Estimating an Almost Ideal Demand System Model for Meats in Iran

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Selected Paper Prepared for presentation at the Agricultural & Applied Economics Association's 2013 AAEA&CAES Joint Annual Meeting, Washington, D.C., August 4-6, 2013

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Abstract

This paper presents a dynamic form of the almost ideal demand system (AIDS). The static AIDS model was employed to determine long-run equilibrium model and represents the short-run dynamics by an error correction mechanism. This estimation procedure is applied to estimate three kinds of popular meats (red meat, chicken and fish) demand function in Iran. The estimated elasticities of red meat and chicken are found to be price elastic in the long run. While fish is price inelastic in the long run. Iranian government will remove all indirect and direct goods subsidies. It is suggested that government should be careful about chicken and red meat pricing policy to decreasing malnutrition after subsidy removal.

Keywords: AIDS, elasticity, dynamic modeling, Iran, meat

Introduction

There are some markets such as wheat, cotton, meat and rice for which the Iranian government intervenes to protect both producers and consumers. On the consumption side, government intervention began in the 1980s with a consumption subsidy and quota system to avoid the effects of increases in world prices. This temporary intervention was designed to reduce domestic price inflation and maintain national status of low-income group. Because consumption grew faster than production and prevented Iran from reaching self-sufficiency, the consumer subsidy and quota started to change during 1990s. With escalating budget costs, the government was forced to cut expenditures by gradually reducing the consumer subsidy and quotation until this policy was removed in 2000. This price policy played a significant role in agriculture as many products such as meat, rice and wheat which are an important part of Iranian dishes.

According to the Central Bank of Iran (CBI, 2009), Iranians intake of rice, bread and red meat fell sharply between 1992 and 2009. Among all of the agricultural products, the

Iranian government should be cautious about major changes to policies towards meat because by Statistical Center of Iran's (2009) reports, red meat consumption per capita decreased 7 Kg between 2001 and 2008, which shows 1% reduction annually. Therefore, it seems that consumers could be sensitive to changes in prices of meat, and investigating meat elasticities is very important for policies set by the Iranian government[1]

To better understand the impacts that different government policies can have on consumers and producers, we investigate the behavior of consumers' sensitivity for popular meat products in Iran. Specifically, this study uses an almost ideal demand system (AIDS) model to estimate own- and cross-price and income elasticities of three kinds of popular meats (i.e., red meat and lamb, fish and chicken) in Iran. The rest of the paper will be organized as follows: first, a review of the past studies looking into meats' demand. A detailed demand system specification and estimation methods will be provided. Next, discussion concerning the data will occur followed by results and post estimation measures such as price and expenditure elasticities.

Background

In this section, related articles to this study are investigated. The reviewed articles use similar methodology and data as this study.

Almost Ideal Demand System (AIDS)

In a recent study by Adetunji and Rauf (2012), they investigated household demand for meat in Southwest Nigeria employing an AIDS model. Using survey data from 240 households in 2012, they showed most respondents preferred beef more than any other meats. Additionally, they found mutton and pork to be luxury goods while beef, chicken and chevon

[1] Subsidy reform plan which was passed by the Iranian Parliament on January 5, 2010. The goal of the subsidy reform plan is to replace subsidies on food and energy (80% of total) with targeted social assistance, in accordance with five year economic development plan and move towards free market prices within a 5-year period.

were normal goods. The authors conclude that price intervention programs should be introduced to help stabilize the fluctuation in meat prices.

Bopape (2006) analyze food expenditure patterns in South Africa, taking into account differences in demand behavior across rural and urban households, as well as across income groups. The quadratic almost ideal demand system (QUAIDS), which a generalization of AIDS that allows for a quadratic relationship between budget shares and expenditure, was used to estimate demand functions for seven food groups: grains, meat and fish, fruits and vegetables, dairy, oils and fats, sugar, and other foods. Results show the magnitudes of demand elasticities can vary widely depending on the functional form used. For instance, the AIDS and LA/AIDS[2] expenditure elasticities tend to be larger than the QUAIDS expenditure elasticities. Thus, the dependence of demand behavioral parameters on model selection is particularly important because of its implications for policy advice.

Wadud (2006) investigated consumer demand for beef, chicken and mutton in Bangladesh using quarterly data between 1980 and 2000. The estimation of an AIDS model reveals cross price elasticities show prevalence of substitutability between beef and chicken, and beef and mutton, and complementary between chicken and mutton. He concluded since there are few studies investigating developing economies demand for meat products (like Iran), the results from this study may be of interest to researchers working in this area.

In a study by Boonsaeng and Wohlgenant (2009), they test separability between imported and domestic meat demand in the United States using static and dynamic AIDS models. A dynamic AIDS model is developed from an autoregressive distributed lag model and incorporated into an error-correction model (ECM) to allow for many periods of short-run dynamic adjustments to long-run equilibrium positions. The data used are quarterly time

[2] The difference between the AIDS and its linear version, the LA/AIDS, lies in the specification of the price index (Taljaard, van Schalkwyk, and Alemu, 2006).

series data from 1971 to 2002 for U.S. beef, pork, and poultry and imported beef and pork. The separability test the static and dynamic AIDS models conclude the same general result, import meat should be included in the analysis of U.S. consumer demand for meat. Moreover, researchers that estimate import demand for beef or pork should take into account the influence of domestic demand on imports.

Taljaard, van Schalkwyk, and Alemu (2006) used 31 years of meat consumption data for beef, chicken, pork and mutton in South Africa to compare AIDS and Rotterdam models. The Bera-McAlees (BM) test statistic, the double-length (DL) regression test statistic, and the Cox's non-nested statistic were computed by simulation. Results show the non-nested test and other direct comparisons (i.e., a priori expectations and a comparison of the statistical significance between the estimated results of the two models), favors the LA/AIDS model. They pointed out that the advantage of AIDS to Rotterdam model is that the marginal expenditure shares and Slutsky terms are assumed to be constant in the Rotterdam model, while they are assumed to be functions of the budget shares in the AIDS model (Lee et al., 1994).

Similar to Taljaard, van Schalkwyk, and Alemu (2006), Paraguas and Kamil (2005) investigated meat demand using both a Rotterdam and LA/AIDS models. They used time series data for per capital annual consumption of beef, pork, mutton and poultry from 1961-2002 in Malaysia. Results suggested that LA/AIDS or the Rotterdam models are both appropriate to represent Malaysian demand for differentiated meat products. One important difference between these two models is that the compensated own-price elasticity estimates of pork and poultry from the Rotterdam model do not carry the expected signs. Also, LA/AIDS fits the data better as reflected by its higher adjusted R^2 relative to Rotterdam model. Thus, the LA/ADIS is more favorable than Rotterdam model.

Mdafri and Brorsen (1993) used AIDS model in order to estimate demand for beef, mutton, poultry and fish in Morocco using annual data between 1969 and 1985. Results show that demand for poultry and beef is elastic. Poultry, beef and fish are considered normal goods while mutton is a luxury good. Results of AIDS model shows Moroccans prefer to eat mutton more than other kinds of meats.

The demand literature contains several specifications of systems of demand equations: the linear expenditure system, Rotterdam, Indirect Translog, and the almost ideal demand system model. These functional forms of demand systems have been extensively applied to demand estimations for decades. After studying the various models mentioned above, this study will use an AIDS model to estimate Iranian demand for red meat, chicken and fish, as they are most popular meats in Iran. This study will contribute the above literature as it will analyze consumer demand for a developing economy and in the Middle East. Additionally, this is the first know study to empirically estimate meat demand in Iran.

Methods

Static AIDS Model

The AIDS model developed by Deaton and Muellbauer (1980) is used. The specification of the AIDS model is as follows:

$$w_{it} = a_i + \sum_{j=1}^{N} \gamma_{ij} \ln (p_{jt}) + \beta_i \ln \left(\frac{x_t}{P_t}\right). \quad (1)$$

For i = 1, 2,…,N; j = 1,2, …,N; t = 1. 2, …, T.

w is the share in the total expenditure of the good (i.e., $w = p*q / x$), p are the prices, x is the total expenditure, P is the price index, i and j are the goods, and t denotes time. The price index is usually represented by a nonlinear equation which is generally replaced by the Stone price index. However, the Stone index typically used in estimating linear AIDS is not invariant to changes in units of measurement, which may affect the approximation properties of the model and can result in biased parameter estimates (Pashardes, 1993; Moschini, 1995). To overcome this problem other specifications for the price index can be used, such as the Paasche or Laspeyres indices. This study uses the Laspeyres index (L_t) in the empirical analysis following equation (2):

$$\ln(P_t^L) = \sum_{i=1}^{N} w_i^0 \ln\left(\frac{p_{it}}{p_t^0}\right) \tag{2}$$

where 0 superscript denotes the base period. To be consistent with microeconomic theory, several restrictions must be satisfied. Additively, homogeneity and symmetry are imposed and denoted as follows:

Adding up: $\sum_{i=1}^{N} \alpha_i = 1, \sum_{i=1}^{N} \gamma_{ij} = 0, \sum_{i=1}^{N} \beta_i = 0$ (3)

Homogeneity: $\sum_{j=1}^{N} \gamma_{ij} = 0$ (4)

Symmetry: $\gamma_{ij} = \gamma_{ji}$. (5)

for i=1, 2… N and j=1, 2… N.

From the above specification, expenditure and Marshallian (or uncompensated) elasticities can be calculated as follows:

$$\varepsilon_{ijt}^M = -\delta_{ij} + \frac{\gamma_{ij}}{w_{it}} - \beta_i\left(\frac{w_{jt}}{w_{it}}\right) \tag{6}$$

$$\eta_{it} = 1 + \beta_i / w_{it} \tag{7}$$

$$\varepsilon_{ijt}^H = -\delta_{ij} + \frac{\gamma_{ij}}{w_{it}} + w_{jt} \tag{8}$$

where $\delta_{ij} = 1$ for $i = j$ and $\delta_{ij} = 0$ for $i \neq j$. η_{it} and ε_{ijt}^M are expenditure and Marshallian (uncompensated) elasticities, respectively. Using the Slutsky equation, the Hicksian (compensated) elasticities, ε_{ijt}^H, can be derived from the Marshallian elasticities.

Dynamic AIDS Model

Dynamic AIDS model helps us to understand the speed of meats consumers' adjustment to their long run behavior. Therefore, the dynamic AIDS model is a complementary model to static AIDS model.

It is required to investigate the time series properties of the data used in order to specify the most appropriate dynamic form of the model and to find out if the long-run demand relationships provided by equation (1) are economically meaningful or they are merely spurious. If all variables in equation (1) are cointegrated, the error correction (ECM) linear AIDS is given as follows (Ray, 1985; Blanciforti et al., 1986):

$$\Delta w_{it} = \sum_{j=1}^{N} \delta_{ij} \Delta w_{jt-1} + \sum_{j=1}^{N} \gamma_{ij} \Delta \ln(p_{jt}) + \beta_i \, \Delta \ln\left({}^{x_t}/_{P_t}\right) + \lambda \hat{e}_{i,t-1} + \mu_{it} \qquad (9)$$

for i = 1,2,…,N, j = 1,2,…,N and t = 1,2,…,T.

Where Δ refers to the difference operator, $\hat{e}_{i,t-1}$represents the estimated residuals from the cointegrated equation (1), λ is the speed-of-adjustment parameter and is $-1 < \lambda < 0$, and μ it is the error term.

In the equation 9, the first-difference terms on the right hand side capture the short-run disturbances in the respective shares of the individual meats in total expenditure. The error correction term, $\hat{e}_{i,t-1}$, captures the long-run equilibrium relationship given by the standard AIDS model (equation 1), and λ captures the speed-of-adjustment toward the long-run equilibrium. If λ is large or closer to one in absolute value then there is a rapid adjustment (i.e., the disturbance quickly disappears and we are back along the long run path). The smaller that λ is the slower the adjustment back to long run equilibrium.

Another issue to consider when estimating demand across time is potential structural change. The cumulative sum (CUSUM) and CUSUM squared (CUSUM-sq) tests can be used to test for a structural change (Pesaran et al., 2001). In statistical analysis, change detection tries to identify changes in the probability distribution of a stochastic process. The CUSUM test takes the cumulative sum of recursive residuals and plots its value against the upper and lower bounds of the 95% confidence interval at each point. If cumulative sum of the recursive residuals go out of upper or lower bound, there is a structural break at that point that we should remedy the structural break in our models.

Data

Data for in this study are annual time-series data from 1982-2007 for beef and lamb (will be referred to as red meat throughout the rest of the paper), chicken and fish.[3] The beef and lamb data are reported a single data series and are referred to as red meat. All (expenditure, price, quantity, and income) data are from the Statistical Center of Iran and the Central Bank of Iran. Variables are shared in the total expenditure of red meat, chicken and fish called in this study by wR, wCH and wF, respectively. All prices are reported in the Iranian Rials and are denoted as PR, PCH and PF as red meat, chicken and fish price respectively) and real expenditure (called by m/p). All variables have been changed to constant of 1997 as the base year using the Iranian Consumer Price Index (CBI) (Central Bank of Iran). The descriptive statistics of the variables used in the estimation process are shown in Table 1.

Results

Static AIDS Model

First step of estimating our model is testing stationary of variables. An Augmented Dickey Fuller (ADF) test was used to test for stationarity on all the variables. As seen in Table 2, all variables, except the chicken share (wCH), were not stable at levels, but are

[3] 1361 - 1386 in Iranian calendar.

stable in their first difference. Thus, all of the variables are non-stationary (integrated to I(1)-except chicken share which is I(0).

Table 3 reports the estimated parameter results of the static AIDS model with homogeneity and symmetry restrictions imposed using an iterative seemingly unrelated regression. All three equations have high R^2. All estimated coefficients in the red meat demand equation are significant at 5% level. In the chicken and fish demand equations, red meat is not statistically significant.

Table 5 presents the Marshallian, Hicksian, and Expenditure elasticities and standard errors calculated at their means for the static AIDS model. All Marshallian own-price elasticities have the expected sign, but only red meat and chicken are statistically significant. The estimated elasticities are -1.15 and -1.16 for red meat and chicken, respectively, indicating these two goods are price elastic. These results are similar to Taljaard, Van Schalkwyk, and Alemu (2006) and Jung and Koo (2000). They calculated beef and chicken own price elasticities and found they are elastic. In regards to the cross-price elasticities, there are some inconsistencies. For example, the negative values for chicken and fish in the red meat demand equation suggests those meats are complementarity goods for red meat. Griffith et al. (2001) found similar results for Australia's meat demand elasticity which the cross-price elasticities show chicken and beef as substitutes.

A Wald test was used to check to see if homogeneity and symmetry (as defined in equations (4) and (5)) are satisfied. The Wald test presents a test statistic of $\chi^2 = 166.11$ and $\chi^2 = 38.11$ for the homogeneity and symmetry restrictions, respectively, which is above the critical value of at the 5% level (7.81 is the critical value). Therefore, indicating a strong rejection of symmetry and homogeneity restrictions. The rejection of homogeneity and symmetry restrictions is probably a consequence of dynamic mis-specification of the model and economics inconsistency (Iootty, et al. 2009).

Dynamic AIDS Model

After estimating long run equations before interpreting of coefficients, cointigration of each equation should be checked, in order to be sure that there is a long run relationship which variables always come back. Regarding to methodology, by Engle-Granger approach, stationary of each equation estimated residuals was checked. Results show in table 4. It is vivid that for all of these three equations residuals are I(0), therefore the long run relationship between variable is relevant.

After testing the long run relationship between variables, the dynamic AIDS model is estimated) which is based on AIDS-ECM. An error correction model is a dynamic system with the characteristics that the deviation of the current state from its long-run relationship will be fed into its short-run dynamics. The dynamic AIDS representation is an error correction form of the AIDS model that models the disequilibrium separate from the AIDS long-run equilibrium and thus gives the short-run relationship between the demand variables (Gallagher and Eakins, 2003).

The dynamic AIDS is estimated using an ISUR procedure and the results for the system are given in table 6. In equation 1, the red meat price has a negative, but is not significant while consumer expenditure has positive and significant effect on red meat consumption. Chicken and fish are substitutes for red meat because the signs of chicken and fish prices are positive. The error correction term coefficient is highly significant and shows 74% of the disturbance to the long-run equilibrium in the previous period is corrected or adjusted back to long-run equilibrium in this period.

In equation 2, chicken price and consumer expenditure have significant negative and positive significant effect on chicken consumption respectively. Red meat and fish are complement and substitute goods for chicken respectively. The error correction term coefficient is highly significant, the chicken error correction term (-0.93) indicates that consumers are able to adjust chicken consumption to long run equilibrium considerably faster than red meat. In equation 3, the fish price is negative and significant while consumer expenditures have positive and significant effect on fish consumption. Chicken and red meat prices have insignificant coefficients. The error correction term (significant at the 1% level) indicates that approximately two-third of the disturbance to the long-run equilibrium path is corrected within the next period.

Table 7 presents the elasticities and standard errors calculated at their means for the dynamic AIDS model. Marshallian own-price elasticities have negative sign for red meat and fish and it has positive sign for chicken, while Hicksian own price elasticties for all goods have negative sign. Regarding to the cross-price elasticities, there are some inconsistencies. For example, the negative value for fish in the chicken demand equation suggests those are complementary goods while positive value in fish demand equation suggests those are substitutions.

Structural Breaks Test

Previous studies have discussed the importance of testing for structural change. A CUSUM test was used in this study to test for structural changes. Figures 1, 2 and 3 show the CUSUM test for structural breaks of red meat, chicken and fish. These tests suggest that there were not any structural changes between 1982 and 2007.

Conclusion

This paper uses an AIDS model to calculate elasticities of red meat, chicken and fish in Iran. The estimated elasticities suggest that red meat and chicken are price elastic. The Iranian government has been decreasing the subsidy to all goods, but should be careful about meat pricing policies. After removing subsidies, prices of the goods will increase and for elastic goods like red meat and chicken, Iranians will decrease their consumption rapidly so malnutrition of lack of protein will increase.

Using a dynamic generating process we were able to calculate consumers' speed of adjustment and we found that consumers are able to adjust their consumption to the long-run equilibrium considerably faster. So by increasing the price of meats, regarding to price elasticity which mentioned above, people will adjust their behavior and decrease their meat consumption. Therefore, in pricing policy and during subsidy removal in Iran, government should be more careful for some goods which are related to people nutrition and health.

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Table 1. Descriptive Statistics of the Variables used in AIDS Estimation

Variable	Description	Units	Mean	Std. Dev.	Max	Min
wR	Budget share of red meat		0.063	0.03	0.120	0.03
wCH	Budget share of chicken		0.02	0.003	0.03	0.01
wF	Budget share of fish		0.007	0.002	0.011	0.005
PB	Price of red meat	Rials	37.15	44.15	153.3	1.9
PCH	Price of chicken	Rials	39.31	40.42	127.6	1.5
PF	Price of fish	Rials	41.46	44.02	153.6	1.7
M/P	Real expenditure	Rials	41455.65	15059.85	24966.22	75638

Table 2. Augmented Dickey Fuller Test Results

Variable	Levels	First Difference	Degree of Stationary
wR	-1.4694	-4.3659	I(1)
wCH	-3.2439		I(0)
wF	-2.1995	-3.0895	I(1)
Ln PR	-0.0141	-5.093	I(1)
Ln PCH	-1.3356	-3.9202	I(1)
Ln PF	-1.2531	-3.5581	I(1)
Ln M/P	-1.2676	-4.4712	I(1)

Critical value at 5% level is -2.99.

Table 3. Parameter Estimates for the Static AIDS model

Equation	Variable	Coefficient	t-statistic	
First Equation (Red Meat[a])	LnPR	-0.00827	-1.84**	R^2=0.92 DW=1.55
	LnPCh	-0.0366	-4.42*	
	LnPF	0.042	4.54*	
	Ln(M/P)	0.009	16.10*	
Second Equation (Chicken)	LnPR	-0.003	-0.92	R^2=0.53 DW=1.59
	LnPCh	-0.0109	-2.41*	
	LnPF	0.0036	1.2	
	Ln(M/P)	0.010	2.75*	
Third Equation (Fish)	LnPR	-0.001	-0.76	R^2=0.57 DW=1.51
	LnPCh	-0.004	-3.43*	
	LnPF	0.006	4.65*	
	Ln(M/P)	$0.446*10^{-3}$	5.53*	

[a] *red meat denotes beef and lamb*

* *significant at 1% level*

***significant at 5% level*

Table 4. Unit root tests on level of estimated residuals of Static model

Variable	Calculated ADF	Degree of cointigration	Critical value at 5% level
First Equation Residuals	-3.6959	I(0)	-2.9907
Second Equation Residuals	-3.8156	I(0)	-2.9907
Third Equation Residuals	-2.9335	I(0)	-2.6355

Table 5. Marshallian, Hicksian and Expenditure Elasticities for the Static AIDS model

		Marshallian Elasticity	Hicksian Elasticity	Expenditure Elasticity
Red Meat	Red Meat	-1.15** (0.06)	-1.09** (0.09)	1.71** (0.06)
	Chicken	-0.7** (0.28)	-0.68 (0.27)	
	Fish	-0.4** (0.06)	0.81** (0.31)	
Chicken	Red Meat	-0.18** (0.02)	-0.08 (0.04)	1.48** (0.144)
	Chicken	-1.53** (0.077)	-1.5** (0.08)	
	Fish	0.17** (0.02)	0.18 (0.02)	
Fish	Red Meat	-0.04** (0.007)	-0.08* (0.05)	1.07** (0.01)
	Chicken	-0.19** (0.03)	-0.59** (0.12)	
	Fish	-0.087 (0.182)	-0.08 (0.18)	

* and ** indicate significance at 10% and 5% level, respectively.

Table 6. Parameter Estimates for the Dynamic AIDS Model

Equation	Variable	Coefficient	t-statistic	
First Equation (Red Meat)	DlnSB(-1)	0.697	5.54*	R^2=0.7 DW=1.99
	DLnPR	$-0.56*10^{-3}$	-0.047	
	DLnPCH	0.0038	0.376	
	DLnPF	0.013	1.65**	
	DLn(M/P)	0.019	2.52*	
	λ (-1)	-0.74	-5.58*	
Second Equation (Chicken)	DlnSCH(-1)	0.36	1.97*	R^2=0.62 DW=1.57
	DLnPR	-0.0023	-0.44	
	DLnPCH	-0.009	-2.30*	
	DLnPF	0.0055	1.72*	
	DLn(M/P)	0.0083	2.63*	
	λ (-1)	-0.93	-4.01*	
Third Equation (Fish)	DlnSF(-1)	$0.94*10^{-3}$	0.0067	R^2=0.60 DW=2.28
	DLnPR	$-0.31*10^{-3}$	-1.39	
	DLnPCH	-0.0014	-0.83	
	DLnPF	-0.0047	-3.37*	
	DLn(M/P)	0.002	1.71*	
	λ (-1)	-0.63	-3.79*	

*significant at 10% level
**significant at 5% level

Table 7. Marshallian, Hicksian and Expenditure Elasticities for the Dynamic AIDS model

		Marshallian Elasticity	Hicksian Elasticity	Expenditure Elasticity
Red Meat Demand	Red Meat	-1.001** (0.004)	-0.94** (0.033)	1.36** (0.144)
	Chicken	-0.08** (0.03)	-0.05* (0.02)	
	Fish	-0.033** (0.004)	0.25** (0.1)	
Chicken Demand	Red Meat	0.08** (0.01)	-0.05** (0.03)	1.40** (0.06)
	Chicken	-1.44** (0.06)	-1.42** (0.067)	
	Fish	0.26** (0.03)	0.27** (0.038)	
Fish Demand	Red Meat	-0.02** (0.004)	-0.016 (0.033)	1.30** (0.06)
	Chicken	-0.068** (0.01)	-0.19** (0.04)	
	Fish	-1.72** (0.14)	-1.71** (0.14)	

*significant at 10% level
**significant at 5% level
ns insignificant

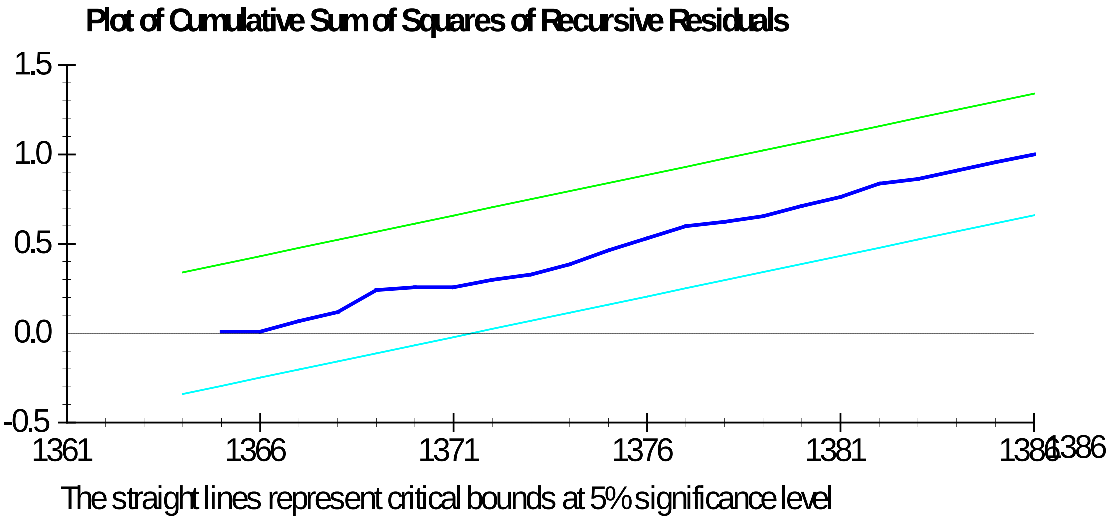

Figure 1.Cusum test for red meat equation residuals

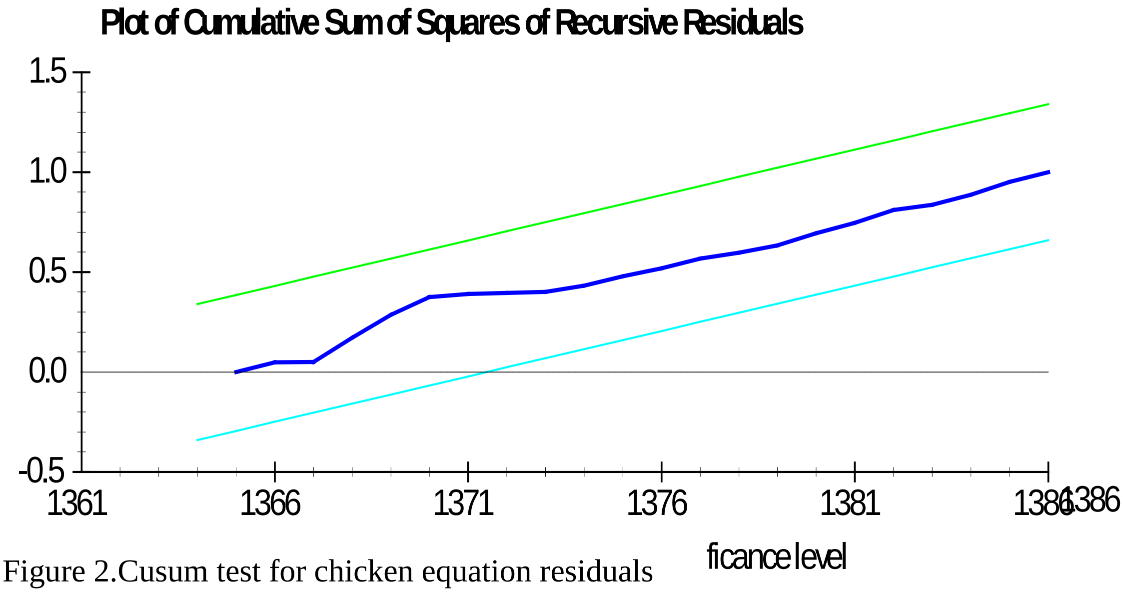

Figure 2.Cusum test for chicken equation residuals

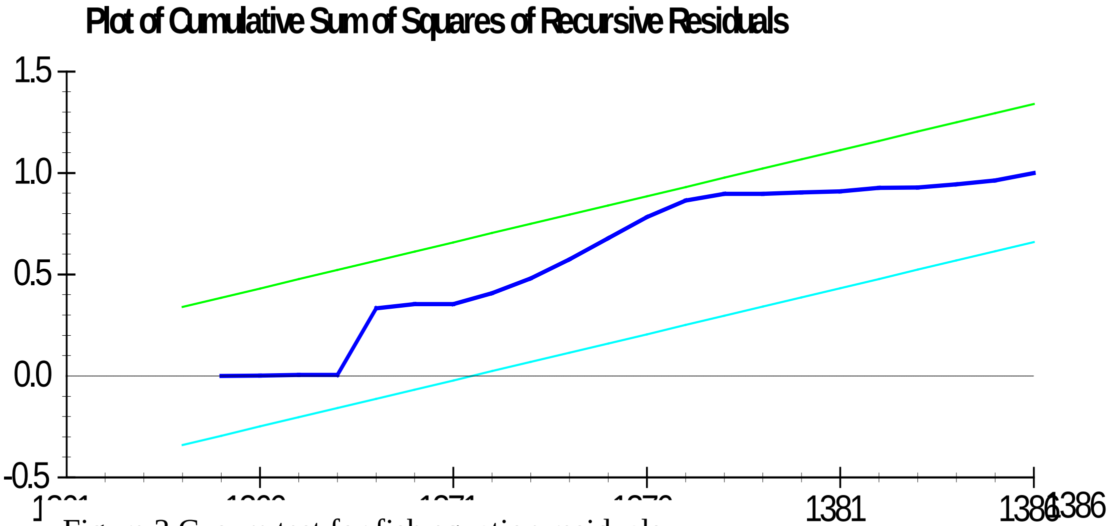

Figure 3.Cusum test for fish equation residuals