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Utility Modelling by Comparative Static and Dynamic Analysis

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***Abstract* — This article investigates the legitimacy of the consumer equilibrium hypothesis within the context of a comparative static and dynamic evidence of equi-marginal theory. The principal aim is to develop a model that determine the likelihood of consumer equilibrium to be either constant or flux over time. On this account, equilibrium position between two interval period. Set against the first model (1980-1998) which uncovered an equilibrium value λ = 0.438 (Paurom, 2012), the second model (2000-2012) replicated significantly the same value = 0.427. The marginal utilities of pork and beef moved continually in an anticipated opposite direction in the short run and converged to a constant value somewhere around .438 and .427 over the long run. The model is robust as the variables are cointegrated at level using augmented Dickey-Fuller (ADF) unit root test. The cointegrating model has both long run and short run causality. The speed at which the regression model corrects the short run disequilibrium is 8.76 percent annually. The residuals of the model are homocedastic, serially uncorrelated, and are not grossly non-normal. The contrived regression forecast model demonstrates higher predictive power than the log-linear models, autoregresssive model (AR), vector error correction model (VECM), and ADF test equation. The persistent and continuous comovement of marginal utilities adjusting to random macroeconomic shocks and consistently revert to the equilibrium demonstrates could be essentially credited to the natural level of utility innate in each consumer. In the light of its potential application to various field of scientific inquiry, the research recommended for defining the restrictions that ought to be imposed in utilizing VECM, VAR and other models to forecast future events. It is also recommended that the procedure adopted in the static model as a way of developing a contrived forecast model should be used as a reason for developing forecast models that may be considerably more exact than the VECM and AR.**

***Keywords* — Utility, Model, Static, Dynamic, Analysis**

I. Introduction

This research article essentially intends to measure *human satisfaction* (in economics known as utility) accepted to be incapable for making an interpretation of itself into quantifiable numbers. Of central significance to the process is to decide a sound measure of utility to validate the theory of consumer equilibrium. The article used the 30-year information on pork and beef per capita consumption of United States from 1998 to 2012 mainly by virtue of the consistency of annual time series data reported. Also, pork and beef serve as the pilot food commodities as these are the most well-known source of meat for human consumption around the world (United Nation Food and Agriculture Organization, 2012).

Being the largest source of livestock products, utility-based analysis of pork and beef industry is essential as it creates enormous impact to the national economies, particularly employment, production in derived demand industries, taxes paid to national governments, multiplier effect of purchases of input supplies, and household spending. Furthermore, pork and beef products are considered price inelastic in the long run as industry supply cannot cope with the demand of consumers (Nasol and Recto, 1982), specifically mounting pressures to increase prices on one hand and loss of purchasing power of the consumers on the other. Methodology dictates this article to hold other factors *cateris paribus* to efficiently bring the analysis to the fore of utility-price relationship. Furthermore, the utility-based demand and supply analysis for pork and beef are essential to rationalize initiatives in seeking for other sources of protein or other production methods, such as feed utilization, better market, and efficient farm management.

Vexing perspectives of utility or in layman's term *satisfaction* require a brief survey of its historical foundation. Utility is said to be intangible, however, utilitarians and marginalistst thought generally as utility maybe intangible in form but material in substance in this manner quantifiable. Figuratively, utility resembles gravity, the latter can't be seen or touched, yet, unequivocally measured by the increasing speed of a falling object as a function of time. Likewise, utility can be measured by the consumption rate of a commodity or service as a function of price. Acceleration and time described in bold stroke how objects in the universe pull in each other through gravity, equally, how happiness or utility derived from consuming a good or service consumed oscillate with price.

The assumption of the physical nature of utility backtracks to the time of the classical economists. They hypothesized that, similarly, as physical laws represent matter, certain physical law "invisible hand" (Smith, 1776) rules human conduct. The "invisible hand" can be considered as a direction finder that aides all the self-seeking ideas bouncing on one's head to the ideal world of nonintervention with "self-interest." A panacea set against the oddities of human affairs, that even the divine law is inconsequential. On this precept, thinkers had come to think of the idea "Laissez Faire" or *Let Things Alone* advanced by Francois Quesnay in 1759, leading to the modern maxim "Free Enterprise System" (NCA). Up till now, however, a universal acknowledgement of the role of science in human conduct stays disputable and scholarly.

Theoretical background of this article is a commentary of three major theories of consumer utility: Bentham's fundamental axiom "greatest happiness of the greatest number as measure of right and wrong", Daniel Bernoulli's "diminishing marginal utility" of money, and Tibor Scitovsky's theory of "optimum arousal". Theory of utility by Jeremy Bentham (1789) to date stays disputable.

The theory asserts that consumers desire goods and services that maximize utility, e.g., happiness, and which can be quantified and compared across individuals. At the societal level, therefore, Bentham proposed that the most ideal system of government ought to be an activity that amplifies the overall good of the society.

The point of issue to dissociate quantity from quality may have had driven Bentham to expect that though intangible, utility could be created in proportion with the amount of commodity or service consumed. Along this line, to contend truly whether utility speaks to an amount or quality need not make any metamorphosis. The margina lists that took after Bentham proposed an alternative to the indefinite utility. While Bentham considered quantities of utility as aggregate sum, margina lists considered just the addition in utility obtained when a consumer consumes extra units or somewhat less of a commodity or service. The basis therefore of one's rational choice should be on marginal levels and on this precept comes the "fundamental principle of marginal utility theory" (Stigler, 1950).

Quantitatively, both aggregate sum and marginal utility of an individual can be inferred by assigning money among different options such that the last amount spent on each unit of commodity or service stays in equilibrium (Georgescu-Roegen, 1968). This principle translates into the following mathematical equation:

$$\frac{MU_i}{P_i} = \frac{MU_i}{P_i} = \frac{MU_n}{P_n} \quad \text{for all i} \quad \textit{Equation (1)}$$

Where: MU_i is the marginal utility of a good and P_i is price.

The principle supposes that money spent on a commodity or service has utility too via money's purchasing power equal to the amount bought, thus, money becomes an objective measure of utility. This supposition is consistent with Bernoulli's theory of diminishing utility saying that "increase in wealth, no matter how insignificant, will always result in an increase in utility inversely proportional to the quantity of goods already possessed" (Daniel Bernoulli, 1738). Monetarily, this connotes the abatement of desire for a good as more units of it acquired. This theory is expressed mathematically as: $\Delta U = (a/x)\Delta a$, or, its logarithmic form: $U(x) = a\log x + b$, where b is constant. The utility of money is measured by its logarithm:

$$E(U) = \sum_{k=1}^{\infty} \frac{1}{ak} \log a^k \qquad (2)$$

$$= \sum_{k=1}^{\infty} \frac{k}{a^k} \log a = a\log a \qquad (3)$$

It has always been the rule that an economic law ought to have stable or stationary qualities thus consumer utility should be relevant to consumer decisions. Albeit, one may contend that individuals contrast in tastes and preferences, the distinction however wanes as utility reaches equilibrium – a condition that Scitovsky (1992) considered constant. Scitovsky clarified his psychological theory of "optimum arousal" that individuals with high arousal level tend to desire those things that bring down their arousal. Individuals with low arousal level tend to fancy those that would raise their arousal. The ideal level of arousal of the two individuals' desire is almost the same. Individuals for the most part contrast in their departure from the ideal and that account for the distinctions in conduct. Similar to the marginalist concept, the important feature of this theory is the tendency of utility to move up and down toward the equilibrium - presumably a constant either in form or substance.

The three imperative speculations on human satisfaction or utility, speak about the tendency of utility to equilibrate, in any case, no one has yet determine as to when it occurs and in what value that is ideal or generally consistent to each individual. This research article may in some degree fulfill interests of those individuals who may earnestly question whether human satisfaction obey certain quantifiable laws like any matter, or, could it might be purely intangible in form without substance, or, a portmanteau of both. This goes back to Aristotle's convention of "hylomorphism."

II. Method

The research is foremost a theory validation and optionally an estimation of the prescient force of the first and second model put together on the short run and long run movement of consumer utility equilibrium. To fill that need, the research uses similar transformation strategy of the curve fit of time series data in 1999 to 2008 taken from the United States Research Review Services (US ERS, 1990) into nonlinear frame with a unique case however of the application of comparative dynamic/static analysis. Nonlinear transformation not only is consistent with the hypothesis of the consumer utility function it also provide a good fit of data points as linear standard regression failed to deal with nonlinear data. Technically, this means transformation of the raw data to make it more linear and permits the use of linear regression more effectively with nonlinear data. The methods utilized to build the second model include the use of 100 random numbers to simulate the raw data points essential to determining the curve fit, equation and the root mean square error (RMSE). The study also utilized comparative static to compare the equilibrium position between the two models. Cointegration was undertaken to determine whether the variables are stationary and cointegrated that would indicate a long run relationship otherwise need to be differenced, or, whether in the process of adjustment, converges to a steady position or diverges from the hypothesized equilibrium.

The first model of consumer equilibrium ignores the time component in determining the parameters of the model. Without consideration of the passage of time, the first model is "static" as it refers chiefly to the changes in the ratio of marginal quantity of beef consumed over its price per kilogram (MQB/Pb) and that of pork (MQP/Pp) respectively taken at a single point in time. Nonetheless, it provided a clear foundation through which the transformed data can be subjected to comparative static and dynamic analysis via cointegration method. The method enabled the research to extract and compare statistical results useful in analyzing the overall stability

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and robustness of the consumer utility model to capture the movement of consumer equilibrium.

III. Results and Discussion

A brief recap of the methods and results of the first model is important to better comprehend the methods used and results in the second model. The procedure began with the (x-y) scatter plot of actual data points $(\frac{\text{MQB}}{\text{Pb}}, \frac{\text{MQP}}{\text{PP}})$ revealing a linear regression line $y = .5664 - .1904x$ with R square = .071 and root mean square error (RMSE) = (.2664). Generally, the parameters and the statistics indicate a poor fit of the data points. This requires transformation of data points into log linear model which consequently shows a logarithmic function $y = -.1405\ln x + .3225$, a better fit than any the other nonlinear functions with R square = .108 and r square = (.2226). Plugging 50 random numbers for$(\frac{\text{MQB}}{\text{Pb}})$into the equation naturally yield the same equation however with an improved R square = .8652 and RMSE = .0887 that correspond to the new predicted $(\frac{\text{MQP}}{\text{Pp}})$ values. By interpolating the equation, the equilibrium value between $\frac{\text{MQB}}{\text{Pb}}, \frac{\text{MQP}}{\text{PP}}$ at λ = (.438) is determine. This consumer equilibrium value is used as reference value to build an exponential model for reasons as follows:

First, logarithmic model does not consider the tendency of data points to equilibrate at λ somewhere between 0 and 0.50 as shown in the scatter plot connecting all data points together, as$\frac{\text{MQB}}{\text{Pb}}, \frac{\text{MQP}}{\text{PP}}$move in opposite direction. In any case, addingλ into the actual data points in this way $(\frac{\text{MQB}}{\text{Pb}} = \frac{\lambda}{\frac{\text{MQP}}{\text{Pp}}})$ results into an appropriate exponential function written as $e^{-.8255-1\ln x}$. This function provides R square = .536 and RMSE = (0.1621). These values are better than the figures in logarithmic function. Second, exponential model is far superior in capturing the movement of utilities - a path through which the pattern of consumer equilibrium through time can be observed. Substitution of random numbers into the equation naturally provides R square – 1.00 with RMSE = 0.

Above all, the benefit of exponential model over its reverse logarithmic function is its simplicity in differentiating and integrating values within a continuous intervals. The succeeding discussion demonstrates how differentiation and integration helps in presenting a relatively robust consumer utility model and equilibrium. To begin with, the derivative and integral of the past model is expressed with graphical illustration as follows:

$$e^{-.8225-1*\ln x} \quad (4)$$

or its equivalent = $\frac{1}{e^{.8255+1*\ln x}}$ with graph shown in figure 1.

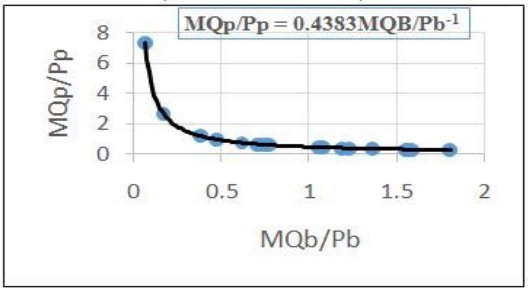

Figure 1. Graph of Consumer Utility Function (1980-1998 Data)

The rate at which the marginal utility decreases downward toward the x – axis $(\frac{\text{MQB}}{\text{Pb}})$ and increases upward toward y-axis $(\frac{\text{MQP}}{\text{Pp}})$ is determined by the derivativeas follows:

$$\frac{e^{-.8255-1*\ln x}}{x} \quad (5)$$

The equation permanently reveals equilibrium value of .438 and is also determine by multiplying MQB/Pb and MQP/Pp for any value of MQP/Pp. The total utility, that is, the area under the curve at a given point along the curve is determined by integration as follows:

$$\int \frac{1}{e^{.8255+\ln x}} = \ln e^{.8255+\ln x}$$

Simplifying the equation:

$$\ln(.e^{.8255})(e^{\ln x}) = \ln[(2.28301)x]$$

$$\ln(2.28301x) \quad (6)$$

Equation 5 and 6 are inferred quantitatively or cardinally to be correct through which the rate of marginal utility and total utility is measured. For example, at x = 1.5, the slope is .1946 and if multiplied by the amount of $\left(\frac{\text{MQP}}{\text{Pp}}\right)$ equal to 1.50 gives the money value of additional utility for beef equal to (.29201). Dividing the additional utility of beef by the slope gives additional utility for pork equal to 1.5 (refer to Table I). The total utility derived is equal to the area under the curve $\frac{1}{e^{.8255+\ln x}}$equal to (1.23096). It appears that as slope decreases with decreasing utility of beef, total utility increases with an increasing amount of pork. The reverse is true as for increasing slope with increasing amount of beef by decreasing the amount of pork, total utility decreases. On the other hand, the total utility at any point along the curve is constant at .438, that is, $(\frac{\text{MQB}}{\text{Pb}} \text{x} \frac{\text{MQP}}{\text{Pp}})$.This constant value may arise from the fact MQP/Pp or MQB/Pbfluctuates within a definite maximum and minimum limit. As MQB/Pb reaches toward the maximum value it is continually pulled down by MQP/Pp and conversely pulled up as it reaches toward the minimum value. Hence, there exist the tendency to equilibrate somewhere within the upper and lower limit imposed by λ. The limits also define the time path of consumer equilibrium will be in the short run and long run. In any case, the movement of utility values over time is consistent with Bernoulli's "diminishing utility" and Scitovsky's "optimum arousal" hypothesis in so far as the pecuniary and quantity related utility value is concern.

Certainly utility values are by any means a form – abstract reality which has no objective units to which it can be measured. In fact, there are so many real life examples whereby cardinal measure has its breaking points. For example: 1) consumers ordinarily are not so rational in calculating utility as they are generally dictated by habits and customs, in which case, impossible to measure utility cardinally. 2) Psychological feeling has no objective measure such that what one's feel about a good or service cannot be treated for objective measures cardinally. 3) Goods are often available in large indivisible units therefore it is difficult if not impossible to equate marginal utility of money. Even so, utility is also a substance that makes the form what it is. Thus, the arguments of utility as a form does not nullify the fact that utility has limits and even with bounded rationality are quantifiable in substance. Interestingly, just as utility values earlier explained are valid in comparative static analysis, they are also true in dynamic analysis specifically in the way consumer equilibrium stays steady over time, even if endogenous and exogenous factors were permitted to change.

Table I. Amount, Slope, Total Utility and Consumer Equilibrium US Annual Pork and Beef Consumption(1980-1998)

Beef Marginal Quantity/Pb	Pork Marginal Quantity/Pp	Slope	Total Utility	Consumer equilibrium
1.752063	0.25	7.008	-0.567	0.4380
0.876031	0.50	1.752	0.132	0.4380
0.584021	0.75	0.778	0.537	0.4380
0.438015	1.0	0.438	0.825	0.4380
0.350412	1.25	0.280	1.048	0.4380
0.292010	1.50	0.194	1.23	0.4380
0.250229	1.75	0.143	1.385	0.4380
0.219007	2.0	0.109	1.518	0.4380

Source: (US ERS, 1980)

Comparative Static and Dynamic Analysis

This section is abbreviated as the strategies of how the first model was built up has as of now been plainly discussed. In the light of the conflicting definitions found in literature, a sharp distinction between comparative static and comparative dynamic is very important. Comparative static focuses on changes of the exogenous factors define outside the model that change the equilibrium condition of an economic model at a given point in time. Comparative dynamic on the other hand, focuses chiefly on how equilibrium change with the passage time. Suffice it to say, comparative static refers to one equilibrium only while comparative dynamic refers to equilbria. The logical approach therefore ought to be the combination of both analytical approaches.

Comparative static is best describe in the general theory of employment, interest and money (Keynes, 1936). Keynes asserted that equilibrium market of goods and services define as equilibrium level of employment depends on interest rate. Increase in interest rate for instance causes decrease in demand for goods and services and employment. Government then play a role in creating jobs by introducing exogenous factors such as policy restoration of interest rate back to equilibrium level or increasing government spending or cutting taxes lower. The process of market adjustment from the previous equilibrium condition, prior to the imposition of interest rate, government expenditure and tax policy, to the new equilibrium after the imposition, is a comparative static. Implicit in comparative static therefore is the focus on those economic variables that metamorphosed in the same point of time. In comparative dynamic analysis time element occupies an important role in that economic equilibrium is viewed in different points in time. The time path to which the process of change occurs whether equilibrium or disequilibrium is said to be more relevant to policy decision. Comparative dynamic also consider the development of an economic model in any particular period taken to depend on or interconnected with other developments that preceded it.

To begin with, the previous consumer utility function$e^{-.8225-1*lnx}$and the equilibrium λ = 0.438 are reference points to comparative dynamic analysis in this segment from the time t_1(1980-1998 data points) and proceeds to time t_0 (2000-2011). Two approaches were used to establish the connection between two interval periods: 1) treat each period separately, each with distinct model and determine whether both models reproduce the same result, 2) treating all data all points in both interval periods with cointegration to determine whether the variables are cointegrated or have a long run relationship. These two approaches will hopefully unravel the existence of consumer equilibrium in real time.

By the same procedure, the data points in 2000 to 2011 shown in Table II, generate a nonlinear function in logarithmic form in equation 6. The function is significant (df=1,9, ρ=.014<.05) with r square of (.502) and RMSE of (.214). Customarily, the smaller the RMSE the better is the fit. Perfect fit however is rarely found in research. The choice of the value of RMSE would not only depend on the degree of correlation between variable considered as acceptable, but, also on the contexts these statistics are used as the researcher saw them fit. A data set may have smaller RMSE and r square, yet, suitable modification is always possible. At any rate, Equation 7 appears to be linear but nonlinear in strict mathematical sense. The second model is derived by adding the equilibrium index to the substituted of random numbers ($\frac{\text{MQB}}{\text{Pb}} = \frac{\lambda}{\frac{\text{MQP}}{\text{Pp}}}$) and by regression analysis, the resulting equation in equation 7 reveals positive slope shown as follows:

$$0.110\text{In}(x) + 0.518 \qquad (7)$$

Table II. Pork-Beef Price and Marginal Quantity Ratios US Annual Pork and Beef Consumption (2000-2011)

BPC	PPC	PB	PP	MQb	MQp	MQb/ Pb	MQp/ pp
69.1	53.9	2.88	2.41				
69.7	52.4	3.08	2.58	0.6	1.5	0.486	0.273
66	53.2	3.1	2.58	3.7	0.8	0.557	0.895
65	55.6	3.12	2.44	1	2.4	0.814	0.455
64.1	54.3	3.21	2.53	0.9	1.3	0.583	0.350
63.4	53.3	3.29	2.6	0.7	1	0.509	0.334
63.1	52.9	3.34	2.63	0.3	0.4	0.109	0.051
64	52.6	3.32	2.65	0.9	0.3	0.053	0.317
64.8	52.3	3.31	2.66	0.8	0.3	1.699	2.036
64.9	51.9	3.35	2.69	0.1	0.4	0.062	0.253
64.5	51.4	3.43	2.74	0.4	0.5	1.903	1.836
64.3	51.1	3.47	2.77	0.2	0.3	0.388	0.339

BPC- Beef Per capita Consumption
PPC- Pork Per Capita Consumption
Source: US ERS (US Economic Research Service, 1999)

Furthermore, 50 random numbers were plugged into equation 7 and by regression the resulting values yields a curve with convergent pattern in figure 3.This can be inferred as the reverse of the previous model – a worst case scenario whereby utility values showed inconsistent pattern opposed to the hypothesized divergent pattern. At any rate, direction of utility values is unimportant than the hypothesized consumer equilibrium (λ) to be either constant or changing. The scatter plot shows that marginal utility of pork and beef converged at the ratio roughly within (0.3 to 0.5.). By interpolation of equation $0.110lnx + .518$, the equilibrium approximately settles at λ = 0.427, quite close to the equilibrium in 1980 to 1998 with $\lambda =$ 0.438. The difference between the two equilibrium values of 1 percentage point could be attributed to bias associated with introduction of new grade commodity, changes in quality, and commodity substitution associated with relative price changes or possibly to as Slutsky (1937) theorized, random shocks causing the ebbs and flows in business cycle independent from meteorological patterns and cyclical forces.

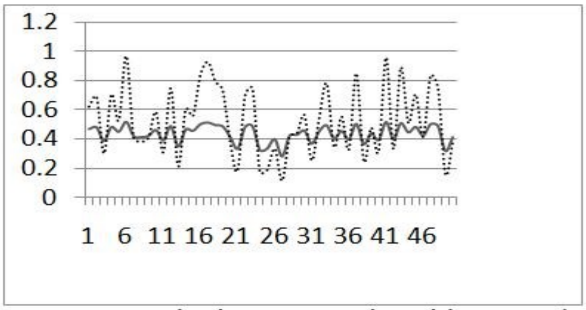

Figure 3. Smooth Line Scatter Plot with 50 Random Numbers

Clearly, the first model run in direction with the second model. Plugging in 50 random numbers into the first model $y = -0.1405\ln x + .3225$ and second model$0.110\ln x + .518$and regress the resulting values give the graph shown in figure 4. It is evident from the graph that the consumer marginal utilities in both models converge and diverge through time but consistently equilibrate between .427 and .438 ratio. The average number of years for marginal utilities to equilibrate is found in the succeeding discussion. Moreover, figure 5 depicts the consistency of the predicted values of MQP/Pp and MQB/Pb between the first and second model.

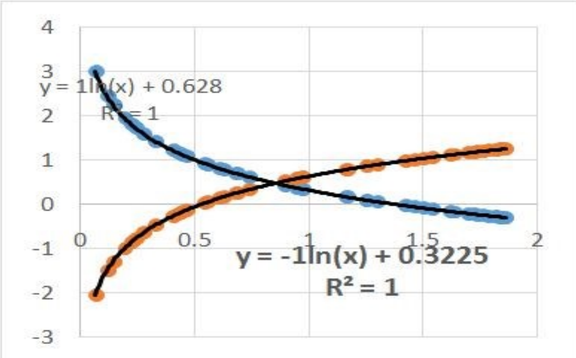

Figure. 4 Randomized Time Series Data MQB/Pb, MQP/Pp

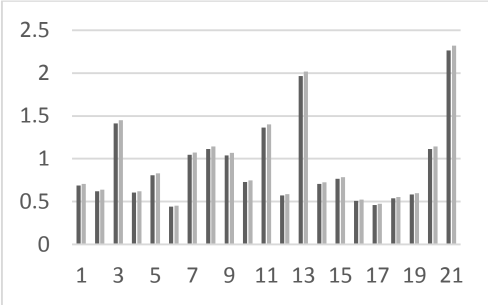

Figure 5. PREDICTED VALUES OF MQP/Pp (1980-1998 and 2000-2011)

ADF Test of Cointegration of MQB/Pp and QP/Pp

Cointegration is used in this segment to determine whether the raw data are stationary and cointegrated otherwise the data should be differenced at a specified lag period. It helps determine whether the variables stay close together despite the tendency to depart from each other unpredictably. Cointegrated variables therefore means that they have long run relationship. If at level or by difference, the data is stationary and cointegrated, vector error correction model (VECM) can be developed along with the tests for statistical discrepancies. Cointegration method also allows for the extraction of more information otherwise not possible using ordinary linear regression. At any rate, Augmented Dickey-Fuller unit root test was used.

Table III reveals probability of less than .05 as evident from trace statistics exceeding the critical values. This means that MQP/Pp and MQB/Pb are stationary or, cointegrated, or have long run association at level. The table also indicates from trace statistics that the model have 2 cointegrating equations. Similar test using Max-Eigen statistics in Table IV also confirm the same results. Max-Eigen statistics indicate 2 cointegrating equations, that is, $f(x) = y$ or $f(y) = x$ where y is MQP/Pp and x is MQB/Pb. The long run relationship between MQP/Pp and MQB/Pb is indicated by the regression equation $y = -2.0854x$ +1.032748. The negative sign of the equation indicates that in the long run MQB/Pp and MQP/Ppmove in opposite direction. As MQB/Pp rises, MQP/Pp falls or the other way around. The findings are consistent with the Bernoulli's hypothesis of diminishing utility and Scitovsky's optimum level of arousal.

Table III. Unrestricted Cointegration Test (Trace Statistics**)**

Hypothesized No. of CE(s)	Eigenvalue	Trace statistics	.05 Critical Level	Prob.**
None*	.4859	25.9878	15.4947	0.0009
At most 1	.2570	8.0223	3.8414	0.0046

Table IV. Unrestricted Cointegration RankTest

Hypothesized No. of CE(s)	Eigenvalue	Trace statistics	.05 Critical Level	Prob.**
None*	.4859	17.9654	14.2646	0.0214
At most 1	.2670	8.0223	3.8414	0.0046

Selection of optimum lag period is necessary before conducting the test of cointegration of which there are five options. Some options are sensitive to cointegration test, like for example, Johansen, Dickey Fuller and Engle-Granger test, while some are not. Hence, the choice of a lag period or length may be biased to other test of cointegration toward the rejection or acceptance of the true cointegation relationship of variables. Generally, the smaller is the lag length or period the better.

Based on the raw data, Table V reveals that out of five lag selection criterion, four can be recommended for one-year lag period and only one for zero lag period. Selecting which criterion from the four would depend entirely on the researcher. However, common sense dictates that one-year lag period should selected as there is unanimity from the four criterion. The research used one-year lag period in conducting the ADF test of cointegration.

Table V. Optimal Lag Selction Criterion

Lag	Log L	LR	FPE	AIC	SC	HQ
0	-43.9	NA	0.12	3.53	3.63*	3.56
1	-37.6	11.1*	0.10*	3.36*	3.65	3.44*
2	-36.8	1.3	0.12	3.60	4.09	3.74
3	-34.1	3.9	0.14	3.70	4.38	3.90

Cointegration test can now be formally conducted. However, the test has one precondition, that is, the variables must be nonstaionary at level but when they are converted into first difference they become stationary or cointagrated in the same level. However, if at level variables are stationary or cointegrated, then they have no trend falling under type I(0) series and cointegration does not exist. Therefore there is no need to go through cointegration. A simple regresion analysis or most importantly the staticsecond model is sufficient. To serve that purpose, each of the variable (MQP/Pp, MQB/Pb) should be tested for stationarity at level or by diffrence if needed via Johansen cointegration method.

Johansen test reveals that all probability values (ρ) are less than .05, therefore the MQP/Pp variable is stationary. This suggest that MQP/Pp has a mean value which will not vary with the sampling period. To be precise, this means that the mean does not differ significantly from the mean at any time interval as it constantly return to its mean as fluctuation occurs. Johansen test for stationarity of MQB/Pb, however, showed that larger number of coefficients (4 out of 7) have probable error less than .05 therefore MQB/Pb variable is non stationary. In this case, Johansen cointegration test is inapplicable since both the independent MQP/Pp and dependent variable MQB/Pb does not share some common movement. The independent variable shows the tendency to stave off from the mean while the dependent variable to constantly revert at mean = 0. In case of shock the independent variable will have a permanent effect on the equilibrium. MQB/Pbhad to be differenced via Augmented Dickey-Fuller unit root test method in the first or second order to make it stationary.

Table VI shows the results of the test at level. Since probable error is less than .05 the null hypothesis that the variable has a unit root is rejected. Therefore, MQB/Pb variable has no unit root indicating that it is stationary at level. Then again, MQP/Pp and MQB/Pp together had to be tested for cointegration as both are stationary. Table VII shows the equation of the variable which is significant at (.05) and has significant coefficient and intercept. The coefficient indicates that 1 unit change in MQB/Pp will have a negative response of -1.388 in MQP/Pp, that is, about 23.42%. Table VIII also shows that the model has no significant trend (ρ =.7514 > ρ =.05), a good indicator of nonstochastic trend and the model has statistically valid measure of the effect of changes in MQB/Pb to MQP/Pp. Both variables are stationary and cointegrated at level (ρ = .0001) as shown in Table VIII.

Table VI. Augmented Dickey-Fuller Unit Root test

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-5.978	0.0001
Test critical values:	1% level	-3.85738
	5% level	-3.04039
	10% level	-2.66055

Table VII. Augmented Dickey-Fuller Test Equation

Variable	Coefficient	Std. Error	t-Statistic	Prob.
X(-1)	-1.388	0.238	-5.814	0.00
C	1.1543	0.366	3.145	0.01
@TREND ("1980")	-0.008	0.028	-0.309	0.76

Table VIII. ADF Test of Cointegration of MQP/Pp and MQB/Pb

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-6.30207	0.0001
1% level	-4.32397	
5% level	-3.58062	
10% level	-3.22533	

Since the variables are cointegrated as shown in Table VIII, that is they have long run association, Vector error correction model (VECM) is suitable model to determine the long run as well short causality of the model. It can also be used as a check on the speed at which the short run disequilibrium is corrected or adjust toward the next equilibrium in one year time. Table IX reveals the long run causality of MQB/Pb to MQP/Pp with relatively small R square of 46. 54% however significant (ρ = .002). The negative sign of the coefficient (-0.087639) indicates that the variables converge in the long run equilibrium. This means that 8.76 percent of the short run disequilibrium is corrected annually and further suggests that the system will return back to long run equilibrium in about 11 years.

Table IX. Long Run Causality of MQB/Pbto MQP/Pp

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.087	0.182138	-0.481	0.634
C(2)	-0.652	0.190663	-3.423	0.002
C(3)	-0.170	0.229788	-0.741	0.465
C(4)	0.042	0.129765	0.326	0.747
R-squared	0.465	Mean DV		0.001
Adjusted R-squared	0.395	S.D. DV		0.865
S.E. of regression	0.672	Akaike info criterion		2.180
Sum squared resid	10.401	Schwarz criterion		2.372
Log likelihood	-25.433	Hannan-Quinn criterion		2.237
F-statistic	6.675	Durbin-Watson stat		2.178
Prob (F-statistic)	0.002			

The error-correction term in VECM refers to the fact that the disequilibrium or deviation from a long-run equilibrium, the error, influences its short-run dynamics or the other way around. Thus, VECM directly estimate the speed at which a dependent variable MQP/Pp returns to equilibrium through its short run adjustments. Table X reveals the Wald coefficient criterion which shows the t, F, and chi-square statistic greater than the probable error of .05. Therefore the hypothesis of short run non-causality is rejected. Hence, MQB/Pb has a short run influence on MQP/Pp.

Table X. Short Run Causality of MQP/Pp to MQB/Pb

Test Statistic	Value	df	Probability
t-statistic	-0.741	23	0.4658
F-statistic	0.549	(1, 23)	0.4658
Chi-square	0.549	1	0.4583

The previous discussion revealed consoling results however the question is whether the residuals of the dependent variable MQP/Pp have statistical errors or not. The basic statistics use to detect error are R square, F value, serial correlation, heterocedasticity, and test of normality. The movement of the dependent variable MQP/Pp as a function of MQB/Pb may be serially correlated over a period of time. If the pattern is zero, then, its values are not correlated and the values occur by chance. If serial correlation is close to 1, then the values are serially correlated, they occur not by chance. In such a case, future values are affected by the past values and the pattern and may be biased to the validity of the model. Using the Breusch-Godfrey correlation LM test, Table XI reveals that the probability of error for F test statistic and observed r square exceeded the critical value of .05, therefore, the regression model via the values of MQP/Pp is not serially correlated.

Table XI. Serial Correlation Test of MQP/Pp Values

F-statistic	0.470	Prob. F(1,22)	0.499
Obs*R-squared	0.565	Prob. Chi-Square(1)	0.452

Heterocedasticy on the other hand refers to the variation of the residuals of MQP/Pp across the residual values of MQB/Pb. When the residuals of MQP/Pp are consistent across the residuals of MQB/Pb then the former is said to be homocedastic as the former consistently predict the latter. Table XII reveals that the probability error exceeds the value of .05, therefore, the relationship of MQP/Pp to MQB/Pb is homocedastic in that the variance of the former are consistent with the other.

Table XII. Test of Heterocedasticy of MQP/Pp and MQB/Pb

F-statistic	0.669	Prob. F(4,22)	0.619
Obs*R-squared	2.931	Prob. Chi-Square(4)	0.569
Scaled explained SS	7.041	Prob. Chi-Square(4)	0.133

Finally, a test of normality of the residuals will tell whether the residuals are normally distributed. A distribution is normal, which in real world is not entirely true, has a mean of zero and a standard deviation of ∓ 2. The supposition is that errors are independent and symmetrically distributed. Independence of the errors is herein given more importance than normal distribution since the latter depends on the former. Thus, it might be the case where a sample may exhibit normal distribution but errors are not random. On this account, homocedasticty is more important than normal distribution. At any rate, Figure 6 indicates a mean less than zero and probability of error = 0 suggesting the acceptance of the hypothesis of non-normality of residuals. However, the assumption of normality is not grossly violated by the way the residuals are distributed as shown in figure 6.

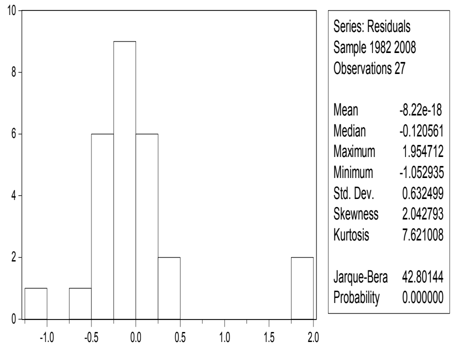

Figure 6. Test of Normality of Residuals

Comparing Predictive Power of the Regression Contrived Model from $e^{-.8225-1*\ln x}$

Whatever remains of the question is whether the contrived model forecast is as prescient as the ADF cointegrating equation or autoregressive model (AR) (be that as it may, without restriction imposed on the parameters) and log-linear function fitted from the raw data. The regression forecast model is contrived from the static model $e^{-.8225-1*lnx}$. The static model has a constant equilibrium equal to its slope λ =.438 which is attributable to the fact that the best of fit regression line equation was interpolated in such a manner that MQP/Pp and MQB/Pb are equal at .438 to mimic the equilibrium indicated in the scatter plot. In any case, the contrived regression model can be derived broadly as follows:

$(\lambda y - \hat{y})$ = error of prediction

Where: y = actual MQP/Pp,

$\hat{y}$ = predicted MQP/Pp and

λ = equilibrium index. The straight line to be used to predict the actual values of MQP/Pp can be written as:

$$\hat{y} = a + bx \quad (8)$$

The difference between the actual y and predicted $\hat{y}$ is the line in which the sum of squares of the errors is at minimum is written as follows:

$$y - \hat{y} = y - a + bx \quad (9)$$

and further rewritten as:

$$\lambda y - \hat{y} = \lambda y - a + bx$$

$$\sum(\lambda y - y)^2 = \sum(\,(\lambda y)^2 - (a + bx))^2 \quad (10)$$

Where the left hand side of the equation is the error of prediction. The value of the intercept *a*and slope *b* can be obtained by differentiation of the above equation with respect to *a* and *b*, and each derivative equated to zero yields the following:

$$b_{yx} = \frac{\sum x(\lambda y) - [(\sum x)(\sum \lambda y)/\,n\,]}{\sum x^2 - \left[(\sum x^{2})/n\right]} \quad (11)$$

$$a_{yx} = \overline{\lambda Y} - b_{yx}\,\bar{\bar{X}} \quad (12)$$

Through the above formulae of the model parameters, the regression forecasting model is:

$$y = 1.011251x - .24024 \quad (13)$$

The forecasting model in equation 13 demonstrates extremely high correlation R which is significant with the predicted values of the independent variable. This is apparent by R^2 =99.4%, RMSE =.018, ρ < (.000) as shown in Table XIII. The model's residuals are homocedastic, serially uncorrelated, and are not grossly non-normal. The contrived model is found to be far more superior in predicting the dependent variable than the log-linear, ADF test equation, VAR, and AR model.

Table XIII. Contrived Model Predictive Power

Model	Estimating equation	R^2	ρ≤ .05	RMSE
Contrived Model	1.011251x-.24084	.994	.000	.018
Log-linear model (fitted curve)	$.3225 - .1405 lnx$	.123	.425	.220
AR model	-.18391 +.31776x	.133	.337	.146
ADF Test Model	$-1.236X + .365$	.613	.000	.210
VAR model	-2.085x +1.0327	.465	.002	.172

IV. Conclusion

The comparative static reinforced dynamic analysis with the basis of defining the restrictions e.g. λ to be imposed in developing a contrived model more prescient than log-linear, VECM, AR and ADF model to forecast future events ex-post or ex-ante. The restriction to be imposed may be applicable to time series data with no significant or nonstochastic trend. In addition, the model may be only true for pork and beef consumption, thus, regression contrived modelling for other commodities could be pursued.

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The author had finished the educational prerequisites for Masters of Arts in economics at Xavier University, Cagayan de Oro City, Philippines and finished a graduate degree in business administration at a close-by school, Capitol University. He received several years of teaching experience in both universities. Prior to college education, he has been a cadet of the Philippine Military Academy. The author, additionally, has been teaching at a US Navy Review Center, a private firm based in the City providing refresher course in mathematics and statistics for young Filipinos then desiring to join US Naval training. The writer is presently teaching economics, statistics, and quantitative management techniques at Capitol University on a part time basis. Through this research paper, the author broadens his conviction, though there are moral struggles, tradeoffs, and ambiguities in business and financial issues that up till now scientists have set up no persuading results, the fitting answers exist in oneself.
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