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Econometric Study of the Price Differences Impact between Domestic and Imported Cattle Meat on Egyptian Consumer Surplus

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ABSTRACT

In addition to livestock sector challenges in Egypt, beef and veal market suffers from decreasing self-sufficiency rate from 75% to 56%, and increasing prices of domestic and import beef during (2002-2020). The problems of this study are: (1) the variation of price increase between domestic and imported beef may declines consumer welfare, (2) imported beef is very discriminated by origin of country (Brazil, India, and rest of world) and product type (boneless and in-bone), and so the total aggregation may causes considerable bias in demand model. According to mentioned problems, the paper aims at: (1) Econometric estimation of the demand system to derive elasticity parameters and check the model inconsistency or aggregation bias. (2) Calculation consumer surplus due to price increase of domestic and imported beef. Rotterdam demand system in the framework of aggregation bias approach is applied to get consistent parameters. Results verify the existence of aggregation problem according to Wald test in the restricted Seemingly Unrelated Regression Estimation (SURE) model. Additionally, for domestic beef, expenditure elasticity is lower than one, and more than one for foreign beef. On the other hand, price elasticity of domestic beef is inelastic and weakly substitute for the foreign beef, while the contrary is not true for foreign beef. Consumers should be compensated by about 21.5% and 10.5 % respectively as domestic and foreign beef prices increase over the average prices. Future research should consider the aggregation bias in estimating elasticities and consumer welfare in demand systems under various income categories and sectors.

***Keywords*:** Aggregation; Bias; Compensated; Variation; SURE.

INTRODUCTION

The livestock sector in Egypt mainly faces a dramatic shortage of the production capacity to meet the growing demand of animal protein due to overpopulation, limited cultivated area of green fodders, and low economic efficiency of grazers in management (El-Rasoul *et al.*2018; Bergel 2016) The Egyptian domestic production average of beef is 402 thousand ton and the Egyptian imports average is 230 thousand ton during (2002-2020) (FAOSTAT, 2021), i.e. the self-sufficiency rate represents about 64% of the local market supply. Figure (1)illustrate the decreasing trend of domestic beef production from 336 to 311 thousand ton, while beef imports fluctuate ups and downs with increasing trend from 110 to 244 thousand ton, i.e. the self-sufficiency rate decreases from 75% to 56% during (2002-2020).

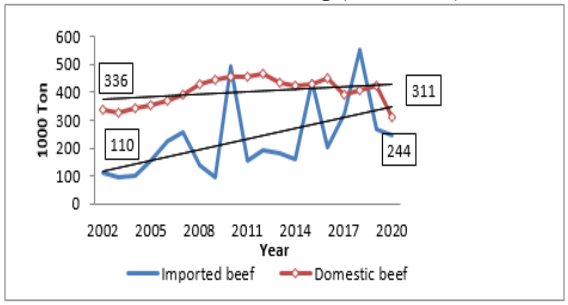

Figure 1. Domestic and imported beef, Egypt (2002-2020)

Figure (2) illustrate that Brazil and India are the major exporting countries of boneless and in-bone in beef and veal, as 65% of Egyptian imports are from Brazil, 21% from India, and 14% from rest of world (ROW).

The self-sufficiency problem worsened since the government imposed the exchange rate liberalization policy in 3rd November 2016.The beef imports value increased by 64% from $756.1 Million in 2016 to $1241.6 Million in 2020. The domestic beef producer price increases by 8.4% from $ 5.6 thousand / ton year 2016 to $6.1 thousand / ton year 2020. The beef import price increases by 38% from $ 3.7 thousand / ton year 2016 to $5.1 thousand / ton year 2020. These differences of increment between domestic and imported beef prices may have dissimilar impacts on the amount of harm or welfare loss of local consumers (FAOSTAT, 2021).

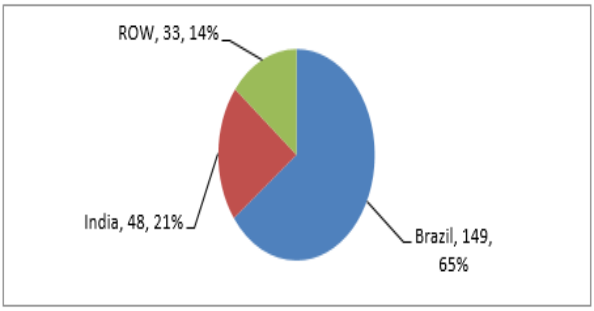

Figure 2. Main exporters of boneless and in-bone beef to Egypt (2002-2020), 1000 ton.

Hundreds of researches investigated the Egyptian supply gap of beef, and the price fluctuation, consumer surplus, demand shift but this study mainly considers the disaggregation of the imported beef and veal into the origin of country and the sub-type of beef (boneless, in-bone). But why the disaggregation may be useful in this study, the answer is that the total aggregation of quantities may cause an inconsistent price that will not reflect the

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average of all types involved in the summation. This study follow the consistent aggregation of Davis, 1997 to avoid aggregation problem. Another consideration of demand system approaches is estimation of consumer welfare or consumer surplus due to normal price shift or other political interventions. Most studies of beef demand in Egypt considered the positive amounts of consumer surplus as a result of subsidies but this study considers the negative amount of consumer welfare or surplus as a result of price increase.

The problem of this study is presented by two main pillars: the first is there is a robust possibility that the consumers will be harmed as a result of the price increases of domestic and imported beef by 8.4% and 38% respectively. The amount of harm faced by the consumers is expressed by the negative value of "consumer surplus", the price that the consumer will pay rather than going without purchasing beef. The price increases will decrease the consumers' welfare, or in other words the consumers will be worse-off because the consumer surplus has negative values. The compensated variation, the amount that keep consumers as well- off as before price changes, will be different in the two products (domestic- imported) beef. Second, imported beef is very discriminated by origin of country (Brazil, India, and rest of the world) and product type (boneless and in-bone), so the total aggregation may cause a considerable aggregation bias in the estimated demand model. According to the mentioned problem, the paper mainly aims at: (1) the econometric estimation of the demand system to derive elasticity parameters and to check the model inconsistency or aggregation bias. (2) Calculation the consumer surplus due to price increase of domestic and imported beef.

This paper is classified as follow: section 2 provides the data and methodology which presents two parts: (1) the aggregation theory approach and Rotterdam demand system; and (2) the consumer welfare analysis which includes consumer price and compensated surplus concepts. Section 3 provides the result and discussion which includes :(1) restricted and unrestricted demand system applying Seemingly Unrelated Regression Estimation (SURE), (2) the price and expenditure elasticities of the fitted model, and (3) the assessment of price increase impact on consumer welfare during (2002-2020). Section 4 concludes with some policy implications of the findings.

MATERIALS AND METHODS

1. Aggregation Bias and Demand System

The paper analyzes the demand system in the framework of the aggregation theory because beef is very discriminated by source and kind, so accounting for product aggregation bias is likely to be essential. The product aggregation theory examines the aggregation bias, the difference between consistent aggregation (superlative[1] quantity and price indices) and inconsistent aggregation (the total quantity and unit –value price) (Diewert *et al* 1993; Davis 1997).

The consistent demand function Q_i and inconsistent demand function Q_i^{Ic} for all beef products (frozen boneless beef and fresh in-bone beef) within ith aggregate: domestic beef (D), foreign beef (F), and rest of the world (R) are as follow:

$$\boldsymbol{Q_i = f(P_D, P_F, P_R), i = D, F, R} \quad (1)$$

$$\boldsymbol{Q_i^{Ic} = f(P_D^{Ic}, P_F^{Ic}, P_R^{Ic}), i = D, F, R} \quad (2)$$

Diewert *et al.* (1993) stated that the consistent aggregated quantitiesQ_i and prices P_i are superlative quantity and price indices, while the observable aggregates in the (inconsistent) aggregate demand system are not more(totals of quantitiesQ_i^{Ic}) and (unit- value of prices P_i^{Ic}) (Davis 1997). If the inconsistent aggregation demand system is simple, i.e. contains only the domestic quantities, the total summation will be proper and equivalent to the consistent aggregation. But if the demand system contains of domestic and imports disaggregated quantities, it will be imposed that all those quantities from all countries and types are perfect substitutable, and consequently homogenous. The mathematical division process of the total value by the total quantity to get the unit price is the main cause of inconsistency, as the consistency means that consumers will choose the lower price product if all types are perfect substitutable (Davis1997). The product aggregation rule imposes that the total expenditure E_i is the result of multiplying quantities Q_i and Prices P_i regardless of consistency as follow:

$$\boldsymbol{Q_i P_i = E_i = Q_i^{Ic} P_i^{Ic}, i = D, F, R} \quad (3)$$

The standard distance (or scaled) function (B_i) is applied to equalize between the consistent scaled demand function and inconsistent demand function. Diewert *et al.* (1993) defined (B_i) as : $B_i = Q_i / Q_i^{Ic}$, and $Q_i = B_i\, Q_i^{Ic}$. Substituting Q_i in terms of biasness and inconsistent quantity into equation (3), $B_i Q_i^{Ic} P_i = Q_i^{Ic} P_i^{Ic}$, so $B_i = P_i^{Ic}/P_i$.The logarithm change in the aggregated biasness for quantity and price in the continuous form is:

$$\boldsymbol{d \ln B_i = d \ln Q_i - dln\, Q_i^{Ic} = dln\, P_i^{Ic} - d \ln P_i\ , i = D, F, R} \quad (4)$$

Where $d \ln Q_i = d \ln P_i$ are the Divisia quantity and price indices respectively. Hulten (1973) approximated the aggregated biasness $d \ln B_i$ in a discrete form by Törnqvist[2] quantity and price indices as following:

$$\boldsymbol{\Delta B_{it} = \Delta Q_{it}^{*} - \Delta\, Q_{it}^{Ic} = \Delta\, P_{it}^{Ic} - \Delta P_{it}^{*}, i = D, F, R} \quad (5)$$

Where $\Delta B_{it} = \ln(B_{it}/B_{it-1})$ is the log change in the aggregation bias from t-1 to t, ΔQ_{it}^{*} and ΔP_{it}^{*} are the Törnqvist quantity and price indices from t-1 to t respectively. $\Delta\, Q_{it}^{Ic} = \ln(Q_{it}^{Ic}/\, Q_{it-1}^{Ic})$, and $\Delta\, P_{it}^{Ic} = \ln(P_{it}^{Ic}/\, QP_{it-1}^{Ic})$ are the log change in total quantity and unit price of the ith aggregate from t-1 to t. If $\Delta B_{it} > 0$, there is negative change in the aggregation bias and the change in total quantities underestimates the change in the consistent aggregated quantities, i.e.$\Delta Q_{it}^{*} > \Delta\, Q_{it}^{Ic}$, and vice versa if$\Delta B_{it} < 0$, there is positive change in the aggregation bias and$\Delta Q_{it}^{*} < \Delta\, Q_{it}^{Ic}$ (Davis 1997).

Aw *et al.* (1986) rewrote the price part of equation (5) and decomposed Törnqvist price index into a unit value price effect and aggregated bias effect. They also decomposed the aggregated bias term into a country effect b_{ic}, product kind effect b_{ik}. To avoid the overestimation of the total product aggregation bias due to only considering the first order effects of countries and products, the interaction effect b_{ick} between country and product should be considered. Davis (1997) justified the decomposition possibility that the product aggregation bias in international trade can be due to changes in the country source mix or to changes in the import product mix. The country and product effects are defined as:

$$\boldsymbol{\Delta\, b_{ijt} = \Delta\, P_{it}^{Ic} - \Delta P_{ijt}^{*}, i = D, F, R; j = c, k} \quad (6)$$

Where ΔP_{ijt}^{*} is a partial Törnqvist price index in which all products within each country are homogeneous for $\Delta\, b_{ict}$ and all countries within a product kind are homogeneous for$\Delta\, b_{ikt}$. The interaction effect is defined to be the residual of subtracting country and product effects from total biasness:

$$\boldsymbol{\Delta\, b_{ickt} = \Delta\, B_{it} - \Delta\, b_{ict} - \Delta\, b_{ikt}, i = D, F, R; j = c, k} \quad (7)$$

Combining equations (5) through (7), the Törnqvist price index can be rewritten as:

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[1] **Superlative index means it can approximate any smooth function, i.e. small change in the relative price for a good is associated with small changes in the corresponded quantities. (Diewert 1978)**

[2] **Törnqvist index was developed by the Finnish Leo Törnqvist in the 1930s at the "Bank of Finland". For more details see Törnqvist (1936).**

$$\Delta P^*_{it} = \Delta P^{Ic}_{it} - \Delta b_{ict} - \Delta b_{ikt} - \Delta b_{ickt}, i = D, F, R; j = c, k \ldots\ldots (8)$$

Simple processes of equations (5) and (8), the Törnqvist quantity index can be similarly decomposed as

$$\Delta Q^*_{it} = \Delta Q^{Ic}_{it} + \Delta b_{ict} + \Delta b_{ikt} + \Delta b_{ickt}, i = D, F, R \quad (9)$$

Divisia Indices of foreign quantity ΔQ^*_{Ft} and price ΔP^*_{Ft} are calculated by calculating the discrete approximation Törnqvist formula between two periods (t, t-1) as follow:

$$\text{Quantity Index} = \ln \Delta_t - \ln \Delta_{t-1} = \sum_{t=1}^{n} \frac{1}{2}(E_{it} + E_{it-1})(\ln(X_{it}) - \ln(X_{it-1})) \quad (10)$$

$$\text{Price Index} = \ln \Delta_t - \ln \Delta_{t-1} = \sum_{t=1}^{n} \frac{1}{2}(E_{it} + E_{it-1})(\ln(P_{it}) - \ln(P_{it-1})) \quad (11)$$

Where: $E_{it} = \frac{P_{it}X_{it}}{\sum_{j=1}^{n} P_{jt}X_{jt}}$, P_{it}, X_{it} are the price and quantity respectively. (JUN 2011).

To consider product aggregation bias effects into a demand system, Theil shows that the absolute price Rotterdam aggregate demand model in the log differential form is theoretically consistent with product aggregation theory (Deaton *et al.* 1980; Davis 1997), as mentioned before, imported beef is very discriminated by origin of country (Brazil, India, and rest of the world) and product type (boneless and in-bone), so the total aggregation may cause a considerable aggregation bias in the estimated demand model. Rotterdam demand system mode calculate Törnqvist price and quantity indices which are the available solution of aggregation bias problem. In other way, Rotterdam is a complete deferential demand system which considers heterogeneity problem.The model is written as:

$$w_{it}(\Delta q^*_{it}) = b_i \Delta Q_t + \sum_{j=D}^{R} c_{ij} \Delta P^*_{jt}, i = D, F, R \quad (12)$$

Where w_{it} is the average expenditure share on the ith group (domestic, foreign, rest of the world) between time period t and t-1, Δq^*_{it} and ΔP^*_{jt} are the ith Törnqvist quantity and price indices respectively. b_i is the marginal propensity to spend on the ith commodity(= $w_i \eta_{im}, \eta_{im}$ is expenditure elasticity), and ΔQ_t is the Divisia volume index (approximated also to discrete Törnqvist index) . c_{ij} is Slutsky price coefficients(= $w_i \eta^*_{ij}, \eta^*_{ij}$ is Hicksian price elasticity).

Concentrating on the domestic/import aggregate quantities and prices of interest, direct substitution for $\Delta Q^*_{Dt}, \Delta P^*_{Dt}, \Delta Q^*_{Ft}, \Delta P^*_{Ft}$ from equations (8) and (9) into equation (12) yields the domestic/ import aggregate beef demand equations as follow:

$$w_{Dt}\,\Delta \mathbf{q}^*_{Dt} = c_{DD}\Delta P^*_{Dt} + c_{DF}\Delta P^{IC}_{Ft} - c_{DF}(g_{Fc}\Delta b_{Fct} + g_{Fk}\Delta b_{Fkt} + g_{Fck}\Delta b_{Fckt}) + c_{DR}\Delta P^*_{Rt} + b_D \Delta Q_t \quad (13.a)$$

$$w_{Ft}\,\Delta q^*_{Ft} = c_{FD}\,\Delta P^*_{Dt} + c_{FF}\Delta P^{IC}_{Ft} - c_{DF}(g_{Fc}\Delta b_{Fct} + g_{Fk}\Delta b_{Fkt} + g_{Fck}\Delta b_{Fckt}) + c_{FR}\Delta P^*_{Rt} + b_F \Delta Q_t - w_{Ft}(g_{Fc}\Delta b_{Fct} + g_{Fk}\Delta b_{Fkt} + g_{Fck}\Delta b_{Fckt}) \quad (13.b)$$

The applied demand system in(13a) and (13b) consists of three equations: (1) the domestic beef and veal (Kandooz-D) ; (2)the aggregated imports of beef and veal along main kinds (in-bone, and boneless) and along the top exporters Brazil, and India(Foreign- F); and (3) the aggregate imports of beef and veal along main kinds and rest of world (R), which is dropped to avoid singularity. Since the domestic source is a unique country (Egypt), there is no aggregation bias from the country source. Furthermore, due to data limitation of obtaining boneless and in-bone domestic beef, there is no aggregation bias also from the product kind, i.e. $\Delta B_{Dt} = 0 (\Delta q^*_D = \Delta q^{Ic}_D)$.The coefficients g's allow for testing product aggregation bias (JUN 2011). System (12), and system (13) are theoretically equivalent but (12) is inconsistent system referring to the product aggregation bias assuming all g's are zero. Likelihood ratio test can be used to check the best model specification, the restricted system without aggregation bias factors, or the unrestricted system with aggregation bias factors (Davis 1997). From equations (13a, 13b) Expenditure and prices elasticities are given by:

$$\eta^*_{im} = \frac{b_i}{w_i}, \eta^*_{ij} = \frac{c_{ij}}{w_i}, \quad i = D, F, j = D, F, R \quad (14)$$

a.Consumer Surplus

Although the French engineer J.Dupuit was the first to introduce the consumer surplus concept in 1850, Marshal was the first economist who analyzed the concept of consumer surplus; he defined it as the price that the consumer is willing to pay rather than go without the commodity. Compensating variation (CV) is one concept which is commonly applied to measure consumer surplus. CV reflects the change in prices and is defined as the amount of compensation (usually in monetary terms) that can be taken from consumers while leaving them just as well off as before the changes. (Ng 2004; Marshal 1920).If the consumer is satisfied at the initial equilibrium utility level u^0, and the price beef is changed from p^0 to p^1 , therefore the CV is defined as the difference of expenditures between price changes as follow:

$$CV = E(P^1, u^0) - E(P^0, u^0) \quad (15)$$

Where the expenditure functions $E(P^1, u^0)$, and $E(P^0, u^0)$ are the minimum expenditures necessary to maintain the initial level of utility u^0 at the given final price P^1 and initial priceP^0. This welfare measure reflects additional expenditures being required to achieve the same level of utility as before the changes in price (Huang1993). Applying a second-order Taylor series expansion and Shephard's lemma on Equation (16), the impact of price variation on consumer will be resulted as follow:

$$\frac{CV}{x_0} \cong \frac{p_{0i}\, q_i(p_0, x_0)}{x_0}\frac{\Delta p_i}{p_{0i}} + \frac{1}{2}\,\varepsilon_d\,\frac{p_{0i}\, q_i(p_0, x_0)}{x_0}\left(\frac{\Delta p_i}{p_{0i}}\right)^2 \quad (16)$$

Where q_i and p_i are the demanded beef quantity and price respectively, x_0 is the original income and ε_d is the own price-price elasticity of demand for beef. Equation (16) can be rewritten in the form:

$$\frac{CV}{x_0} \cong CR_b\frac{\Delta p_i}{p_{0i}} + \frac{1}{2}\,\varepsilon_d\, CR_b\left(\frac{\Delta p_i}{p_{0i}}\right)^2 \quad (17)$$

CR_b is the budget share which is defined as the proportion of the budget which is assigned for domestic or foreign beef from total expenditure (Badolo *et al.* 2015). This paper simulates the price change between the maximum and average price in the observed time series during 2002-2020. Budget share of domestic and foreign beef and own price elasticities are estimated from the fitted Rotterdam demand system.

b. Data

The paper extracts the annual data of Egyptian imports of beef and veal from FAOSTAT(2021) and UN Cometrade Database(2021) during 2002-2020. The beef and veal products include two types: (1) fresh, chilled, or frozen with bone (code 867); and (2) boneless fresh, chilled, or frozen (code 870) (FAOSTAT 2021).The Egyptian domestic beef and veal production and wholesale price are derived from Annual Bulletin of Livestock Statistics (CAPMAS, 2021). Domestic and imports prices are deflated by the consumer price Index (CPI, base year is 2015) given by FAOSTAT (2021). Exchange rate is given by the Monthly Statistical Bulletin (Central Bank of Egypt, 2021).

Table (1) shows the descriptive statistics of the Egyptian and imported beef and veal (2002-2020) as follow: the domestic production mean is 402 thousand ton, ranges between 310.6 and 464.6 thousand ton, while the whole price mean is $4.7 /ton, ranges between $2.6 to $6.2 .The Brazilian boneless quantity

mean is 149 thousand ton, ranges between 42 and 483 thousand ton, while the price mean is $3.2 /ton, ranges between $1.6 to $5.1. The Indian boneless quantity mean is 47.5 thousand ton, ranges between 0.026 and 125.8 thousand ton, while the price mean is $2.9 /ton, ranges between $1.7 to $6.9.

The Brazilian in-bone quantity mean is 0.085 thousand ton, ranges between 0.0018 and 0.216 thousand ton, while the price mean is $3.0 /ton, ranges between $1.3 to $4.7. The Indian in-bone quantity mean is 0.778 thousand ton, ranges between 0.198 and 2.315 thousand ton, while the price mean is $2.7 /ton, ranges between $1.18 to $3.55.

The budget share mean for domestic production is 0.73 ranges between 0.61 to 0.85, while for foreign beef and veal import; it is 0.24 ranges between 0.11 to 0.37, and for rest of world (ROW), it is 0.03 ranges between 0.01 to 0.05.The higher coefficients of variance of quantities, prices and budget shares of imports reflect instability due to high degree of dispersion of the standard deviations around the means.

Table 1. Descriptive statistics of the Egyptian and imported beef and veal (2002-2020)

Variable	Mean	Minimum	Maximum	Coff. Of Variance (%)
Domestic Production Quantity	402	310.6	464.6	12
Domestic Wholesale Price	4.7	2.6	6.2	23.4
Brazilian Boneless Quantity	149	42	483	143.9
Brazilian Boneless price	3.2	1.6	5.1	272.3
Indian Boneless Quantity	47	0.026	125.8	118.7
Indian Boneless price	2.9	1.7	6.9	162.1
Brazilian In-Bone Quantity	0.085	0.0018	0.216	135.4
Brazilian In-Bone price	3.0	1.3	4.7	274.8
Indian In-Bone Quantity	0.778	0.198	2.315	82.3
Indian In-Bone price	2.7	1.18	3.55	248.7
Budget Share of Domestic Beef	0.73	0.61	0.85	5.7
Budget Share of Foreign Beef	0.24	0.11	0.37	45.3
Budget Share of Rest of World Beef	0.03	0.01	0.05	47.2

Unit: Quantity =1000 Ton, Price = $1000/Ton
Source: Author's own calculation

RESULTS AND DISCUSSION

c. Aggregation Bias Components

Table (2) shows the foreign aggregation bias term decomposed into country effect, product effect, and interaction effect as introduced by Aw *et al.* (1986) in equation (5, 6, 7).The contribution of the country effects and product effects to the total foreign products aggregation bias are both negative, i.e. $\Delta b_{FC} < 0, \Delta b_{FK} < 0$, indicating the change in the total quantity of imported beef and veal overestimates the change in the true imported quantity. This result confirms the aggregation bias existence and even if the data are disaggregated by product (boneless and bone-in), there is still significant country product aggregation bias (Davis 1997, Beghin *et al.* 1992).

d. Demand System of Beef

Seemingly Unrelated Regression (SUR) technique is applied to estimate the Rotterdam demand system in Equations (11a. and 11.b.). To conserve the degrees of freedom, the symmetry and homogeneity assumptions are imposed as follow:

- The symmetry hypothesis:

$$- c_{FD} = c_{DF}.$$

- The homogeneity hypothesis:

$$- c_{DD} + c_{DF} + c_{DR} = 0\,, c_{FD} + c_{FF} + c_{FR} = 0.$$

To check the aggregation bias, Wald test is applied to check the null hypothesis- foreign aggregation bias:

$$g_{FC} = g_{FK} = g_{FCK} = 0\,.$$

To compare between the restricted and unrestricted models, likelihood Ratio (LR test) is calculated as follow:

$$LR = -2(L_r - L_u)$$

Where L_r and L_u are the maximized values of the log likelihood functions of the restricted and unrestricted models respectively. The degrees of freedom in LR test are the difference between parameters of unrestricted and restricted models.

Table 2. Aggregation bias in foreign imported beef and veal (2002-2020)

Year	Price Index ΔP^*_{Ft}	Quantity Index ΔQ^*_{Ft}	Aggregation Bias $\Delta B_{it} = \Delta P^{LC}_{Ft} - \Delta P^*_{Ft}$	Country Effect Δb_{Fct}	Product Effect Δb_{Fkt}	Interaction Effect Δb_{Fckt}
2002-03	0.8634	0.4498	-0.9460	-0.9477	-0.9948	0.9965
2003-04	1.0836	1.1449	-1.0033	-1.0033	-1.0033	1.0033
2004-05	1.0358	1.4715	-1.0009	-1.0007	-1.0008	1.0006
2005-06	1.0140	1.5261	-1.0001	-0.9998	-1.0004	1.0001
2006-07	1.0415	1.2259	-0.9982	-0.9981	-1.0003	1.0002
2007-08	1.8433	0.5158	-1.2354	-1.2384	-1.2289	1.2319
2008-09	1.2150	0.7008	-1.0275	-1.0278	-1.0187	1.0190
2009-10	1.0097	1.7423	-1.0040	-1.0046	-0.9995	1.0001
2010-11	1.0124	0.9096	-1.0003	-1.0003	-1.0001	1.0001
2011-12	1.1015	1.2552	-0.9996	-0.9997	-1.0053	1.0054
2012-13	0.9659	1.0059	-1.0287	-1.0288	-1.0019	1.0019
2013-14	1.1252	1.1332	-1.1840	-1.1575	-1.0019	0.9755
2014-15	0.8151	1.7599	-1.0672	-0.9200	-1.0292	0.8820
2015-16	1.0587	0.6040	-0.9785	-0.9644	-1.0032	0.9891
2016-17	0.9056	1.1930	-1.0246	-1.0444	-1.0068	1.0266
2017-18	0.6692	1.6802	-1.0834	-1.0834	-1.0751	1.0751
2018-19	1.3923	0.5026	-1.0605	-1.0604	-1.0617	1.0617
2019-20	1.7341	0.8916	-1.1834	-1.1832	-1.1840	1.1838
Average	1.1048	1.0951	-1.0459	-1.0368	-1.0342	1.0252

Source: Author's own calculation

The results of SUR estimates of unrestricted and restricted models in table (3) show that the coefficients of domestic price (c_{DD}), foreign prices (c_{DF}) and total quantity(b_D, b_F) are statistically significant with expected signs in unrestricted and restricted models except for the insignificance of foreign price (c_{FF}) parameter in restricted model. In the unrestricted model, although the country and product aggregation bias parameters are statistically insignificant, the interaction aggregation bias parameter is statistically significant. Table(3) shows the significance of LR statistic at more than 1% statistical level, i.e. unrestricted model which consider the aggregation bias is preferable than the restricted model.

Table (4) shows the results of Wald test, indicates to that p-value is less than 0.05, i.e. the null hypothesis is rejected, and the model has aggregation bias.

e. price and expenditure elasticities

Table (5) shows the results of expenditure, own price, cross price elasticities of domestic and foreign beef. The domestic beef and veal has an expenditure elasticity of 0.420, which means that as total expenditure rises by 1%, the expenditure on domestic beef would tend to rise by only 0.420%. This result is consistent with the fact that domestic beef and veal (Kandoz) is necessary good specially in case of relative stability of income in which consumers couldn't change the expenditure on essential commodities as the income slightly increases. The expenditure elasticity of foreign beef is 4.455, which means that, as total expenditure rises by 1%, the expenditure on foreign beef would tend to rise by higher than one, i.e. it is classified as luxury good.

Table 3. SUR estimates of unrestricted and restricted models

Equation	Parameter	Unrestricted Model			Restricted model		
		coefficient	t-stat.	p-value	coefficient	t-stat.	p-value
Domestic Equation	α_D	-3.55E-05	-0.006	0.995	-0.003	-0.578	0.568
	c_{DD}	-0.402	-2.725	0.046	-0.421	-3.544	0.001
	c_{DF}	0.365	3.097	0.005	0.577	4.841	0000
	b_D	0.373	4.329	0.000	0.514	5.910	0.000
Foreign Equation	α_{DF}	-0.014	-0.872	0.391	-0.009	-0.859	0.398
	c_{FF}	-0.105	-3.166	0.004	-0.035	-0.599	0.554
	b_F	0.489	6.353	0.000	0.294	3.727	0.001
	g_{FC}	-0.092	-0. 946	0.353	-	-	-
	g_{FK}	-0.093	-0.908	0.372	-	-	-
	g_{FCK}	0.056	6.552	0.000	-	-	-
Log-likelihood		91.1			75.7		
LR Statistic= 30.8 , df.=3, p-value= 9.37E-7							

Source: Author's own calculation

Table 4. Hypothesis test of aggregation biasness

Hypothesis	χ^2	D.F.	P-Value	Decision
No aggregation bias $g_{FC} = g_{FK} = g_{FCK} = 0$	12.13	3	0.007	Reject

Source: Author's own calculation

The own price elasticities of demand for domestic and foreign beef are negative and lower than unity and consistent with the economic theory. The domestic beef has price elasticity of -0.475, i.e. the demand for domestic beef is inelastic to reflect the low sensitivity of domestic demand to price change due to relative fixed consumption of domestic beef as a necessary commodity in the household food items. The foreign beef has price elasticity of -0.955, and i.e. the demand for foreign beef is almost elastic. According to the values of cross-price elasticities, the domestic beef, foreign beef, and beef from rest of the world are substitute to each other. The domestic beef equation has cross-price elasticity values of 0.415, and 0.043 with foreign and ROW respectively, while the foreign beef equation has cross-price elasticity values of 3.318, and 0.345 with domestic and ROW respectively. The small magnitude of cross price elasticity of domestic beef refers to low substitutability between domestic and foreign beef, while the high magnitude of cross price elasticity of foreign beef refers to the considerable substitutability between foreign and domestic beef.

Table 5. Elasticity parameters of unrestricted model

	Expenditure elasticity	Price Elasticities		
		Domestic	Foreign	ROW
Domestic	0.420	-0.457	0.415	0.043
Foreign	4.455	3.318	-0.955	0.345

Source: Author's own calculation.

Table 6. The impact of price differences of domestic and foreign beef on compensated variation

Item	domestic beef	foreign beef
Initial price 1000 $/ton	4.7	3.2
Initial quantity 1000 ton	402	197
Total expenditure Million $	2601	2601
Max price1000 $/ton	6.2	5.08
Own Price elasticity	-0.457	-0.955
Compensated Variation(CV), %	21.5	10.2

Source: Author's own calculation.

f. Compensated Variation

The compensating variation measures the total transfer required to compensate consumers due to price increase between the average price (initial point) and maximum price observed during 2002-2020. This paper simulates the price change of domestic beef between the maximum price ($ 6.2 thousand/ ton) and average price ($4.7 thousand/ ton) during 2002-2020. The identical simulation for foreign beef is preceded between the maximum price ($ 5.08 thousand/ ton) and average price ($3.2 thousand/ ton) during 2002-2020. The results suggest that consumers suffer welfare loss for both domestic and foreign beef due to the price increase, but they suffer more from changing domestic beef prices. Table (5) shows that consumers should be compensated by about 21.5% and 10.5 % in case of domestic and foreign beef respectively.

2. Summery and Conclusion

This paper introduces the Egyptian demand system for beef in the framework of aggregation bias approach to get consistent parameters of price elasticities and then the consumer surplus. The aggregation bias of foreign beef is decomposed into country effect (Brazil, India and rest of the world) and product effect (boneless and in-bone beef). The country effects and product effects in foreign beef during (2002-2020) are both negative indicating to that the inconsistent aggregation of imported beef quantity overestimates the consistent aggregation. To check aggregation bias and derive the consistent elasticity parameters, Rotterdam demand system is applied to estimate the beef demand system by Seemingly Unrelated Regression Estimation (SURE). The system consists of 3 equations (domestic, foreign, and rest of the world) in the restricted form without aggregation bias components and the unrestricted form with aggregation bias. The hypothesis of no aggregation bias is rejected according to Wald test. The parameter of interaction aggregation bias is statistically significant, LR test proved the preference of the unrestricted model than the restricted model.

The parameters of expenditure elasticity are 0.420, 4.455 for domestic and foreign beef respectively. The first glimpse for the high expenditure elasticity parameter of foreign beef as luxury product may be confusing and unexpected, but it may be interpreted easily if we consider it as two kinds of products; the non-prepared beef which is consumed by households sector specially the low income consumers' category but at the same time it is considered as input in intermediary producing of semi-prepared beef in the sector of food processing enterprises. In the last ten years, and as a result of households' income improvement, Egyptian food consumption converted to fast food even inside homes or out-homes in restaurants and hotels to simulate life style of west countries. This new consumption pattern induces the demand for foreign beef by business sector to match the increase demand for households, restaurants, and hotels.

The domestic and foreign beef own price elasticities are -0.475 and -0.955 respectively. The inelastic demand of domestic beef reflect the low sensitivity of consumers to price change due to relative fixed consumption of domestic beef as a necessary commodity in the household food items. On the contrary, the demand for foreign beef is almost elastic to reflect the less necessity for consumers than domestic beef. The domestic and foreign beef cross-price elasticity values are 0.415,

3.318 respectively. It could be concluded from these results that foreign beef may be an appropriate substitutes if the domestic price increases specially for the low income consumers' category, while the opposite is not true because the consumers of domestic beef discriminate between domestic and foreign beef and consider them as two different products in terms of taste.

To illustrate the consumer surplus, this paper simulates the price change of domestic and foreign beef between the observed maximum price and average price in each type during 2002-2020. The results suggest that consumers suffer welfare loss for both domestic and foreign beef due to the price increase, but they suffer more from changing domestic beef prices. Consumers should be compensated by about 21.5% and 10.5 % as the domestic and foreign beef prices increase over the average prices. The differences of compensation percentage between domestic and foreign beef may be interpreted by inelastic demand for domestic beef, and the almost elastic demand for foreign beef.

Although the domestic and foreign beef exhibit the same challenge of exchange rate liberalization policy since 2016 which increased the import bill of foreign beef and forages, the domestic beef supply faces greater challenge represented by shortage of fodders due to the limited cultivated area and then domestic price increased. On the Contrary, the price of foreign beef faces less challenge due to the zero tariffs of meat imports in Egypt. Based on the main results and finding, consumer welfare may be improved through stabilizing domestic beef prices by enhancing the supply side which includes: developing the livestock farms, selecting high- yield breeds, improving the fodder productivity and veterinary services.

Future research should consider the aggregation bias in estimating the domestic and imported demand under various income categories(high- middle- low), seasons (normal days- celebrations and feasts), sectors (home, outdoor (restaurant), food processing enterprises) and type (fresh slaughtered , semi-prepared, processed, offal). Another interesting starting point for future analysis is considering the role of socioeconomic and demographic characteristics on the demand shift and estimation the expenditure and price elasticities for various situations and categories.

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التقدير القياسى لأثر التباين السعرى للحوم الماشية المحلية والمستوردة على فائض المستهلك المصرى

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فى إطار التحديات التى تواجه قطاع الثروة الحيوانية فى ج. م. ع. ، يواجه الطلب على لحوم الماشية عددا من المشكلات، أهمها: إنخفاض نسبة الإكتفاء الذاتى من 75% إلى 56% ، إرتفاع أسعار الأصناف المحلية والمستوردة خلال الفترة (2002-2020). وتتمثل مشكلة البحث فى : (1) تباين الضرر على رفاهية المستهلك نتيجة تباين الزيادة السعرية ، (2) التحيز التجميعى لنموذج الطلب نظرا للتميز الشديد للحوم المستوردة وفقا للدولة المصدرة (البرازيل-الهند- العالم) ووفقا للنوع (بدون عظام – بالعظام). وفقا لذلك، فقد إستهدف البحث : (1) التقدير القياسى لنموذج الطلب لإشتقاق المرونات ولفحص تحيز النموذج. (2) حساب فائض المستهلك نتيجة لإرتفاع الأسعار . تم تطبيق نموذج طلب روتردام فى إطار مدخل التحيز التجميعى للحصول على معلمات متسقة إحصائيا. أوضحت النتائج وجود مشكلة التحيز التجميعى بإستخدام إختبار Wald بالنموذج المقيد لتقدير الانحدار غير المرتبط ظاهريا SURE . كما تبين أن معامل المرونة الإنفاقية يقل عن الواحد للحوم البلدية ، بينما يزيد عن الواحد بالنسبة للحوم المستوردة. و أوضحت معاملات المرونة السعرية أن الطلب على اللحوم البلدية طلب غير مرن ، كما أوضحت معاملات المرونة التقاطعية أن اللحوم البلدية ضعيفة الإحلال كبديل للحوم المستوردة ، بينما تعتبر اللحوم المستوردة بديل مناسب للحوم البلدية. وأخيرا فقد تبين أنه بارتفاع أسعار اللحوم البلدية والمستوردة عن متوسط سعر كل منهما خلال الفترة (2002-2020) فإنه يجب تعويض المستهلك بحوالى 21.5% ، 10.5 % من نسبة الإنفاق على اللحوم البلدية والمستوردة على الترتيب. ويقترح من تلك النتائج ضرورة تضمين مفهوم التحيز التجميعى بنماذج الطلب مستقبلا لتقدير مرونات متسقة وأثره على فائض المستهلك على مستويات الدخول المختلفة وعلى كافة القطاعات الإستهلاكية.

الكلمات المفتاحية: التحيز التجميعى،التباين،التعويضى،SURE.