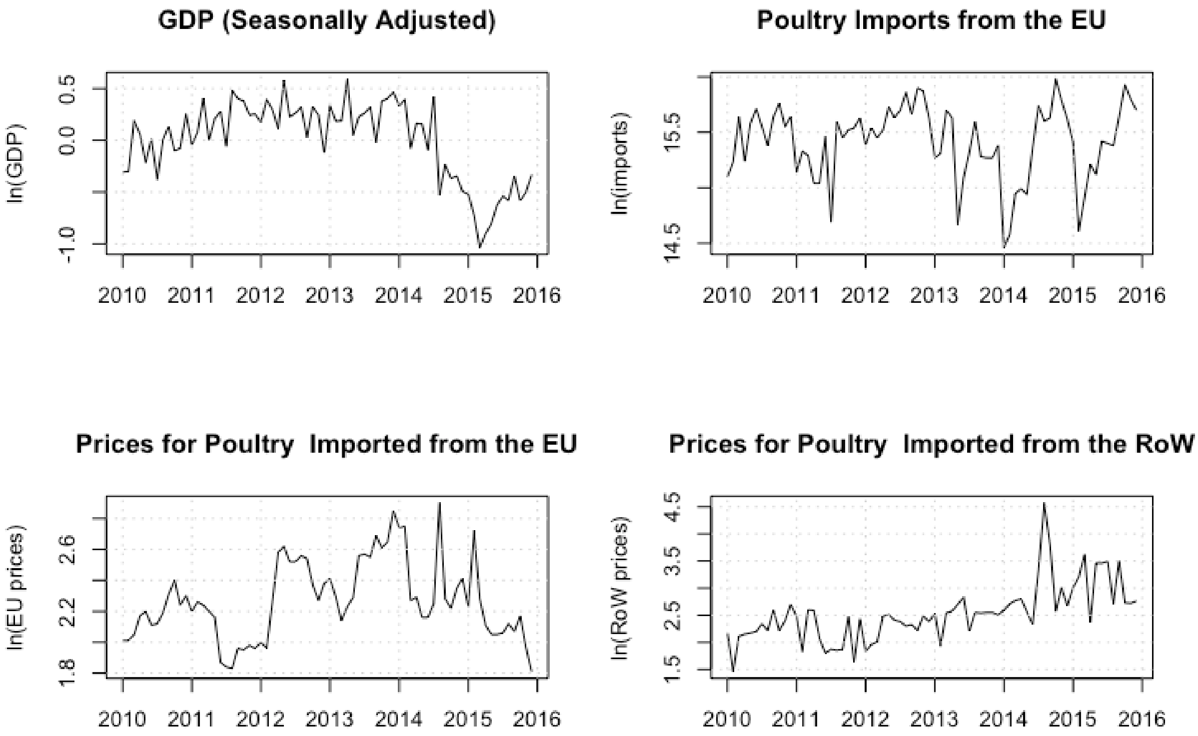
Figure 4: Monthly Series of the Dependent and Explanatory Variables for the Estimation of Pork Imports Price Elasticities over 2010-2015 (in Natural Logarithms)



Source of the data: http://ukrstat.gov.ua/, access: 10 July 2017.

While the pork imports do not seem to contain a trend and appear to follow a random walk (or perhaps follow a downward trend, which is not clear due to a seemingly increased variation in the last two years), the GDP series is clearly affected by seasonality and the EU pork prices data seem to follow an upward trend (or perhaps a RW with a drift process). At the same time, it is hard to make any inferences about the behavior of the world prices. Upon their visual inspection, one may suspect the presence of a positive trend.

Figure 5: Monthly Series of the Dependent and Explanatory Variables for the Estimation of Poultry Imports Price Elasticities over 2010-2015
(with Seasonally Adjusted GDP, in Natural Logarithms)

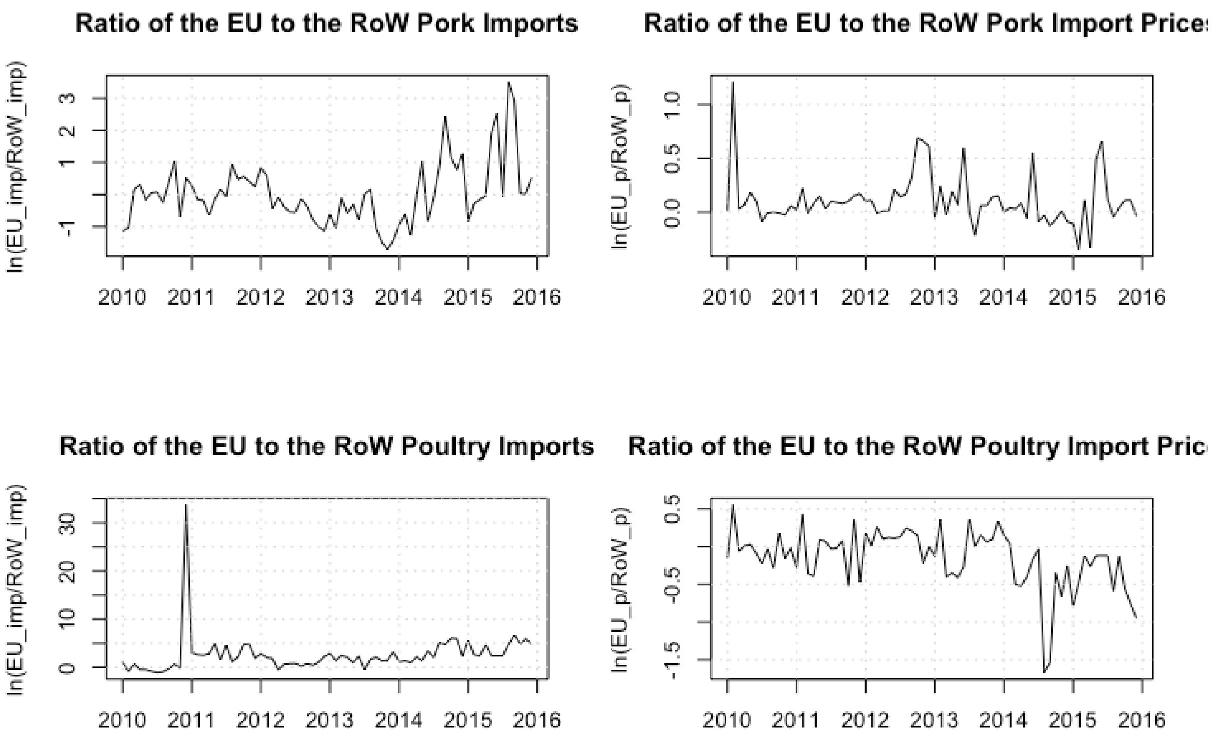


Source of the data: http://ukrstat.gov.ua/, access: 10 July 2017.

The visual inspection of the seasonally-filtered GDP series (using X-12 procedure) allows to suspect the random walk process in the data, although there is a greater variation in the series in the last two years of observation. At the same time, the series of poultry imports and the EU import prices also seem to follow a random walk process, whereas the RoW imports prices series appears to contain an upward trend.

As for the data used to estimate the elasticities of substitution, Figure 6 illustrates that in the first four years of observation, the EU/RoW pork imports ratio appears to follow a random-walk process, whereas in the last two years, the relative share of the EU imports jumps up sharply in some periods. The EU/RoW pork import price ratio over the period under investigation seems to be a random walk process. But for the spike in December 2010, the ratio of the EU/RoW poultry imports also appears to follow a random walk process. At the same time, the EU/RoW poultry price ratio seems to be slightly trending down over the period under investigation.

Figure 6: Monthly Series of Pork and Poultry Imports and Price Ratios over 2010-2015 used for the Estimation of Elasticities of Substitution (in Natural Logarithms)



Source of the data: http://ukrstat.gov.ua/, access: 10 July 2017.

Upon the visual inspection, the estimated series are now subject to the formal testing for the presence of a unit root. The results are summarized in the following chapter.

4.3. Unit Root Testing

Although the ARDL bounds testing approach to integration has an advantage that both I(0) and I(1) can enter the equation for testing the significance of a long-run relationship, the approach is not valid for I(2) variables. To make sure that the data at hand can be fitted in the ARDL model, all the series are first tested for the presence of a unit root and the order of integration. For this purpose, the ADF (lag lengths for the test are based on SC) and KPSS tests are applied to the series. The unit root tests are however carried out, bearing in mind that their power is quite low due to relatively short lengths of the series under consideration.

For each of the series, the ADF test equations were first estimated to include both a constant and a trend, in cases where the null hypothesis of unit root couldn't be rejected and at the same time it couldn't be rejected that the trend coefficient is equal to zero, the test was repeated for an equation without a trend term. If the test still failed to reject the unit root, it was repeated for the differences of the respective series. The conclusions on the order of integration of the examined series are summarized in Table 1. The particular results of the tests are presented in Appendix E.

Table 1: Results of ADF and KPSS Tests

Variable	Order of integration according to the ADF test[7]	Order of integration according to the KPSS test[8]
GDP (seasonally adjusted)	I(1)	I(1)
Pork imports	I(1)	I(1)
Pork prices (for the EU imports)	I(1)	I(0)
Pork prices (for imports from the rest of the world)	I(0)	I(0)
Poultry Imports	I(0)	I(0)
Poultry prices (for the EU imports)	I(1)	I(0)
Poultry prices (for imports from the rest of the world)	I(0)	I(1)
Imports ratio for pork	I(0)	I(0)
Price ratio for pork	I(0)	I(0)
Imports ratio for poultry	I(1)	I(0)
Price ratio for poultry	I(0)	I(1)

Source: summary of the test results presented in Appendix E.

It should be noted, that due to the detected seasonality in the GDP series, the seasonally adjusted series were used for the further analysis. The test results are inconclusive for the EU pork and poultry prices, RoW poultry prices, as well as imports and price ratios for poultry, with the unit root tests yielding contradictory results regarding the order of integration of the respective series. At the same time, as Table 1 suggests, none one the series seems to have an order of integration greater than 1, which makes it possible to apply the ARDL model for the estimation of the medium-term elasticities.

4.4. Causality Testing

Before the bounds testing is carried out, the data are tested for the direction of relationships by means of the multivariate Block Exogeneity Wald Test (for the estimation of price elasticities) and the Granger Causality Test (for the estimation of elasticities of substitution). Since the unit root tests in the previous subchapter indicated that the seasonally adjusted GDP and pork import series appear to be I(1), the differences of the respective

[7] Ho of unit root is rejected at 5% significance level
[8] Ho of stationarity is rejected at 5% significance level

variables were taken for the estimation of the VARs for the causality testing. In the cases where the unit root tests were inconclusive (EU imports prices for pork and poultry, RoW imports prices for poultry, imports and price ratios for poultry), the VARs were repeatedly estimated to include whether levels or differences of the respective series. Upon the comparison of their goodness of fit and the results of residuals testing, the final models were selected for the causality testing. The lag lengths were chosen based on the AIC and SC rather on LR, since, due to the existing limits on the number of observations, a more parsimonious model is preferred. The model was further checked not to include unit roots. In cases where a problem of autocorrelation in residuals occurred, additional lags were included. Finally, the residuals were also tested for normality and heteroscedasticity. The results of the Granger causality testing are summarized in the Tables 2 and 3:

Table 2: Block Exogeneity Wald Tests for the Estimation of Price Elasticities of Pork and Poultry Imports

Pork				**Poultry**			
Dependent var.:	***D(Imports)***			Dependent var.:	***Imports***		
Excluded	**Chi-sq**	**df**	**Prob.**	**Excluded**	**Chi-sq**	**df**	**Prob.**
EU Price	0.20	2	0.91	EU Price	1.74	2	0.42
RoW Price	3.94	2	0.14	RoW Price	1.69	2	0.43
D(GDP)	3.93	2	0.14	D(GDP)	3.27	2	0.20
All	13.9	6	0.03	*All*	6.83	6	0.34
Dependent var.:	***EU Price***			Dependent var.:	***EU Price***		
Excluded	**Chi-sq**	**df**	**Prob.**	**Excluded**	**Chi-sq**	**df**	**Prob.**
D(Imports)	7.10	2	0.03	Imports	0.36	2	0.62
RoW Price	7.14	2	0.03	RoW Price	3.53	2	0.17
D(GDP)	1.50	2	0.47	D(GDP)	3.31	2	0.19
All	17.58	6	0.01	*All*	9.07	6	0.16
Dependent var.:	***RoW Price***			Dependent var.:	***RoW Price***		
Excluded	**Chi-sq**	**df**	**Prob.**	**Excluded**	**Chi-sq**	**df**	**Prob.**
D(Imports)	0.81	2	0.67	Imports	1.12	2	0.57
EU Price	7.58	2	0.02	EU Price	2.04	2	0.36
D(GDP)	1.33	2	0.51	D(GDP)	0.86	2	0.65
All	11.00	6	0.09	*All*	4.59	6	0.60

Table 2 (cont.)

Dependent var.:	*D(GDP)*			Dependent var.:	*D(GDP)*		
Excluded	**Chi-sq**	**df**	**Prob.**	**Excluded**	**Chi-sq**	**df**	**Prob.**
D(Imports)	0.44	2	0.80	Imports	0.58	2	0.75
EU Price	0.75	2	0.68	EU Price	2.70	2	0.26
RoW Price	2.01	2	0.36	RoW Price	6.78	2	0.03
All	8.96	6	0.18	*All*	11.07	6	0.09

Source: own estimations based on the data from http://ukrstat.gov.ua/, access: 10 July 2017.

According to the obtained results, the differenced pork imports series appears to be jointly Granger-caused by the EU and RoW pork prices and differences of the GDP at 5% significance level. At the same time, the null hypothesis of no Granger causality from any of these explanatory variables on their own to the differenced pork imports cannot be rejected. The results also suggest that the EU import prices are caused jointly by the other three variables, at 5% significance level, and that there is a joint causality from the differenced pork imports, EU prices and differenced GDP to the RoW pork prices, at 10% significance level. In addition, the test implies the existence of a unidirectional Granger causality from differenced imports to the EU prices and a bidirectional causality between the EU and the RoW prices.

In the case of poultry, neither of the other variables seems to Granger-cause the imports of poultry from the EU (neither separately nor jointly, which contradicts the theoretical assumptions), at 10% significance level, whereas the differenced GDP is shown to be Granger-caused by the RoW prices for poultry (at 5% significance level) and by the poultry imports, EU prices and RoW prices jointly (at 10% significance level).

Table 3: Granger Causality Test for the Estimation of Elasticities of Substitution for Pork and Poultry

	Pork			**Poultry**		
Dependent variable:	***Imports ratio***					
Excluded	**Chi-sq**	**df**	**Prob.**	**Chi-sq**	**df**	**Prob.**
Price ratio	3.39	2	0.18	13.39	2	0.00
Dependent variable:	***Price ratio***					
Excluded	**Chi-sq**	**df**	**Prob.**	**Chi-sq**	**df**	**Prob.**
Imports ratio	2.42	2	0.30	2.73	2	0.26

Source: own estimations based on the data from http://ukrstat.gov.ua/, access: 10 July 2017.

In the case of the series of imports and price ratios, the Granger causality test for pork shows no existence of Granger causality in any of the directions. At the same time, the test for poultry implies that the imports ratio is Granger-caused by the price ratio, which corresponds with the earlier assumptions.

It should be noted, however, that the results of the above tests should be taken with great caution, since their power is quite low due to the small sample sizes and the need to difference some series for the VAR estimation preceding the tests (whereas the ARDL model enables the direct estimation of both I(0) and I(1) variables in the same regression), as well as due to the lack of a unified "proper" procedure for the lag selection for VAR estimation. The tests, therefore, may not correctly reflect the true relationships between the series. Hence, although the above results partially contradict the assumptions of the considered theoretical model, they appear not to be strong enough to preclude the further analysis.

4.5. Bounds Testing

Now one can finally proceed to the bounds testing itself. To this end, unrestricted ECMs have been estimated in accordance with the procedure outlined in Subchapter 4.1. The lag lengths for the ECMs were first selected according to the SC. In cases where the Breusch-Godfrey Serial Correlation LM test rejected the Ho of no serial correlation, additional lags were included to ensure serially independent errors. Afterwards, the stability of the selected models was checked by testing if the inverse roots of the associated characteristic equations lie within the unit circle. The results of the bounds testing for the unrestricted ECMs are presented in the table below. The table also contains the critical values for small samples provided by Narayan (2005).

Table 4: Bounds Testing Results (Ho: No Long-Run Relationship Exists)

<table>
<tr><th rowspan="3">Significance level</th><th rowspan="3">Calcul. t-stat.</th><th rowspan="3">Calcul. f-stat.</th><th colspan="4">Critical values according to Pesaran et al. (2001)</th><th colspan="2">Critical values according to Narayan (2005)</th></tr>
<tr><th colspan="2">t-statistic[9]</th><th colspan="2">f-statistic</th><th colspan="2">f-statistic</th></tr>
<tr><th>I(0) Bond</th><th>I(1) Bond</th><th>I(0) Bond</th><th>I(1) Bond</th><th>I(0) Bond</th><th>I(1) Bond</th></tr>
<tr><td colspan="9">Unrestricted ECM for the estimation of pork import demand price elasticities:
$\Delta m_t = 1.79 + 0.2\Delta m_{t-1} - 0.25\Delta p_{2,t} + 0.54\Delta p_{2,t-1} - 0.31 m_{t-1} + 0.07 p_{1,t-1} - 0.84 p_{2,t-1} + 0.47 gdp_{t-1}$
p-value: [0.65] [0.12] [0.34] [0.04] [0.00] [0.90] [0.04] [0.25]</td></tr>
<tr><td>1%</td><td rowspan="3">-3.69*</td><td rowspan="3">4.39**
(**)[10]</td><td>-3.43</td><td>-4.37</td><td>4.29</td><td>5.61</td><td>3.92</td><td>5.09</td></tr>
<tr><td>5%</td><td>-2.68</td><td>-3.78</td><td>3.23</td><td>4.35</td><td>2.92</td><td>3.86</td></tr>
<tr><td>10%</td><td>-2.57</td><td>-3.46</td><td>2.72</td><td>3.77</td><td>2.48</td><td>3.31</td></tr>
</table>

[9] Pesaran et al. (2001, 303-304).

[10] According to critical bounds for small samples provided by Narayan (2005).

Table 4 (cont.)

Significance level	Calcul. t-stat.	Calcul. f-stat.	Critical values according to Pesaran et al. (2001)				Critical values according to Narayan (2005)	
			t-statistic[11]		f-statistic		f-statistic	
			I(0) Bond	I(1) Bond	I(0) Bond	I(1) Bond	I(0) Bond	I(1) Bond
Unrestricted ECM for the estimation of poultry import demand price elasticities: $\Delta m_t = 6.82 - 0.51m_{t-1} - 0.16p_{1,t-1} + 0.01p_{2,t-1} + 0.13gdp_{t-1}$ p-value: [0.00] [0.00] [0.28] [0.87] [0.56]								
1%	-4.19**	5.38** (***)	-3.43	-4.37	4.29	5.61	3.92	5.09
5%			-2.68	-3.78	3.23	4.35	2.92	3.86
10%			-2.57	-3.46	2.72	3.77	2.48	3.31
Unrestricted ECM for the estimation of elasticities of substitution of pork imports: $\Delta M_t = -0.01 - 0.3M_{t-1} + 0.37P_{t-1}$ p-value: [0.90] [0.00] [0.35]								
1%	-2.96*	6.33** (**)	-3.43	-3.82	6.84	7.84	7.17	8.41
5%			-2.68	-3.22	4.94	5.73	5.06	5.92
10%			-2.57	-2.91	4.04	4.78	4.13	4.89
Unrestricted ECM for the estimation of elasticities of substitution of poultry imports: $\Delta M_t = -0.72 - 1.11\,\Delta P_t - 0.51M_{t-1} - 1.75P_{t-1}$ [0.01] [0.05] [0.00] [0.01]								
1%	-4.56***	10.53*** (***)	-3.43	-3.82	6.84	7.84	7.17	8.41
5%			-2.68	-3.22	4.94	5.73	5.06	5.92
10%			-2.57	-2.91	4.04	4.78	4.13	4.89

Source: own estimations based on the data from http://ukrstat.gov.ua/, access: 10 July 2017.

According to the results presented above, the null hypothesis of no cointegration is rejected for all the test equations at least at 5% significance level, for the calculated f-statistic exceeds the respective critical bound. Moreover, the no cointegration hypothesis is rejected at 1% level for the ECM selected for the estimation of the poultry import demand price elasticities according to the critical bounds for small samples presented by Narayan (2005), and for the ECM testing the long-run relationship for the elasticities of substitution for poultry, according to both Pesaran et al. (2001) and Narayan (2005) critical values. The conclusion about the existence of a long-run relationship between the variables is supported by the t-statistic for m_{t-1} in the first two equations at 10% and 5% significance levels accordingly, and by the t-statistic for M_{t-1} in the latter two equations at 10% and 1% significance levels respectively.

Hence, it can be concluded that there exists a long-run relationship between the variables under consideration, and one can proceed with the selection of optimal ARDL models to estimate the medium-term import demand price elasticities and elasticities of substitution required for the evaluation of the trade effects under the SMART model.

[11] Pesaran et al. 2001, 303-304.

4.6. Estimation of Medium-Term and Short-Run Elasticities under the ARDL Model

The medium-term elasticities of import demand for pork and meat and the respective medium-term elasticities of substitution are derived using formulas (27a) – (28b) from the coefficients of the optimal ARDL models selected according to SC. The results are summarized in the tables below[12].

Table 5: Medium-Term Import Elasticities for Product-Specific ARDLs

Pork ARDL(2,0,2,0) p-value	$m_t = -5.38 + 0.82m_{t-1} - 0.21m_{t-2} - 0.16p_{1,t} - 0.16\, p_{2,t} + 0.1\, p_{2,t-1} - 0.67p_{2,t-2} + 1.26gdp_t + \hat{e}_t$[13] [0.15] [0.00] [0.07] [0.71] [0.56] [0.69] [0.00] [0.00]		
Long-run coefficients on:	p_1 (β_1 in Eq. (19))	p_2 (β_2 in Eq. (19)))	*gdp* (β_3 in Eq. (19))
p-value:	-0.41 [0.71]	-1.87** [0.04]	3.22*** [0.00]
Poultry ARDL(1,0,0,0) p-value	$m_t = 1.22 + 0.44m_{t-1} - 0.24p_{1,t} + 0.02\, p_{2,t} + 0.73gdp_t + \hat{e}_t$ [0.55] [0.00] [0.05] [0.78] [0.00]		
Long-run coefficients on:	p_1 (β_1 in Eq. (19)))	p_2 (β_2 in Eq. (19))	*gdp* (β_3 in Eq. (19)))
p-value:	-0.44* [0.06]	0.03 [0.78]	1.30*** [0.00]

Source: own estimations based on the data from http://ukrstat.gov.ua/, access: 10 July 2017.

Now the hypotheses derived in Subchapter 3.4. can be tested. First, it can be checked whether there are income effects on import demand for a particular variety of good *g*, and if so, whether these have a positive influence on the import demand:

$$H_1: \beta_3 = 0,\ H_{1A}: \beta_3 \neq 0;$$

$$H_4: \beta_3 \leq 0,\ H_{4A}: \beta_3 > 0.$$

According to Table 5, the medium-term coefficient on *gdp* both for pork and poultry imports from the EU is significant at 1% level and greater than 1. Therefore, one can reject H_1 and H_4 and conclude that increase in income positively affects imports of pork and poultry from the EU.

Further, the assumptions on medium-term own- and cross-price elasticities of demand can be tested:

$$H_2: \beta_1 \geq 0,\ H_{2A}: \beta_1 < 0;$$

$$H_3: \beta_2 \leq 0,\ H_{3A}: \beta_2 > 0.$$

It has been assumed that own-price elasticity of import demand for a good imported from the EU should be negative reflecting the fact that a price increase of the respective good should negatively influence its imports. Thus, H_2 should be rejected. According to Table 5, the own-price coefficient for pork imported from the EU is negative, which is in accord with the

[12] See outputs for the respective regression equations in Annex F

[13] Where $\hat{e}_t$ is the equilibrium correction term.

theoretical assumptions, but is insignificant. At the same time, the corresponding coefficient for poultry is also negative and significant at 10% level. Both own-price elasticities for the EU pork and poultry imports are estimated to be less than unity in absolute value, which means that the import demand for the examined products is inelastic.

The cross-price elasticity of import demand for the EU meat products is expected to be positive, meaning that a price rise for meat imported from countries outside the EU should result in reduction of meat consumption from that countries and its redirection to the EU sources of imports. Therefore, H_3 should be rejected. This is not the case for the EU imports of pork, where the estimate of the cross-price elasticity is less than -1 and is significant at 5% level, which is a counterintuitive result. The cross-price elasticity of the EU import demand for poultry is estimated to be positive, but close to zero (0.03) and insignificant.

Table 6: Medium-Term Elasticities of Substitution for Product-Specific ARDLs

Pork ARDL(1,0) p-value	$M_t = 0.08 + 0.65M_{t-1} - 0.43P_t + \hat{e}_t$ [0.43] [0.00] [0.23]	LR coefficient of substitution (δ): -1.25 [0.25]
Poultry ARDL(1,1) p-value	$M_t = 0.72 + 0.5M_{t-1} - 1.11P_t - 0.64\,P_{t-1} + \hat{e}_t$ [0.01] [0.00] [0.05] [0.24]	LR coefficient of substitution (δ): -3.46 [0.00]

Source: own estimations based on the data from http://ukrstat.gov.ua/, access: 10 July 2017.

As for the elasticities of substitution, it is expected that they are greater in absolute value than unity and have a negative sign:

$$H_5: \delta \geq -1,\ H_{5A}: \delta < -1$$

For both pork and poultry, the estimated coefficients have the expected signs and values of the coefficients, but only in the case of poultry is the coefficient of substitution significant (at 1% level).

To check the assumptions on the short-run elasticities made in Subchapter 3.4, the latter have been estimated by the restricted ECM specifications of the above ARDLs and summarized in the tables below:

Table 7: Restricted ECM Specifications for the ARDL Models (for Price Elasticities Estimation)

Imported good	ECT_{t-1}	Δm_{t-1}	Δm_{t-2}	$\Delta p_{1,t}$	$\Delta p_{2,t}$	$\Delta p_{2,t-1}$	$\Delta p_{2,t-2}$	ΔGDP_t	***Constant***
Pork p-value	-1.00*** [0.00]	0.83*** [0.00]	-0.20 [0.13]	-0.42 [0.56]	-0.11 [0.67]	0.13 [0.56]	-0.64*** [0.00]	1.25*** [0.00]	0.00 [0.97]
Poultry p-value	-0.75*** [0.00]	0.16 [0.25]	-	-0.19 [0.26]	-0.04 [0.56]	-	-	0.95*** [0.00]	-0.00 [0.99]

Source: own estimations based on the data from http://ukrstat.gov.ua/, access: 10 July 2017.

Import demand is expected to be completely inelastic with respect to price changes in the short run, that is, the following hypothesis is expected to be rejected:

$$H_{60}: \varepsilon_{g,EU}{}^{SR} \neq \varepsilon_{g,\neq EU}{}^{SR} \neq 0;\ H_{6A}: \varepsilon_{g,EU}{}^{SR} = \varepsilon_{g,\neq EU}{}^{SR} = 0$$

In the case of import demand elasticities, in most cases the short-run price elasticities are estimated not to significantly differ from zero for both pork and poultry, except for the coefficient on the second lag of price difference for the pork imported outside the EU, which is negative and significant at 1% level, but is less than unity in absolute value. The above hypothesis may therefore be rejected and it can be concluded that there is no influence of price changes on imports in the short run (perhaps due to persistent habits, contractual obligations, shipment lags etc.).

Table 8: Restricted ECM Specifications for the ARDL Models (Elasticities of Substitution Estimation)

Imported good	***ECT_{t-1}***	***ΔM_{t-1}***	***ΔP_t***	***ΔP_{t-1}***	***Constant***
Pork p-value	-0.89** [0.01]	0.60* [0.06]	-1.28*** [0.00]	-	-0.06 [0.49]
Poultry p-value	-0.77*** [0.00]	-0.05 [0.80]	-0.31 [0.55]	-0.19 [0.70]	-0.00 [0.98]

Source: own estimations based on the data from http://ukrstat.gov.ua/, access: 10 July 2017.

The estimated short-run elasticities of substitution are insignificant for poultry for concurrent and lagged ratios, but the concurrent coefficient for pork is less than -1 and is significant at 1% level, which makes it impossible to reject the above hypothesis.

Tables 5-8 illustrated that the values of the respective medium-term and short-run coefficients are theoretically correct and significant only for the poultry imports (the estimated elasticity of substitution is significant at 1% level). Thus, the further calculations of the trade effects seem to be empirically justified only for the poultry imports. Although the estimated medium-term price elasticities and the elasticity of substitution for the imported pork turned out to be insignificant, since their values lie within the theoretically plausible ranges and due to the lack of better alternatives, the obtained values will still be taken for the evaluation of possible trade creation and trade diversion effects.

CHAPTER 5. RESULTS OF THE SMART MODEL

5.1. Calculation of the Tariff Equivalents

Another issue to be handled with before the SMART model can be applied to assess the effects of trade liberalization under the DCFTA for pork and poultry is the fact that no direct tariff reduction is foreseen for these products. Pork and poultry are the two out of the three goods to which Ukraine applies import tariff quotas under the DCFTA. The tariff rates before the implementation of the Agreement were at 10% and 12 % for pork and at 5%, 10%, 12% for poultry, depending on particular tariff lines imported. Under Annex I-A to the Agreement, Ukraine undertakes to annually import 20 ths. tones of pork and 10 ths. tones of poultry (plus 10 ths. tones of specified tariff lines of poultry products) from the EU under zero tariff. Base tariff rates (which are equal to the pre-FTA rates stated above) are levied on the exceeding quantities. The tariff quotas are distributed on a “first-come, first-served” basis. Therefore, to compute the tariff reduction term used in the SMART model, it is important to calculate the tariff equivalents of tariff quotas for each tariff line within the product group, which will depend on the volumes of trade.

Table 9: Tariff Equivalents Depending on the Volumes of Meat Imported, in % and ths. kg

Tariff equivalents	**Volumes of pork imports, by tariff lines (in ths. kg)**				**Volumes of poultry imports, by tariff lines (in ths. kg)**		
%	*203110000*	*203190000*	*203210000*	*203290000*	*207120000*	*207140000*	*207270000*
0	0-20	0-20	0-20	0-20	0-20	0-10	0-10
1	21-22	21-22	21-23	21-23	21-22	11	11-14
2	23-25	23-25	24-26	24-26	23-25	12-13	15-19
3	26-28	26-28	27-30	27-30	26-28	14-15	20-33
4	29-31	29-31	31-36	31-36	29-31	16-18	34-99
5	32-36	32-36	37-44	37-44	32-36	19-22	100+
6	37-43	37-43	45-57	45-57	37-43	23-28	
7	44-53	44-53	58-79	58-79	44-53	29-39	
8	54-68	54-68	80-133	80-133	54-68	40-66	
9	69-95	69-95	134-399	134-399	69-95	67-199	
10	96-159	96-159	400 +	400 +	96-159	200 +	
11	160-479	160-479			160-479		
12	480+	480+			480+		

Source: own calculations based on Annex I-A to the DCFTA Agreement and data from http://ukrstat.gov.ua/, access: 10 July 2017.

Based on the trade levels during the period under consideration, the pre-FTA average weighted import tariff rates were calculated at 10.7% and 9.3% for pork and poultry respectively. Since the import quotas are filled based on the “first-come, first-served” basis, the post-FTA tariff equivalents may range between 5% and 8% for pork and between 4% and 8% for poultry (assuming the average trade levels during the period under review), depending on which tariff lines within each product group are imported first. That is, the expected tariff reduction for pork will lie between 2.7% and 5%, and between 1.3% and 5.3% for poultry. These ranges will be used for the evaluation of the trade effects in the next subchapter.

5.2. Trade Creation and Trade Diversion Effects

Table 10 summarizes the trade effects resulting from the enactment of the Agreement on the DCFTA between the EU and Ukraine, which were calculated in accordance with the SMART procedure specified in Subchapters 3.2 and 3.3.

Table 10: Trade Effects of the DCFTA for the Pork and Poultry Imports from the EU (in ths. tones)

	Pork		Poultry	
Trade effects (in ths. kg)	Lower range	Higher range	Lower range	Higher range
Trade creation ($TC_{g,EU}$)	0.42	0.78	0.32	1.32
Trade diversion ($TD_{g,EU}$)	0.90	1.66	1.49	6.07
Total increase in imports from the EU ($TC_{g,EU} + TD_{g,EU}$)	1.32	2.44	1.81	7.39

Source: own calculations.

As pointed out in the previous subchapter, the expected tariff reduction can range between 2.7% and 5% for pork and 1.3% and 5.3 for poultry, depending on the specific tariff lines imported and the respective imports volumes. Therefore, the respective ranges for the trade effects of tariff reduction have been calculated. According to the obtained results, in the medium-term one can expect an annual increase of 1.32 to 2.44 ths. tones in pork imports and 1.81 to 7.39 ths. tones in poultry imports. This corresponds to a 3-6% and 3-12% increase compared to the average yearly pork and poultry imports over the examined period accordingly. For the both goods, the trade diversion prevails in the expected total imports increase constituting 0.9 to 1.66 ths. tones (a 2-4% imports increase) for pork and 1.49 to 6.07 ths. tones (a 2-10% imports increase) for poultry annually. This means that the major part of the import increase is expected to result from the diversion from more efficient producers outside the FTA to less efficient producers in the EU.

It should be noted, however, that the obtained results can be used only as reference value, due to the limitations of the SMART model itself (which is quite simplified and takes into account only the direct impact of price reduction on trade flows, leaving a number of factors and impediments to international trade out of the analysis), as well as due to the deficiencies of the data (relatively short sample period, volatile monthly data) and of the estimated ARDL models (low power of the tests, insignificant estimated elasticities for pork). Still, the assessed traded effects support the theoretical assumption that tariff cuts under FTAs should promote trade between the partners in the FTA and may lead to the diversion of trade from the third parties.

CONCLUSION

The present master thesis pursued the goal of evaluating the future effects on trade in meat between the EU and Ukraine resulting from the creation of the free trade area between the parties under the DCFTA Agreement. In particular, the possible trade creation and trade diversion effects of the tariff reduction on pork and poultry were calculated. Since most of the previous studies on this topic have been carried out on the macro level, it seems to be attractive to conduct a research on the disaggregated data to see the direct impact of tariff cuts on a particular industry. According to the obtained results, it can be expected that the trade liberalization in the considered sectors will lead to the growth in import volumes from the EU to Ukraine. The forecasted medium-term import increase in pork constitutes 1.32 to 2.44 ths. tones annually (3-6% growth), whereas the respective forecast for poultry lies within the range from 1.81 to 7.39 ths. tones (3-12% growth). It should be noted that for both meat types examined, the rise in imports is expected primarily due to the trade diversion effect, which means that the tariff reduction under the DCFTA might lead to the redirection of trade away from more efficient meat producers outside the Agreement to less efficient producers in the EU. Taking into account, that in the recent years the EU has already become Ukraine's major source of pork and poultry imports (see Figure 2), such development might lead to the total refusal on behalf of Ukraine from imports of these goods from the non-EU countries. Considering the recent mutual import bans between Ukraine and some CIS countries on various food products including meat, one may expect that the meat imports will in the first place be diverted from the traditional CIS partners in meat trade, such as Russia (pork and poultry), Kazakhstan (poultry) and Uzbekistan (poultry).

At the same time, it should be noted that the forecasts resulting from the present analysis should be taken with some caution and that they merely represent a possible scenario of the future developments that may change due to different factors. Moreover, the estimated behavioral parameters used for the calculation of the trade effects turned out to be significant only for poultry, which, unfortunately affects the reliability of the model results for pork. However, the obtained values of forecasted trade effects for pork imports lie within the reasonable range and might still be taken as a reference value.

One should also outline the limitations of the applied methods. Firstly, it should be taken into consideration that the partial equilibrium SMART model itself is quite simple, which makes it easy to implement and allows to go by with a limited amount of data. As long as the present analysis was focused on the disaggregated data, and the investigated sector is relatively small compared to the whole economy, the partial equilibrium model appears to fit well to achieve the objectives set in this thesis. At the same time, the SMART is designed to analyze only the direct price reduction effects on trade, resulting from the tariff cuts, failing to capture other impacts that influence trade. This is especially important in the case of trade in agricultural products, including meat, which are subject to numerous non-trade barriers, such as sanitary norms, certification, licensing, etc. The regulation of applying such barriers to trade under trade agreements might have a more substantial effect on trade than mere tariff cuts. In addition, the effect of tariff reduction could not be directly evaluated in its "classical" meaning, since the imports in pork and poultry is regulated by tariff quotas, which is why the respective tariff equivalents had to be calculated to enable the further analysis.

Secondly, a longer period of investigation could bring more significant and informative results. Using quarterly or annual data (instead of monthly data used in the current analysis) over a longer span of time might help make better inferences about the trade effects. This would enhance the power of the tests applied prior to and after estimation of the ARDL model, and enable to estimate the trade effects in a longer run. This problem is, however, hard to fix due to the relatively short history of Ukraine's international trade and even shorter period of its stable economic development, since during more than the first half of the period of its independence (gained in 1991), the country had to first overcome the transition from the administrative economy and its further integration into the global economy.

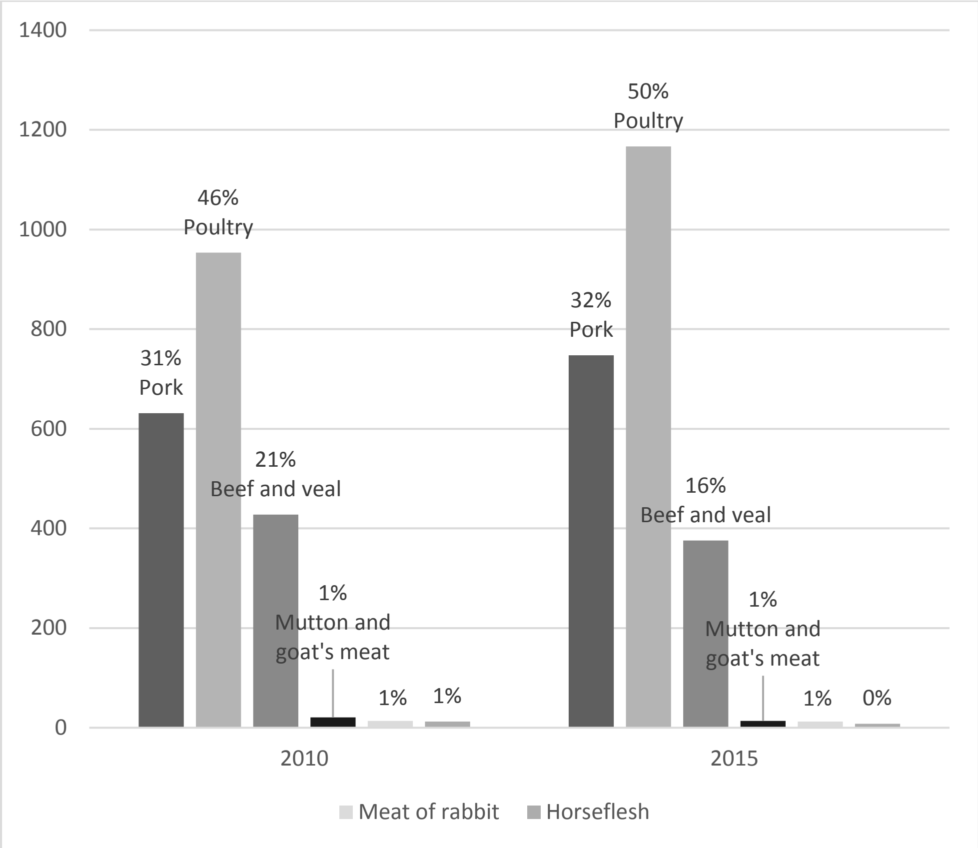
Thirdly, since the estimated series contained disaggregated data in terms of the imported tariff lines, the aggregation bias could not be totally avoided due to the aggregation across the countries.

Finally, the ARDL technique is not univocal and that restrictive in many stages of estimation, including the optimal lag selection, making conclusions on the presence of cointegration (especially in cases where the calculated statistic falls between the critical bonds). Therefore, certain caution should be taken in interpreting its results.

The mentioned issues, however, clear the path to further research in this direction. It would be enlightening to evaluate the trade effects, taking into account other regulations and non-tariff trade barriers traditionally applied to the sector. Although the estimation of longer series appears to be problematic due to the absence of the data, one could still extend the research to evaluating effects on trade with particular countries within and outside the EU, as well as by additionally assessing the respective effects on the other economies. Comparing the results of other techniques for estimation dynamic models could also increase the robustness of the obtained forecasts.

APPENDIX A. STRUCTURE OF MEAT PRODUCTION IN UKRAINE IN 2010 VS. 2015

Figure A.1: Meat Production in Ukraine in 2010 vs. 2015 (in Slaughter Weight, thsd.t.)



Source of the data: http://ukrstat.gov.ua/, access: 10 July 2017.

APPENDIX B. DERIVATION OF THE IMPORT DEMAND FOR THE VARIETIES OF GOOD g

Under the assumptions presented in Chapter 3, the procedure for finding the demand functions for each import good variety would be first to obtain the total demand for each import group g by maximizing utility equation (2) subject to the budget constraint $y = \sum_g p_g m_g + n$, and then to minimize the costs $y = \sum_g \sum_c p_g^c m_g^c + n$ subject to the constraint $u_g(m_g) = \phi_g(m_g^1, m_g^2)$.

In the first step, one can solve the utility maximization problem using the Lagrangian method:

$$\mathcal{L}_1 = U - \lambda(BC) \tag{B1}$$

The symmetric solution for import demand functions for each good g can be derived as follows:

$$\frac{\partial \mathcal{L}_1}{\partial m_g} = u_g'(m_g) - \lambda p_g = 0$$

$$u_g'(m_g) = \lambda p_g$$

$$m_g = f(p_g) = f(p_g(p_{g,r}\ ;\ p_{g,\neq r})) \tag{B2}$$

Inserting the obtained solutions in the budget constraint allows to solve for the consumption of the composite numeraire good:

$$n = y - \sum_g p_g m_g$$

In the second step, to solve the cost minimization problem, the general representation of the CES utility function $u_g(m_g) = \phi_g(m_{g,1}, m_{g,2}) = \left[b_{g,1} m_{g,1}^{-\rho_g} + b_{g,2} m_{g,2}^{-\rho_g}\right]^{-\frac{1}{\rho_g}}$ is applied:

$$\mathcal{L}_2 = \sum_g \sum_r p_{g,r} m_{g,r} - \tau\left(\left[b_{g,1} m_{g,1}^{-\rho_g} + b_{g,2} m_{g,2}^{-\rho_g}\right]^{-\frac{1}{\rho_g}} - \overline{m}_g\right) \tag{B3}$$

The solutions for m_{11} and m_{12} can be obtained as follows:

$$\frac{\partial \mathcal{L}_1}{\partial m_{g1}} = p_{11} - \tau\left(b_{11} m_{11}^{-\rho_1 - 1} (b_{11} m_{11}^{-\rho_1} + b_{12} m_{12}^{-\rho_1})^{-\frac{1}{\rho_1} - 1}\right) = 0$$

$$\frac{\partial \mathcal{L}_1}{\partial m_{g2}} = p_{12} - \tau\left(b_{12} m_{12}^{-\rho_1 - 1} (b_{11} m_{11}^{-\rho_1} + b_{12} m_{12}^{-\rho_1})^{-\frac{1}{\rho_1} - 1}\right) = 0$$

$$\frac{\partial \mathcal{L}_1}{\partial \tau} = -\left(\left[b_{11}m_{11}^{-\rho_1} + b_{12}m_{12}^{-\rho_1}\right]^{-\frac{1}{\rho_1}} - \bar{m}_1\right) = 0$$

Using that $(b_{11}m_{11}^{-\rho_1} + b_{12}m_{12}^{-\rho_1})^{-\frac{1}{\rho_1}-1} = \bar{m}_1{}^{1+\rho_1}$ one may now transform the above equalities and solve for m_{11} and m_{12} as follows:

$$p_{11} = \tau b_{11}m_{11}^{-\rho_1-1}\bar{m}_1{}^{1+\rho_1}$$

$$m_{11}^{-(\rho_1+1)} = \frac{p_{11}}{\tau b_{11}\bar{m}_1{}^{1+\rho_1}}$$

$$m_{11} = \left(\frac{p_{11}}{\tau b_{11}\bar{m}_1{}^{1+\rho_1}}\right)^{-\frac{1}{(\rho_1+1)}} = \bar{m}_1\left(\frac{p_{11}}{\tau b_{11}}\right)^{-\frac{1}{(\rho_1+1)}} \quad \text{(B4)}$$

Remembering that $m_1 = f(p_{11}; p_{12})$, m_{11} can be expressed as the function of domestic prices on imports of good 1:

$$m_{11} = f(p_{11}; p_{12}) \quad \text{(B5)}$$

Since the problem is symmetric,

$$m_{12} = f(p_{11}; p_{12}) \quad \text{(B6)}$$

And in its general form:

$$m_{g,r} = f\left(p_{g,r}^d; p_{g,\neq r}^d\right), \forall g, r \quad \text{(B7)}$$

And finally, given that $\sum_g p_g m_g = \sum_g \sum_c p_{g,r} m_{g,r}$, the demand function for the numeraire good would look like:

$$n = y - \sum_r \sum_g p_{g,r}^d m_{g,r} \quad \text{(B8)}$$

APPENDIX C. DERIVATION OF THE TRADE DIVERSION

By extending the equation of the elasticity of substitution:

$$\sigma_{g,r,\neq r} = \frac{d\left(\frac{m_{g,r}}{m_{g,\neq r}}\right) \Big/ \frac{m_{g,r}}{m_{g,\neq r}}}{d\left(\frac{p^d_{g,r}}{p^d_{g,\neq r}}\right) \Big/ \frac{p^d_{g,r}}{p^d_{g,\neq r}}} < 0 \qquad \text{(C1)}$$

and solving for $dm_{g,r}$ (which is by definition equal to $-dm_{g,\neq r}$) one obtains:

$$d\left(\frac{m_{g,r}}{m_{g,\neq r}}\right) \Big/ \frac{m_{g,r}}{m_{g,\neq r}} = \left(\frac{1}{m_{g,\neq r}} dm_{g,c} - \frac{m_{g,r}}{\left(m_{g,\neq r}\right)^2} dm_{g,\neq r}\right) \Big/ \frac{m_{g,r}}{m_{g,\neq r}} =$$

$$\left(\frac{dm_{g,r}}{m_{g,\neq r}} + \frac{dm_{g,r} m_{g,r}}{\left(m_{g,\neq r}\right)^2}\right) \Big/ \frac{m_{g,r}}{m_{g,\neq r}} = \frac{dm_{g,r}\left(m_{g,\neq r} + m_{g,r}\right)}{\left(m_{g,\neq r}\right)^2} \Big/ \frac{m_{g,r}}{m_{g,\neq r}} = \frac{dm_{g,r}\left(m_{g,\neq r} + m_{g,r}\right)}{m_{g,r}\, m_{g,\neq r}} \qquad \text{(C2)}$$

Assuming that the price for the good g in the rest of the world remained unchanged:

$$d\left(\frac{p^d_{g,r}}{p^d_{g,\neq r}}\right) \Big/ \frac{p^d_{g,r}}{p^d_{g,\neq r}} = \frac{\frac{p^W_{g,r} dt_{g,r}}{p^W_{g,\neq r}(1+t_{g,\neq r})}}{\frac{p^W_{g,r}(1+t_{g,r})}{p^W_{g,\neq r}(1+t_{g,\neq r})}} = \frac{dt_{g,r}}{(1+t_{g,r})} \qquad \text{(C3)}$$

Then

$$\sigma_{g,r,\neq r} = \frac{dm_{g,r}\left(m_{g,\neq r} + m_{g,r}\right)}{m_{g,r}\, m_{g,\neq r}} \Big/ \frac{dt_{g,r}}{(1+t_{g,r})} \qquad \text{(C4)}$$

and

$$TD_{g,r} = dm_{g,r} = \frac{m_{g,r}\, m_{g,\neq r}}{m_{g,\neq r} + m_{g,r}} \frac{dt_{g,r}}{(1+t_{g,r})} \sigma_{g,r,\neq r} \text{ for } -dm_{g,r} \leq m_{g,\neq r} \qquad \text{(C5)}$$

Taking into account, that the trade diversion cannot exceed the initial imports from the rest of the world, $TD_{g,r} = m_{g,\neq r}$ if $-dm_{g,r} > m_{g,\neq r}$.

APPENDIX D. SPECIFICATION OF A REGRESSION MODEL FOR ESTIMATING ELASTICITIES: JUSTIFICATION OF A LOG-LINEAR FUNCTION

Price elasticities of demand. Price elasticity of import demand for good g from the EU can be defined as follows:

$$\varepsilon_{g,EU} = \frac{\partial m_{g,EU}/m_{g,EU}}{\partial p_{g,EU}/p_{g,EU}} < 0 \tag{D1}$$

To prove that in the regression model (the income variable was omitted to simplify the calculations, since it will be cancelled out in the end in any case)

$$\ln m_{g,EU\ t} = \alpha + \beta_1 \ln p_{g,EU\ t} + \beta_2 \ln p_{g,RoW\ t} + \epsilon_t \tag{D2}$$

β_1 is the sought own-price elasticity, the above equation can be rewritten as follows:

$$m_{g,EU\ t} = exp(\ln m_{g,EU\ t}) = exp(\alpha + \beta_1 \ln p_{g,EU\ t} + \beta_2 \ln p_{g,RoW\ t} + \epsilon_t)$$
$$= exp(\alpha + \epsilon_t) exp(\beta_1 \ln p_{g,EU\ t}) exp(\beta_2 \ln p_{g,RoW\ t}) =$$
$$exp(\alpha + \epsilon_t) exp(\ln p_{g,EU\ t}{}^{\beta_1}) exp(\ln p_{g,EU\ t}{}^{\beta_2}) = exp(\alpha + \epsilon_t) p_{g,EU\ t}{}^{\beta_1}\, p_{g,RoW\ t}{}^{\beta_2} \tag{D3}$$

$$\frac{\partial m_{g,EU\ t}}{\partial p_{g,EU\ t}} = \beta_1\, exp(\alpha + \epsilon_t) p_{g,EU\ t}{}^{\beta_1 - 1}\, p_{g,RoW\ t}{}^{\beta_2} = \frac{\beta_1}{p_{g,EU\ t}}\, exp(\alpha + \epsilon_t) p_{g,EU\ t}{}^{\beta_1} p_{g,RoW\ t}{}^{\beta_2} = \beta_1 \frac{m_{g,EU\ t}}{p_{g,EU\ t}} \tag{D4}$$

$$\beta_1 = \frac{\partial m_{g,EU\ t}}{\partial p_{g,EU\ t}} \frac{p_{g,EU\ t}}{m_{g,EU\ t}} = \varepsilon_{g,EU} \tag{D5}$$

In a similar fashion, it can be shown that β_2 represents the cross-price elasticity of demand for good g:

$$\beta_2 = \frac{\partial m_{g,EU\ t}}{\partial p_{g,RoW\ t}} \frac{p_{g,RoW\ t}}{m_{g,EU\ t}} = \varepsilon_{g,RoW} \tag{D6}$$

Elasticity of substitution. The elasticity of substitution between the EU and RoW varieties of good g is estimated using the following regression equation:

$$\ln\left(\frac{m_{g,EU}}{m_{g,RoW}}\right)_t = \mu + \delta \ln\left(\frac{p_{g,EU}}{p_{g,RoW}}\right)_t + \varphi_t \tag{D7}$$

As can be seen from the derivations for the import price elasticities, in the general case of log-linear specification with x as an explanatory and y as a dependent variable, the following holds:

$$\ln(y) = a + b\ln(x) + e \tag{D8}$$

$$\frac{\partial y}{\partial x} = b\frac{y}{x} \tag{D9}$$

$$b = \frac{\partial y}{\partial x}\frac{x}{y} = \varepsilon \tag{D10}$$

Substituting $y = \frac{m_{g,EU}}{m_{g,RoW}}$ and $x = \frac{p_{g,EU}}{p_{g,RoW}}$ into Equation (D8) yields:

$$\frac{\partial \frac{m_{g,EU}}{m_{g,RoW}}}{\partial \frac{p_{g,EU}}{p_{g,RoW}}} = \frac{\delta \frac{m_{g,EU}}{m_{g,RoW}}}{\frac{p_{g,EU}}{p_{g,RoW}}}; \qquad \delta = \frac{\partial\left(\frac{m_{g,EU}}{m_{g,RoW}}\right) / \frac{m_{g,EU}}{m_{g,RoW}}}{\partial\left(\frac{p_{g,EU}}{p_{g,RoW}}\right) / \frac{p_{g,EU}}{p_{g,RoW}}} = \sigma_g^{EU,RoW} \tag{D11}$$

APPENDIX E. RESULTS OF THE UNIT ROOT TESTS

Table E.1: Results of the ADF Unit Root Test (Null Hypothesis: Series Has a Unit Root)

Variable	**Test Statistic**							**Critical Values at Different Significance Levels**		
		Pork (except for the GDP variables)			**Poultry (except for the GDP variables)**					
GDP		*(in levels)*	*(in 1st diff.)*	*(in 2nd diff.)*	*(in levels)*	*(in 1st diff.)*	*(in 2nd diff.)*	*1%*	*5%*	*10%*
	τ_3	-1.81	-1.72	-12.92***	-	-	-	-4.04	-3.45	-3.15
	ϕ_2	1.56	1.14	55.74***	-	-	-	6.50	4.88	4.16
	ϕ_3	2.11	1.69	83.59***	-	-	-	8.73	6.49	5.47
	τ_2	-2.04	-1.58	-	-	-	-	-3.51	-2.89	-2.58
	ϕ_1	2.39	1.27	-	-	-	-	6.70	4.71	3.86
GDP (deseasonalized)	τ_3	-1.66	-11.06***	-	-	-	-	-4.04	-3.45	-3.15
	ϕ_2	1.45	40.97***	-	-	-	-	6.50	4.88	4.16
	ϕ_3	2.08	61.43***	-	-	-	-	8.73	6.49	5.47
	τ_2	-0.81	-	-	-	-	-	-3.51	-2.89	-2.58
	ϕ_1	0.42	-	-	-	-	-	6.70	4.71	3.86
Imports	τ_3	-2.69	-6.28***	-	-4.52***	-	-	-4.04	-3.45	-3.15
	ϕ_2	3.01	13.18***	-	6.84***	-	-	6.50	4.88	4.16
	ϕ_3	4.38	19.76***	-	10.23***	-	-	8.73	6.49	5.47
	τ_2	-1.16	-	-	-	-	-	-3.51	-2.89	-2.58
	ϕ_1	0.80	-	-	-	-	-	6.70	4.71	3.86
Prices (for the EU imports)	τ_3	-3.21*	-10.16***	-	-2.87	-10.02***	-	-4.04	-3.45	-3.15
	ϕ_2	3.62	34.55***	-	3.00	33.49***	-	6.50	4.88	4.16
	ϕ_3	5.28	51.78***	-	4.49	50.23***	-	8.73	6.49	5.47
	τ_2	-2.09	-	-	-3.01**	-	-	-3.51	-2.89	-2.58
	ϕ_1	2.33	-	-	4.55*	-	-	6.70	4.71	3.86
Prices (for imports from the rest of the world)	τ_3	-4.84***	-	-	-6.32***	-	-	-4.04	-3.45	-3.15
	ϕ_2	7.82***	-	-	13.32***	-	-	6.50	4.88	4.16
	ϕ_3	11.70***	-	-	19.97***	-	-	8.73	6.49	5.47
	τ_2	-	-	-	-	-	-	-3.51	-2.89	-2.58
	ϕ_1	-	-	-	-	-	-	6.70	4.71	3.86
	ϕ_2	13.32***	-	-	-	-	-	6.50	4.88	4.16
	ϕ_3	19.97***	-	-	-	-	-	8.73	6.49	5.47
	τ_2	-	-	-	-	-	-	-3.51	-2.89	-2.58
	ϕ_1	-	-	-	-	-	-	6.70	4.71	3.86

Table E.1 (cont.)

Variable	**Test Statistic**							**Critical Values at Different Significance Levels**		
		Pork (except for the GDP variables)			**Poultry (except for the GDP variables)**					
Imports ratio	τ_3	-3.71**	-8.75***	-	-2.52	-13.79***	-	-4.04	-3.45	-3.15
	ϕ_2	4.63*	25.67***	-	2.30	63.36***	-	6.50	4.88	4.16
	ϕ_3	6.90**	38.43***	-	3.20	95.05***	-	8.73	6.49	5.47
	τ_2	-3.65***	-	-	-2.55	-	-	-3.51	-2.89	-2.58
	ϕ_1	6.68***	-	-	3.49	-	-	6.70	4.71	3.86
Price ratio	τ_3	-6.77***	-	-	-2.57	-5.97	-	-4.04	-3.45	-3.15
	ϕ_2	15.30***	-	-	2.52	11.92	-	6.50	4.88	4.16
	ϕ_3	22.95***	-	-	3.61	17.88	-	8.73	6.49	5.47
	τ_2	-	-	-	-4.61***	-	-	-3.51	-2.89	-2.58
	ϕ_1	-	-	-	10.64***	-	-	6.70	4.71	3.86

Source: own estimations.

Table E.2: Results of the KPSS Unit Root Test (Null Hypothesis: Series Is Stationary)

Variable	**Test Statistic**							**Critical Values at Different Significance Levels**		
		Pork (except for the GDP variables)			**Poultry (except for the GDP variables)**					
GDP		*(in levels)*	*(in 1st diff.)*	*(in 2nd diff.)*	*(in levels)*	*(in 1st diff.)*	*(in 2nd diff.)*	*1%*	*5%*	*10%*
	$\hat{\eta}_\mu$	0.11	-	-	-	-	-	0.74	0.46	0.35
	$\hat{\eta}_\tau$	0.09	-	-	-	-	-	0.22	0.15	0.12
GDP (deseasonalized)	$\hat{\eta}_\mu$	0.46**	0.17	-	-	-	-	0.74	0.46	0.35
	$\hat{\eta}_\tau$	0.24***	0.07	-	-	-	-	0.22	0.15	0.12
Pork imports	$\hat{\eta}_\mu$	0.74***	0.16	-	0.08	-	-	0.74	0.46	0.35
	$\hat{\eta}_\tau$	0.26***	0.02	-	0.06	-	-	0.22	0.15	0.12
Pork prices (for the EU imports)	$\hat{\eta}_\mu$	0.94***	0.15	-	0.26	0.19	-	0.74	0.46	0.35
	$\hat{\eta}_\tau$	0.11	0.11	-	0.17**	0.08	-	0.22	0.15	0.12
Pork prices (for imports from the rest of the world)	$\hat{\eta}_\mu$	0.81***	0.40*	0.23	1.00***	0.14	0.18	0.74	0.46	0.35
	$\hat{\eta}_\tau$	0.09	0.39***	0.18**	0.15**	0.14*	0.13*	0.22	0.15	0.12
Imports ratio for pork	$\hat{\eta}_\mu$	0.29	0.06	-	0.18	-	-	0.74	0.46	0.35
	$\hat{\eta}_\tau$	0.20**	0.05	-	0.11	-	-	0.22	0.15	0.12
Price ratio for pork	$\hat{\eta}_\mu$	0.18	-	-	0.64**	0.40	-	0.74	0.46	0.35
	$\hat{\eta}_\tau$	0.10	-	-	0.18**	0.40***	-	0.22	0.15	0.12

Source: own estimations.

APPENDIX F. REGRESSION OUTPUTS FOR THE ARDL MODELS ESTIMATED IN SUBCHAPTER 4.6

Table F1: ARDL Model Output for Price Elasticities Estimation for Pork

Dependent variable: $Imports_t$
Sample (adjusted): 03.2010 – 06.2015
Included observations: 64 after adjustments
ARDL(2,0,2,0)

Variable	***Coefficient***	***Std.Error***	***t-Statistic***	***Prob.***
C	-5.38	3.64	-1.47	0.15
$Imports_{t-1}$	0.82	0.12	6.69	0.00
$Imports_{t-2}$	-0.21	0.12	-1.82	0.07
EU $Price_t$	-0.16	0.43	-0.37	0.71
RoW $Price_t$	-0.16	0.27	-0.58	0.56
RoW $Price_{t-1}$	0.10	0.24	0.40	0.69
RoW $Price_{t-2}$	-0.67	0.23	-2.95	0.00
GDP_t	1.26	0.36	3.47	0.00

R-squared	0.88	Mean dependent var	14.74
Adjusted R-squared	0.87	S.D. dependent var	1.23
S.E: of regression	0.45	AIC	1.33
Sum of squared resid	11.09	SC	1.61
Log likelihood	-34.73	HQ	1.44
F-statistic	61.01	DW statistic	2.03
Prob(F-statistic)	0.00		

Source: own estimations

Table F2: ARDL Model Output for Price Elasticities Estimation for Poultry

Dependent variable: $Imports_t$
Sample (adjusted): 02.2010 – 12.2015
Included observations: 71 after adjustments
ARDL(1,0,0,0)

Variable	***Coefficient***	***Std.Error***	***t-Statistic***	***Prob.***
C	1.22	2.04	0.60	0.55
$Imports_{t-1}$	0.43	0.09	4.66	0.00
EU $Price_t$	-0.25	0.12	-1.98	0.05
RoW $Price_t$	0.02	0.06	0.28	0.78
GDP_t	0.74	0.17	4.26	0.00

R-squared	0.47	Mean dependent var	15.41
Adjusted R-squared	0.44	S.D. dependent var	0.34
S.E: of regression	0.25	AIC	0.16
Sum of squared resid	4.22	SC	0.32
Log likelihood	-0.54	HQ	0.22
F-statistic	14.51	DW statistic	2.03
Prob(F-statistic)	0.00		

Source: own estimations

Table F3: ARDL Model Output for Substitution Elasticities Estimation for Pork

Dependent variable: Imports ratio$_t$				
Sample (adjusted): 02.2010 – 09.2015				
Included observations: 64 after adjustments				
ARDL(1,0)				
Variable	***Coefficient***	***Std.Error***	***t-Statistic***	***Prob.***
C	0.08	0.10	0.80	0.43
Imports ratio$_{t-1}$	0.65	0.10	6.71	0.00
Price ratio$_t$	-0.41	0.36	-1.20	0.23
R-squared	0.44	Mean dependent var		-0.01
Adjusted R-squared	0.42	S.D. dependent var		0.94
S.E: of regression	0.71	AIC		2.20
Sum of squared resid	30.89	SC		2.30
Log likelihood	-67.51	HQ		2.24
F-statistic	24.28	DW statistic		1.84
Prob(F-statistic)	0.00			

Source: own estimations

Table F4: ARDL Model Output for Substitution Elasticities Estimation for Poultry

Dependent variable: Imports ratio$_t$				
Sample (adjusted): 02.2010 – 12.2015				
Included observations: 59 after adjustments				
ARDL(1,1)				
Variable	***Coefficient***	***Std.Error***	***t-Statistic***	***Prob.***
C	0.72	0.26	2.80	0.01
Imports ratio$_{t-1}$	0.50	0.11	4.47	0.00
Price ratio$_t$	-1.11	0.55	-2.01	0.05
Price ratio$_{t-1}$	-0.64	0.54	-1.19	0.24
R-squared	0.51	Mean dependent var		1.91
Adjusted R-squared	0.48	S.D. dependent var		1.87
S.E: of regression	1.34	AIC		3.50
Sum of squared resid	99.58	SC		3.64
Log likelihood	-99.16	HQ		3.55
F-statistic	19.18	DW statistic		2.53
Prob(F-statistic)	0.00			

Source: own estimations

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