Using Double-Log Imperfect Import Substitutes Model to Estimate Compensated Elasticities and Welfare Impacts

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Abstract

Decisions on the effects of safeguard mechanisms have been more on theoretical grounds often due to lack of precise estimation of elasticities that can be used to calibrate welfare effects. Alston et.al., (2002) demonstrate that the double logarithmic demand models can be augmented by Slutsky equation to create compensated demand equations which, when estimated result into precise compensates elasticities important for welfare analysis. This study demonstrates a similar adjustment on a dynamic double log Imperfect Import substitutes model to allow for estimation of compensated and uncompensated elasticities. Elasticities from three estimators OLS, SURE and IV indicate that imported wheat, maize and rice are normal commodities in Kenya. The uncompensated elasticites are bigger in magnitude than the compensated elasticities. Focusing on wheat, these compensated elasticities are subsequently used to estimate welfare measures of import tariffs or safeguard mechanisms through the manifested price changes. Results favour a non-tariff wheat importation regime and also favor consumer protection. The study recommends removal of the tariff rate and alternative ways of improving domestic wheat production rather than import restrictions.

JEL: Q17 Q18

Key Words: *Safeguard mechanism; Imperfect import substitutes; welfare impacts; wheat; Kenya.*

Introduction

The effects of import restrictions or import taxes have mostly been based on theoretical judgment. In the theoretical literature, the bearing of these policy measures is well hypothesized, yet empirical assessment has been very limited. Particularly, the main reason could be due to the rigor required in the estimation of elasticities which would be precise in the estimation of the actual measures of, say consumer and producer surplus. The requirement of estimating such measures of welfare is in particular the compensated elasticities. Compensated elsaticities or hicksian elasticities are net of income effect and are useful in estimation of welfare measures. Import demand, takes the approach of the general demand system and could be entrenched within the usual demand theory. Several studies have so far entrenched import demand or related issues of international trade into the theory of demand (see Hong, 1999), estimated the elasticities and even computed some welfare measures

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e.g. Bandinger et al., (2002), Seleka, (2006), Kang et al., (2008). However, none has attempted to interpret the estimated elasticities as to whether they are compensated or uncompensated which would be exact approximation of Compensating Variation (CV).

There are several challenges to import demand studies. One, imports are not perfect substitutes to the domestic products else assumed. Secondly, estimation of import demand functions is faced by the problem of endogeneity and price taking behavior of countries, particularly the developing countries are price takers and thirdly the estimation of whether conditional or unconditional elasticities. The fourth and perhaps the focus of this paper is the problem of estimating compensated elasticities from import demand function. The first challenges could be addressed through empirical specification of the import functions in particular the imperfect substitutes model while the second could be addressed through instrumentation following tests of endogeneity. The third is a matter of choice of the opportunity set to be used in the import function. The fourth challenge is tackled in this paper. Despite these challenges, this paper attempts to show that an import function derived from demand theory, without use of duality, can be deflated in a manner similar to Alston et al., (2002) approach to double log models. Challenges related to the deflating index are also tackled. The paper also compares estimates from OLS, SURE and IV estimators.

The paper proceeds as follows; in the second part, a discussion of the cereal imports and production in Kenya is given, the third section covers the analytical framework while in the fourth section, the model is applied to maize and wheat imports in Kenya. The last part concludes the paper.

Kenya Cereal Production and Imports

For a long time, Kenya has not been sufficient in three and most important cereals; maize, wheat and rice. The production of these important cereals has remained relatively constant against the growing population which has pushed the consumption levels upwards. For instance, Kenya meets only 40 percent of its total wheat consumption. In 2007, Kenya's domestic wheat demand was estimated at 677.0 thousand tonnes, against the production of 113 thousand tonnes prompting imports amounting to 1,129.0 thousand tonnes (UNComtrade, 2009). The domestic production, between 1980 and 2007, realized only 2.4 percent for maize, 3.0 percent for wheat and 0.8 percent for rice average growth[2]. The population growth rate[3] at 4.9, over the same period, surpassed the cereals growth rate. The relatively constant trends in domestic production over the considered period are depicted in Figure 1.

The high population growth rate, buoyed by a 0.4 percent real income growth[4] between 1980 and 2007, has pushed cereals demand against the poor against the relatively constant production growth. The result has been increasing deficit in demand for the cereals.

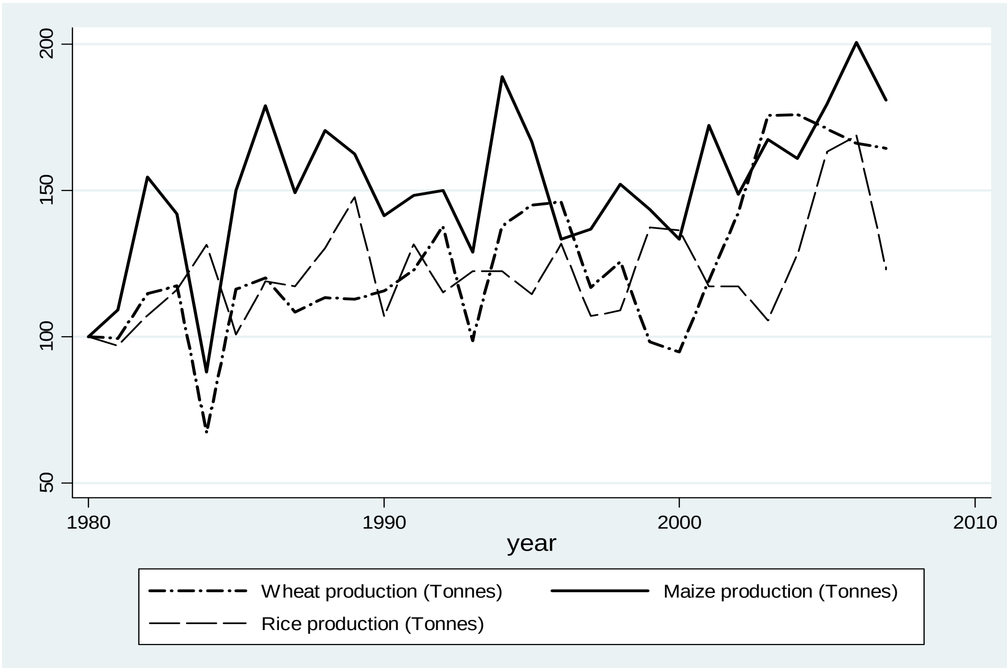

Figure 1. Domestic Cereal Production trends 1980-2007 (1980=100)

(Source: FAOSTAT database 2009)

Cereal imports have been the easier option to fill the deficit and have been rationed based on the domestic production levels. This is to avoid over surplus that would dampen the producer prices (Nyangito et.al, 2002). The imports have increased overtime, a sign that, the country may not in the near future regain significant production potential. Imports of cereals, although exhibit an erratic trend, have been on increase. An Economic Partnership Agreement (EPA) report by KIPPRA[5], (2005) forecasted that by 2015 Kenya's wheat consumption is projected to be about 2,400 thousand tonnes against a production level of 1,900 thousand tonnes. By 2025, wheat

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[2] Estimates from FAOSTAT database 2009
[3] Estimates from KNBS data (Various Economic Surveys)
[4] Estimates from KNBS data (Various Economic Surveys)
[5] KIPPRA (Kenya Institute for Public Policy Research and Analysis)

is projected to have overtaken maize as the leading staple food in Kenya. Wheat grain imports increased from over 49 thousand tonnes in 1980 to over 616 thousand tonnes in 2007. The share of wheat imports in Kenya relative to the world imports increased 0.07% to 0.44% between 1980 and 2006, while within Africa, Kenya's share of imports increased from 0.4% to 2% over the same period. Maize relatively declined from over 323 thousand tonnes to less than 114 thousand tonnes while Rice equivalent imports increased from over 13 thousand tonnes to over 259 thousand tonnes. Figure 2 shows the trends of imports over the period under consideration. The trends in maize import decline, though production grew slightly, may be occasioned by consumption shifts to other soft cereals. This shift from maize to cereals such as rice and wheat could explain somehow the increasing demand for the later two cereals and consequently their increasing imports. Besides, rice production in Kenya reduced with the collapsing of most of the irrigation schemes in late 1990s and this also contributed to the increased importation.

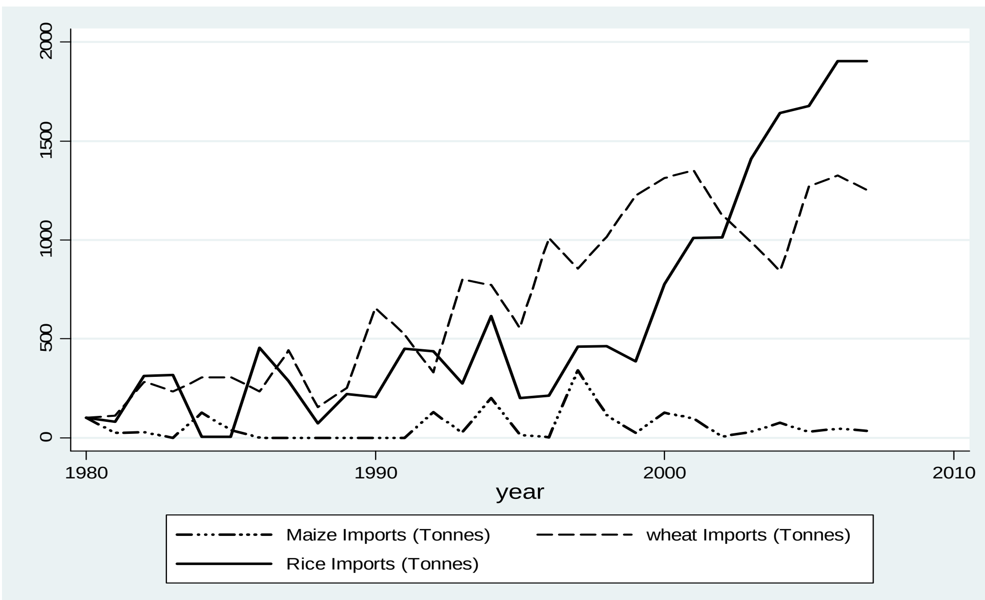

Figure 2. Cereal Import Trends in Kenya 1980-2007 (1980=100)

Source: FAOSTAT database 2009

The government, citing increasing imports and particularly for wheat and in a bid to curb over importation and promote domestic wheat industry, introduced some safeguard mechanisms in 2000; import tariffs. The imposed import tariffs have ranged from 25% in 1997 to 35% (plus 50% suspended duty) in 2000.These duties are reviewed after every three months to offer producers protection depending on the level of production and domestic demand (Nyangito et al., 2002). Since 2001, through a safeguard mechanism granted by COMESA, a tariff rate of 35% has been applied on imported wheat from all countries. The tariff on wheat was to be zero rated by early 2009 for imports from COMESA country states to allow for regional integration.

While the tariff make imported wheat expensive than the locally produced wheat and have far reaching effects to both producers and consumers, the domestic pricing mechanism is based on the prices of imported wheat hence giving the imported wheat an edge in the market. The import tariff is expected to have adversely affect wheat consumers who are increasing especially in the urban areas (Nzuma and Sarker, 2010) through erosion of their welfare as wheat products prices increase while at the same time protecting the domestic wheat industry. Under the safeguard mechanism, the gains accrued to producers should be commensurate to the losses incurred by consumer. This implies that the safeguard mechanism should set all the stakeholders well off. The low response in domestic wheat production, increasing wheat grain importation and increasing consumer prices for wheat products at the background of imposed safeguard mechanism points to unbalanced benefits between producers, consumers and the intermediary agents. Analysis of the effects of the wheat safeguard mechanism and the resulting welfare are sensitive to the estimates of import demand elasticities. The magnitude of the benefits to producers and the importing firms/government and losses to consumers are not well known raising questions as to whether the wheat safeguard mechanism should continue being applied. This stems from lack of sufficient, exhaustive and elaborate empirical examination of wheat import demand and the implied impacts of wheat import tariffs on wheat producers, consumers, importing and wheat processing firms and the resultant resource reallocation under poor enterprise competitiveness. Consequently the result has been ad-hoc imposition of import tariffs and inconclusive decisions on whether to continue with the safeguards measures or not.

Analytical Model

From the theory of demand and drawing analogy from specification of usual demand functions, an import demand function can be specified as quantity imported as a function of price of the imported commodity, prices of substitutes and income (see Faini et al., 1988; Khan, 1974; Kalyoncu, 2006) as follows;

$$M_t^d = f(p_{mt}^{\beta_m} p_{dt}^{\beta_d} Y_t^{\beta_Y} e_t^{u_t}) \qquad (1)$$

Equation (1) can be linearized to;

$$\ln M_t^d = \alpha_o + \beta_1 \ln p_{mt} + \beta_2 \ln p_{dt} + \beta_y \ln Y_t + u_t \qquad (2)$$

Where, M_t^d is the desired quantity of importation at time period t, p_{mt} is the import price of the commodity, p_{dt} is the price of similar domestically produced commodities and Y_t is the GDP of the importing country which in import demand can be replaced with import expenditure. Two forms of equation (1) are estimated; with absolute prices or with relative prices (Sinah 1997). The former connotes imperfect substitution between imports and domestic commodities and is referred to as the traditional import demand function (Faini et al., 1988) or the imperfect import substitutes model while the latter connotes perfect substitution of the imports and domestically produced commodities. In most import demand studies, equation 1 connotes the widely known Marshallian demand function (Duarte, et al., 2006) and therefore the estimated price coefficients from the linearized function represented by equation 2 can be interpreted as Marshallian elasticities and the income coefficient as income elasticity of import demand. In theoretical understanding these are uncompensated elasticites. The left hand side variable of equation (1) is not observable the equation is not estimable if partial adjustment mechanism is not specified. This requires that the actual change (difference) in imports over subsequent periods be related to desired quantity for imports in period t and actual imports in period $t-1$ (Khan, 1974) as follows;

$$\Delta \ln M_t = \gamma[\ln M_t^d - \ln M_{t-1}] \qquad (3)$$

Where, $0 \leq \gamma \leq 1$ is the range of coefficient of adjustment and $\Delta \ln M_{it} = \ln M_{it} - \ln M_{it-1}$ is the actual change. Substituting (2) into (3) and solving for imports in period t, results to the following import demand short run partial adjustment model in equation 4.

$$\ln M_t = \gamma\alpha_o + \gamma\beta_1 \ln p_{mt} + \gamma\beta_2 \ln p_{dt} + \gamma\beta_y \ln Y_t + (1-\gamma)\ln M_{t-1} + \gamma u_t, \qquad (4)$$

The framework of equation 4 defines the dynamic import demand function and the elasticities are the associated parameters.

The imperfect substitutes model is recovered from equation (4) by simply using the price ratios of the import unit values to the domestic prices of the same type or category as follows;

$$\ln M_{jt} = \gamma\alpha_o + \gamma\beta_j \sum_{j=1}^{3} \ln\left[\frac{p_{mjt}}{p_{djt}}\right] + \gamma\beta_y \ln Y_t + (1-\gamma)\ln M_{jt-1} + \gamma u_t \qquad (5)$$

j=1, 2, 3 for Wheat, Maize and Rice respectively

The imperfect substitutes model is build under the assumption that imports are not perfect substitutes to the domestically produced commodities (Hong, 1999). There can be several imported commodities like the cereals. However, the elasticities cannot be interpreted as compensated "hicksian" but rather uncompensated or "marshallian". In accordance with Alston et al., (2002) deflating the price of commodities and income included in the model with one of the relative commodity prices imposes homogeneity and homogeneity can be maintained and tested as;

$$\gamma\beta_1 + \gamma\beta_2 \ldots\ldots\gamma\beta_n + \gamma\beta_y = 0 \qquad (6)$$

In most studies Consumer Price Index (CPI) is used to deflate income and price variables (see for instance Aziz and Horsewood, 2008). The pitfall of the use of the CPI is that it adds another variable in the model rather than imposing homogeneity Alston et al, (2002) since it is constructed including extra prices not considered in the model.

Following Alston et al., (2002) framework compensated elstaicities can be obtained from equation 4 through Slutsky equation. The Slutsky equation is denoted as;

$$\beta_{ij}^{m} = \beta_{ij}^{h} - \beta_y w_j \qquad (7)$$

Where β_{ij}^{m} is the uncompensated elasticity, β_{ij}^{h} is the compensated elasticity and β_y is the income elasticity with w_j being the share of the jth commodity in the import expenditure. Substituting 7 into 5 yields;

$$\ln M_{jt} = \gamma\alpha_o + \gamma\sum_{j=1}^{j}[\beta_{ij}^{h} - \beta_y w_j]\ln p_j^{*} + \gamma\beta_y \ln Y_{yt} + (1-\gamma)\ln M_{jt-1} + \gamma u_t \qquad (8)$$

This is simplified to;

$$\ln M_{jt} = \gamma\alpha_o + \gamma\beta_{ij}^h \ln p_j^* + \gamma\beta_y \frac{\ln Y_t}{\sum_{j=1}^{3} w_j \ln p_j^*} + (1-\gamma)\ln M_{jt-1} + \gamma u_t \qquad (9)$$

Where $p_j^* = \frac{p_{mjt}}{p_{djt}}$. The index $\sum_{j=1}^{n} w_j \ln p_j^*$ is the Stone's price index and is approximated as $\sum_{j=1}^{n} w_j (\ln p_{mjt} - \ln p_{djt})$. The elasticities of equation 9 with respect to price can now be interpreted as compensated elasticties. Further, to impose homogeneity in equation 8, it is possible to use the price of any substitute commodity to deflate the other prices in the model.

Results of the estimated Import Demand Functions

Estimation issues of Time series data

Since time series data is prone to stationarity Augmented Dickey Fuller (ADF) tests were undertaken. The ADF tests were conducted for variables at level and at first difference with trend. The non-stationarity hypothesis was tested against 1%, 5% and 10% the critical values and stationarity accepted using the MacKinnon p-values. The variables used in the models are described in Appendix 1. The results (not reported here) of Augmented Dickey-Fuller test for unit root (ADF) showed that, at level, the hypothesis of non-stationarity could not be rejected unlike at first difference except for the domestic production trends for maize and rice. While the GDP for Pakistan which was used as an instrument for rice price was integrated of second order. Several diagnostics tests important when using Instrumental Variable 2SLS included the *Sargan*, and *Bassman* which validate the instruments used.

Definitely there are several estimators for equation 9. Potential pitfalls of estimating equation 9 relate to endogeneity of import prices, the income (expenditure on imports) and imported quantities. Endogeneity between the expenditure variable and the dependent imported quantities follows the derivation of the former from prices and quantities making it correlated with the error term (LaFrance, 1991). In Musyoka, (2009) endogeneity between the imported quantities of wheat and the import prices was reported. This requires instrumentation of the import price from the import supply equation hence prompting the use of instrumental estimation techniques. The exogeneity between the adopted income variable and the dependent variable (imported quantities) is assumed. Further, the three cereal imports could be estimated as a system of three equations since the error covariance matrix cannot be assumed to be an identity matrix and this can be solved by use of seemingly unrelated regression analysis (SURE). Equation (9) is estimated for wheat, maize and rice imports using OLS and Instrumental Variable (IV) regressions and SURE. The Stone's Price index is adjusted according to Moschini (1995) to invoke units of measurement variation respectively. However, the correction by Eales and Unnevehr, (1988) is not done since in the left hand side, the dependent variable is quantity rather than a share as is in Linear Approximate Almost Ideal demand System (LA/AIDS) and other share dependent variables models. In both estimators, the model is estimated for uncompensated and compensated and with homogeneity. In the analysis, demands are specified with inclusion of substitutes.

The OLS[6] estimates of the compensated and uncompensated models are reported in Table 1. From the general look, except the rice equation, the equations for wheat and maize are relatively well fitting.

Table 1 OLS Estimates of the Imperfect imports model

Compensated Imperfect Model				**Uncompensated Imperfect Model**		
Variable	**Wheat**	**Maize**	**Rice**	**Wheat**	**Maize**	**Rice**
β_{pw}	**-0.395****	1.037	-0.982	**-0.711*****	0.234	-1.108
	(0.019)	(0.507)	(0.308)	(0.000)	(0.904)	(0.362)
β_{pm}	-0.038***	**0.331*****	-0.037	-0.039***	**0.346*****	-0.033
	(0.000)	(0.000)	(0.469)	(0.000)	(0.000)	(0.515)
β_{pr}	0.433**	-1.369	**1.019**	0.750***	-0.580	**1.141**
	(0.010)	(0.376)	(0.285)	(0.000)	(0.764)	(0.344)
β_{y}	0.485***	**2.311****	**0.536**	0.451***	1.712*	0.353
	(0.000)	(0.026)	(0.445)	(0.000)	(0.074)	(0.545)
DW	1.504	2.467	2.270	1.26	2.44	2.25
***significant at 1%, **significant at 5% and * significant at 10%, P-values in parenthesis						

A short discussion of the results before comparing the compensated and uncompensated elasticites is important. The compensated import demand price elasticity for wheat is (-0.385) and maize (0.331) and are highly significant. The wheat estimate compares favorably with the results of Musyoka, (2009). Maize import price elasticity is positive which is anti theoretical and requires some explanation. When a country imports essential commodities, it is hard to respond

[6] Reported here are only the elasticities for the Price matrix (***pw****-import price of wheat,* ***pm****-import price of maize,* ***pr****-import price of rice and* ***y****-the expenditure on import of the three cereals*) and the expenditure. The rest of coefficients are available upon request. The same trend is also maintained for results of SURE and IV

immediately to the world price changes (Wejeweera et al., 2008). Indeed, the positive elasticity of the maize import price elasticity points to how essential the imported maize or generally maize is in Kenya. The compensated cross price elasticities for the substitutes are also significant. The import price elasticities of Maize and rice, which are considered substitutes for wheat are (-0.037) and (0.422) and are significant. Maize appears to be a complement for wheat while rice is a substitute. Partly, the behavior of rice and wheat may explain the shifts in demand between the two. The behavior of maize as a complement can be as resulting from its importance as the staple cereal in the country. The income elasticities are positive across all the equations emphasizing on the essentiality of the cereal imports but they are only significant for wheat and maize. This point to the increasing demand for imports as the domestic income increases. The fact that there is no negative income elasticity points to that, the domestic production of these cereals has not increased more than the corresponding imports. Imported maize is highly income elastic while imported wheat is income inelastic pointing to the growing importance of wheat in the diets of Kenyans.

A comparison between the compensated and uncompensated elasticities, reveal a similar trend about the importance of the variables of income and import price and that, as expected theoretically, the compensated elasticities are relatively smaller than the uncompensated. Rice equation is in both cases not well fitting and particularly this may call for different specification of the equation which is not tackled here. A Slutsky equation construction for wheat between from the compensated demands nearly approximates the uncompensated demands, that is, the compensated import price elasticity for wheat is (-0.385), income (0.470) while the share is (0.51). Fitting these values in a Slutsky equation, the uncompensated elasticity is (-0.63), close to the uncompensated functional estimate (0.70). This is a pointer to the existence of Slutsky relationship in import demand functions.

The SURE estimation is based on that the error covariance structure is not an identity matrix and thus the three equations are not independent. SURE estimation controls for possible equation dependence portrayed by the error covariance matrix. A test of independence confirmed residual correlation. The results of iterative SURE estimation are presented in Table 2. The results of the SURE estimation are relatively similar to those of the OLS estimates. The estimated compensated own price elasticity of imports for wheat is 0.42, for maize 0.33 and for rice 1.17. But the own elasticity for rice is not significant. The estimated compensated and uncompensated elasticities are similar to those of OLS, just slightly larger and the trend of significance is maintained. All the cereals imported are normal goods since the uncompensated elasticities are larger than the compensated elasticities.

Table 2. Maximum Likelihood SURE Estimates of the Imperfect imports model

	Compensated			Uncompensated		
	Wheat	Maize	Rice	Wheat	Maize	Rice
β_{pw}	**-0.419*****	1.434	-1.140	-0.723***	0.195	-1.204
	(0.002)	(0.282)	(0.141)	(0.000)	(0.907)	(0.217)
β_{pm}	-0.034***	**0.325*****	-0.034	-0.036***	0.342***	-0.027
	(0.000)	(0.000)	(0.405)	(0.000)	(0.000)	(0.509)
β_{pr}	0.453***	-1.760	**1.174**	0.759***	-0.537	1.231
	(0.001)	(0.183)	(0.125)	(0.000)	(0.745)	(0.204)
β_{y}	0.495***	2.872***	0.688	0.451***	2.307***	0.378
	(0.000)	(0.001)	(0.209)	(0.000)	(0.004)	(0.415)
R sqrd	73	78	15	77	78	14
Breusch-Pagan test of independence: chi2(3)			8.684 (0.0338)			7.058 (0.0701)
Dw			1.63			1.3
***significant at 1%, **significant at 5% and * significant at 10%, P-values in parenthesis						

The IV estimates are presented in Table 3. The Instrumental variable approach controls for the possible endogeneity between imported quantities and prices. The specified inverse supply function of equation 9 is instrumented by the real incomes from the main importing countries. For wheat, the real GDP for Argentina is used while for maize, real GDP from South Africa and for rice, Pakistan are used. Only the compensated estimates are presented here for comparison with the OLS estimates. First, the Sargan and Basmann tests are insignificant to indicate that the instruments used are valid, otherwise a statistically significant test statistic always indicates that the instruments may not be valid.

The results from the IV estimation reveal not very different estimates from the OLS. Although the existence of simultaneity may not be ruled out in the OLS estimations, the close estimates may show that it is insignificant. In Musyoka, (2009), the simultaneity between import prices and imported quantities was evident only under robust error estimations of the Hausman specification tests hence the possibility of wishing it away here since it may affect the end conclusion in a very slight way.

Although the reported elasticities are relatively lower than those of the OLS and SURE estimators the trends of importance of variables are also here maintained especially for wheat and maize equations. But more, at least some coefficients are significant for rice unlike in the OLS. The import price elasticity for rice is significant and positive and again can be interpreted similarly as done for maize in the OLS; that is the imported rice plays an essential role in the consumption pattern. The significance of some coefficients in the IV equation for rice emphasizes for special attention in modeling rice imports demand in Kenya.

Table 3. Instrumental Variable (IV) estimates of Compensated Demand equations

Compensated Imperfect IV				**Uncompensated Imperfect IV**		
	Wheat	**Maize**	**Rice**	**Wheat**	**Maize**	**Rice**
β_{pw}	**-0.299***	0.527	-3.101*	**-0.712*****	-0.397	-3.458**
	(0.076)	(0.704)	(0.057)	(0.001)	(0.815)	(0.048)
β_{pm}	-0.037***	**0.376*****	-0.017	-0.037***	**0.388*****	-0.004
	(0.000)	(0.000)	(0.724)	(0.000)	(0.000)	(0.926)
β_{pr}	0.335**	-0.903	**3.118***	0.750***	0.009	**3.462****
	(0.044)	(0.509)	(0.054)	(0.001)	(0.996)	(0.047)
β_{y}	**0.424*****	**2.768*****	**1.413***	0.446***	2.121**	1.139
	(0.000)	(0.002)	(0.081)	(0.000)	(0.012)	(0.112)
Tests of over identifying restrictions:						
Sargan chi2(1)	0.042 (P= 0.838)	0.006 (p= 0.940)	0.403 (p= 0.526)	0.086 (p = 0.769)	0.095 (p= 0.758)	0.372 (p = 0.541)
Basmann chi2(1)	0.027356 (P= 0.869)	0.0037 (p= 0.952)	0.26754 (p= 0.605)	0.0566 (p = 0.812)	0.0624 (p= 0.803)	0.2481 (p = 0.618)
DW	1.478	2.2685	2.394	1.272	2.396	2.241
***significant at 1%, **significant at 5% and * significant at 10%, P-values in parenthesis						

Welfare Estimation

Having estimated the compensated elasticities, and drawing analogy of partial trade models, it is possible to simulate the consumer surplus/or more precisely the compensating variation to consumers due to effects of a price increase emanating from a safeguard restriction or import tariff. There are three important measures to welfare; consumer surplus (CS), compensating variation (CV) and equivalent variation (EV). Although consumer surplus is the classical tool which can be used in approximating welfare changes on the consumer side, it is a perfect estimator of consumer surplus under quasi-linear utility functions but in the case where the utility function is not a quasi-linear the consumer surplus could be used as an approximate measure of welfare (Varian, 1992). A quasi-linear utility function connotes a demand function which has no income effect or else, income is held constant. If such hypothesis is made, then these demand functions connote the compensated or hicksian demands. In the case of imports, the importing country considered as a consumer can be taken to have a compensated demand equation 9 and the estimated elasticities could be interpreted as compensated elasticities. To this effect, through integration of the equation 9 over the domestic and import price gives the area under the compensated demand curve and this could be interpreted as compensating variation. On the other hand, similar integration of the uncompensated version of equation 9 estimates the consumer surplus. Using the OLS[7] estimates of for wheat, I simulate the effects of the 35% import tariff to evaluate the loss in CV while assuming that the supply is perfectly inelastic[8] such that even in the highest change in prices, supply response in minimal. This fits the Kenya's wheat production sub-sector which seems irresponsive to the imposition of the import tariffs. I focus on the estimation of consumer surplus since I can only rely on estimates from the literature to estimate the producer surplus. The estimations of CV and CS can be represented as follows:

Following a similar approach as in Seleka, (2006), from the OLS estimates, if other prices are held constant, the associated estimated compensated import demand function (using the price and income coefficients significant from zero) can be fitted as;

$$Q_{mw0} = \varnothing pw^{-0.40} \tag{10}$$

While the uncompensated is

$$Q_{mw} = \theta pw^{-0.70} \tag{11}$$

It is important to remember that equation 10 and 11 represent the estimates of "hicksian" and "marshallian" demand elasticities which by integration can be used in estimation of CV and CS respectively. It is possible to integrate the estimated logarithmic function over the price change or simply reformulate the logarithmic function to a power function and integrate over the same. The parameters (shifting parameters) $\varnothing$ and θ are estimated from inverting the respective equations. From equation (10) and (11) it is possible to estimate compensating variation and consumer

[7] There is no justification for choosing the OLS estimates as the best estimates. But from all the estimators the price elasticity of wheat import is estimated to be between 0.3 and 0.4.

[8] Nzuma and Sarker, 2010 estimates wheat supply price elasticity at 0.8, which actually can be rounded to one.

surplus respectively by integrating the compensated and uncompensated demand functions over price change due to import restriction as follows;

$$CV = \emptyset \int_{pm0}^{pm1} (pw^{\varepsilon_h}) dpw \qquad (12)$$

$$CS = \theta \int_{pm0}^{pm1} (pw^{\varepsilon_m}) dpw \qquad (13)$$

Where p_{m1} is the import price inclusive of the 35 percent import tariff which is the price of imports at the domestic market (import unit values plus the tariff) and p_{m0} is the import price at the border point (import unit value). Starting with the illustration of the situation, wheat price trends are shown in Figure 3. The price trends reveal that before liberalization of the economy in early 1990s, the domestic and import prices for wheat were nearly equal. This was during the import substitution policy. However after liberalization, the domestic prices relatively increased compared to imported wheat prices, a trend which has been maintained. In 2000, the introduction of a safeguard mechanism saw the increase in imported prices reducing the wedge between the imported and domestically produced wheat. The region on the right of the reference line at 2000 in Figure 3, shows the prevailing prices of wheat due to the import restrictions. Corresponding to the post 2000 region, the demand functions (10 and 11) are integrated over the prices inclusive of tariff and the border price.

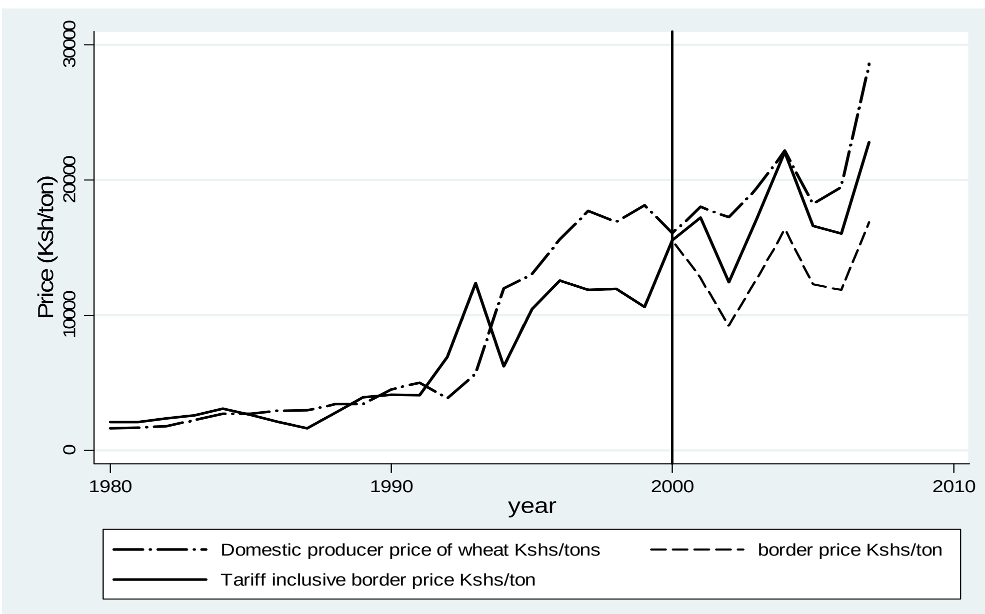

Figure 3 Wheat Price trends 1980-2007

The trends of the approximated CV and CS as in equations 12 and 13 respectively are reported in Figure 4. Expressed on US dollars, the tariff rate is estimated to have resulted to an average loss of over 1.1 US dollars millions on CV and over 0.5 US dollars millions CS, with a maximum of 11.0 US dollars and 4.0 US dollars respectively over the period between 2001 and 2007. These would be billions of Kenya Shillings at national level. The consumers are relatively loosing from the import restriction as theoretically hypothesized and it is clear that the domestic wheat production has not had significant increase. This could point to that, the benefits expected to enhance domestic production are not reaching the farmers and are ending up as government revenue.

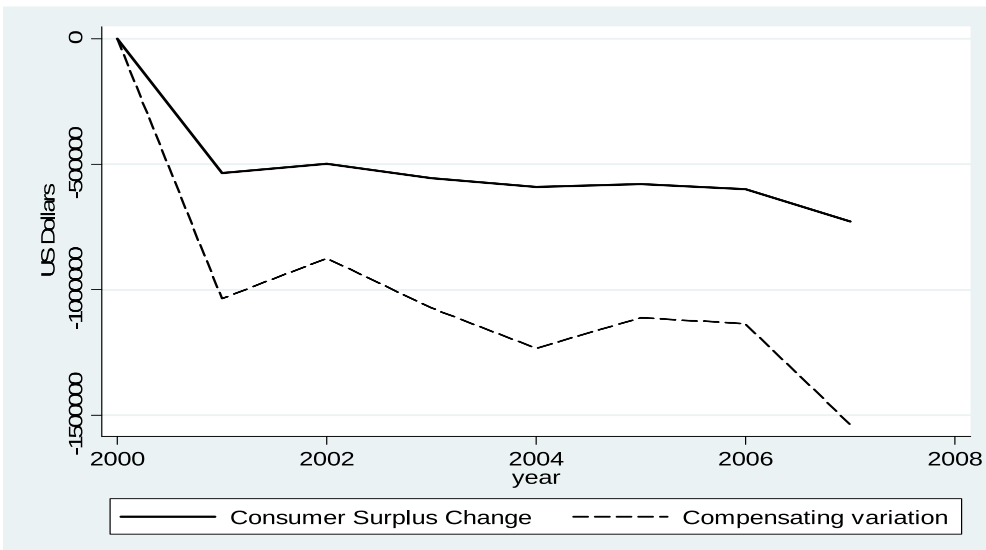

Figure 4. Trends in CV and CS due to 2000 Import tariff Imposition

Conclusion

The objective of this paper was to attempt to augment imperfect imports substitute model by Slutsky equation and estimate uncompensated and compensated elasticities for estimation of welfare measures. Double-log import demand functions have been augmented by the Slutsky equation to estimate compensated demand functions, from which compensated elasticities have been estimated and welfare measures calibrated. The compensated demand equations have been estimated for three cereals using OLS, SURE and IV estimators. The OLS and SURE estimators show similarities in results while the estimates of IV estimator are relatively smaller in magnitude. The IV shows better results for rice equation while for wheat and maize, the OLS and SURE estimates are relatively better and the choice of any may depend on the context and in particular, presence of simultaneity between imported quantities and prices. Similarly in quantity dependent models there could also be simultaneity between the expenditures used in the left hand side. All the three cereal imports are considered normal as shown by the elasticites in that the compensated elasticities are smaller in magnitude than the uncompensated counterparts. It is clear from the import elasticities that, wheat and maize are inelastic while rice price is elastic confirming that maize and wheat are very essential. The income elsaticities, by being all non-negative confirm that imported cereals are still very important especially with the relative constant domestic production with increasing real incomes.

The estimated compensated elasticities are used in the calibration of CS and an approximation of CV. From the estimates, the consumers are substantially loosing due to the import restriction. Since they have been shown to be essential, cereal imports should not be restricted to avoid hurting the consumers. The price increase due to import restriction is being passed to the consumers. It is anticipated that with increasing shift from hard to soft cereals particularly witnessed in urban areas, increasing demand will prompt more importation since the domestic production may not respond to satisfaction. Import restrictions, although imposed with the objective of protecting the domestic wheat industry, may be hijacked as an easy way of raising revenues by the government while at the sometime the commensurate benefits from the tariff may not be trickling down to the wheat farmers. Therefore, if the objective is to protect the domestic production, alternative ways that will enhance the advantages of the domestic enterprises should be sought and in particular, in particular supporting the domestic production though productive input access. Otherwise, the safeguard mechanism, while limiting the availability of increasingly important wheat, impacting negatively on food security and inhibiting regional integration, is creating welfare loss to the increasing wheat consumers in the country and should be possibly removed.

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Apendix 1 Variables included in the Model

Variable		**Definition**
qim	qim	quantity of Maize imported tons
qiw	qiw	quantity of Wheat imported tons
qir	qir	quantity of rice imported tons
β_{pw}	D.lnpwI	Wheat price ratio (import unit value to domestic producer price)
β_{pm}	D.lnpmI	Maize price ratio(import unit value to domestic producer price)
β_{pr}	D.lnprI	**Rice price ratio** (import unit value to domestic producer price)
β_{y}	D.lnexpISTPIs	**Import expenditure normalized by Stone price index**
β_{Ldw}	LD.lndwpxn	Domestic wheat production
β_{LDqiw}	LD.lnqiw	Lagged Difference of quantity of wheat imports
β_{DA}	D.lnagdpn	Argentina GDP
$\beta_{D.SA}$	D.lnsngdp	South Africa GDP
β_{Dmdp}	D.lnmaizepxn	Domestic Maize production
β_{LDqim}	LD.lnqim	Lagged Difference of quantity of maize imports
$\beta_{LD2pgdp}$	lnpngdp	Pakistani GDP
β_{ricepx}	lnricepxn	Domestic rice production
β_{LDqir}	LD lnqir	Lagged Difference of quantity of rices
β_{t}	year	Time trend for technological progress