Structural Change in Greek Meat Demand

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Abstract

The hypothesis of structural change in Greek meat demand was tested in a four meat dynamic almost ideal demand system. A gradual structural change was found. The estimated path of structural change implies a gradual transition to a new regime in the beginning of the decade of 80's. The structural change is biased towards pork and chicken and against beef and lamb & mutton and it does not affect the estimated elasticities concerning their elastic/inelastic nature but only the magnitude.

Key words: *structural change, meat demand, switching regression models, almost ideal demand system.*

Introduction

In demand analysis, hypotheses of structural change are often framed in terms of 'changing tastes and preferences', although different studies and analysts may have different notions of what that means. In some cases, one thinks of changes in the shape of individual utility functions of a stable population of consumers, as brought about by health concerns and attention to quality, possibly related to new information and improved scientific knowledge. In others, one may think of a changing demographic composition of a heterogeneous collection of consumers who have different preferences. Moreover, one may postulate changes in preferences individual displays, induced by firm strategies such as advertising and product innovation. Alternatively, individual choices may be based upon their basic characteristics and if the content of those characteristics changes over time, individual preferences for goods may be affected. Whereas the differences in these examples may call into question the loose character of the notion of 'changing tastes and preferences', from an operational point of view it is sufficient to realise that they can all be modelled.

Structural change in demand may be investigated by means of parametric and non-parametric methods. Both methods have their pros and cons and they are described in details in Moschini and Moro (1996). Considering the parametric methods, a distinction can be made between systematic and random variation in parameters. Systematic variations imply a certain deterministic pattern of change for the parameter vector to be modelled, even the most general, while stochastic

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variations allow for a more flexible specification of the pattern of change. Switching regression techniques allow for periods of structural stability followed by an interval of change, followed by future stability (Moschini and Meike, 1989; Reynolds and Goddard, 1991; Rickertsen, 1996; and Xu and Veeman, 1996).

Consumption patterns for meat products have changed considerably over the last few decades. This development is illustrated in Figure 1, which shows the expenditure shares covering a period between 1965 and 1995. The most striking feature is the steady increase in Pork expenditure form the beginning of 70's until mid of 80's where reaches a peak. Moreover, beef and lamb and mutton followed a more complicated pattern over time. Evidence of structural change is of considerable interest for the meat industry because it implies a less favourable climate warranting adjustments in both production and marketing strategies. Econometric modelling for forecasting and policy analysis is also affected because changes in the data-generating process have direct bearings on the model specification and estimation.

This paper will use switching regression techniques to investigate whether there have been systematic effects resulting in a structural break in meat demand for Greece. Also, this study will investigate the bias of this structural change on the consumption patterns and the estimated elasticities. For this purpose, a dynamic time varying version of the AI mode is employed, which assumes unknown joint points (points in time associated with the beginning and ending of transition periods between regimes) and accommodates a gradual transition to a new regime.

The paper proceeds by first reviewing the gradual switching AI model and set out how dynamics can be employed. The empirical results are then presented and discussed before summarising in the final section

Model specification

In the subsequent analysis, it is assumed that consumer's preferences are weakly separable with respect to meat and thus a two stage budgeting process is implied. In the first stage, consumers decide how much of their total expenditure will be allocated to meat and then in the second stage the demand for each meat item is determined by the expenditures of the individual meat items and meat prices. In the spirit of Moschini and Meike (1989), it is possible to develop a switching AIDS, which has been adopted by Reynolds and Goddard (1991) and was specified as:

$$w_{it} = \alpha_i + z_i h_t + \sum_j [\gamma_{ij} p_{jt} + \delta_{ij}(h_t p_{jt})] + \beta_i y_t + \delta_i(h_t y_t) \quad (1)$$

where: $\mathbf{w_i}$= the budget share of the ith good

z, γ, β and δ are parameters to be estimated

$\mathbf{p_j}$= the log of the nominal price of the jth good

$\mathbf{y}=\ln(m/P^*)$, with m being total expenditure and P^* a price index approximated by the corrected Stone price index ($\ln P^* = \sum_i w_i \ln(p_i / p_{0i})$) as proposed my Moschini (1995) and

h_t=a transition function expressing the transition of time path from one regime to the other, defined as:

h_t= 0 for $t=1,\ldots t_1$

h_t= $(t-t_1)/(t_2-t_1)$ for $t=t_1+1\ldots,t_2-1$ (2)

h_t= 1 for $t=t_2,\ldots T$

$t_1 \leq T-x/(k-1)$, $t_2 \geq x/(k-1)$, $t_1<t_2$

where: t_1= the end of the first regime, t_2= the start of the second regime, k= the number of free parameters to be estimated, x= the number of observations and n= the number of equations in the demand system.

According to equation 2, at time $t=t_1$ the parameters $\phi_1=(\alpha_i, \gamma_{ij}, \beta_i)$ of equation 1 begin to gradually switch along a linear time path to $\phi_2=(\alpha_i+z_i, \gamma_{ij}+\delta_{ij}, \beta_i+\delta_i)$. At $t=t_2$, the switch is complete; hence t_2 signifies the beginning of the second regime. Note that if $t_2=t_1+1$, the shift in regime is abrupt. Note also that with $z_i=\delta_{ij}=\delta_i=0$, equation 1 reduces to the basic AIDS model developed by Deaton and Muellbauer (1980). After the joint estimation of ϕ, t_1 and t_2, a test for structural change can be constructed as a test of the hypothesis that $\phi_2-\phi_1=0$.

By construction, the demand system represented by equation (1) should satisfy the adding up restriction; hence the following are implied:

$$\sum_i \alpha_i = 1, \qquad \sum_i z_i = \sum_i \gamma_{ij} = \sum_i \beta_i = \sum_i \delta_{ij} = \sum_i \delta_i = 0 \tag{3}$$

The homogeneity and symmetry conditions implied by demand theory are satisfied respectively by the following restrictions:

$$\sum_j \gamma_{ij} = \sum_j \delta_{ij} = 0 \tag{4}$$

$$\gamma_{ij}=\gamma_{ji} \text{ and } \delta_{ij}=\delta_{ji} \tag{5}$$

A change in the price and expenditure parameters of the model suggests the way in which consumers respond to changes in prices and income. A comparison of the price and expenditure elasticities, before and after the structural change, may indicate the nature of this behavioural change.

Static demand theory can be considered as nested within the dynamic theory. Hence, dynamic effects have been incorporated into the functional form in a way that adding up restriction is still preserved, using the specifications of Alessie and Kapteyn (1991) but replacing the lagged budget shares by the corresponding quantities lagged one time period (t-1).

In principle, all the parameters can vary over time. So, a dynamic gradually switching AI model is thus written:

$$w_{it} = \alpha_i + z_i h_t + \sum_j [\gamma_{ij} p_{jt} + \delta_{ij}(h_t p_{jt})] + \beta_i y_t + \delta_i(h_t y_t) + \sum_j [d_{ij} q_{j(t-1)} + v_{ij}(h_t q_{j(t-1)})] \tag{6}$$

Due to lack of degrees of freedom, only some of the parameters can be allowed to vary. Moschini and Meike (1989) estimated the model in first difference form with quarterly dummy variables, and they found changes in the intercepts and the seasonal components of the intercepts but not in price and income parameters. Following the inference of Moschini and Meike, the estimated gradual dynamic switching AI model in this paper is specified as:

$$w_{it} = \alpha_i + z_i h_t + \sum_j \gamma_{ij} p_{jt} + \beta_i y_t + \sum_j d_{ij} q_{j(t-1)} \qquad (7)$$

The restrictions of adding up, homogeneity and symmetry implied by the demand theory are satisfied respectively by the following restrictions:

$$\sum_i \alpha_i = 1, \qquad \sum_i z_i = \sum_i \beta_i = \sum_i \gamma_{ij} = \sum_i d_{ij} = 0 \ \sum_j \gamma_{ij} == 0 \text{ and } \gamma_{ij} = \gamma_{ji} \qquad (8)$$

The price and income elasticities are estimated using the expressions proposed by Chalfant (1987) and Goddard (1983). To obtain elasticities after the structural break, the mean budget share w_i for the whole period is substituted by the mean budget share in the second regime w_i^a. Additionally, to obtain the elasticities before the structural change, w_i is substituted by w_i^b which is the mean budget share before the structural change.

Data

The data used for the empirical estimation consists of annual unpublished disappearance time series data of consumption expenditure collected from the National Statistical Services of Greece (NSSG) over a period 1965 to 1995. Because the data set includes only expenditure in constant and current prices, prices are obtained from the implicit price index formed by dividing current expenditures by real expenditures (i.e Paasche indices). In like manner, due to the absence of statistics concerning the absolute consumed quantity for each commodity, an implicit quantity index for each commodity was constructed by dividing the real expenditure at any year by the corresponding expenditure of the base year.

Results

The dynamic switching regression AIDS model (7) was estimated using iterative seemingly unrelated regression procedure available in SHAZAM 7.0 which converges to the maximum likelihood estimator. Due to singularity of variance-covariance matrix the model has three equations (the chicken equation was omitted). To estimate the parameters of the structural path, the system of equations was estimated for all the combinations of t_1 from 1965 to 1981 and t_2 from 1977-1995. This set of combinations ensures that all the parameters of the system are estimable estimating the system of equations a total of 240[1] times.

The estimated coefficients for the three-equation system conditional of the optimal $(\hat{t}_1, \hat{t}_2)$ are reported in the Table 1 along with some single equation statistics (R^2 and DW statistics). The fit of all the equations is satisfactory and the Durbin-Watson statistic can be interpreted as a rough test of the validity of the dynamic specification. All the time varying parameters and the expenditure ones are significant at 95% significance level. The sign of the parameters on the lagged own-quantity, d_{ii}, is positive for all goods. However, the only significant lagged own-quantity is for beef.

Table 1. Estimated parameters of Switching AIDS model for seven meat items

	Beef	**Lamb& Mutton**	**Pork**	**Chicken**
z_i	-0.2355	-0.1388	0.2493	0.1250
	(0.0810)	(0.0431)	(0.0606)	(0.0540)
γ_{1j}	-0.2172	0.0490	0.0588	0.1094
	(0.0805)	(0.0332)	(0.0528)	(0.0394)
γ_{2j}	0.0490	0.0057	-0.0020	-0.0527
	(0.0332)	(0.0272)	(0.0248)	(0.0222)
γ_{3j}	0.0588	-0.0020	-0.0802	0.0234
	(0.0528)	(0.0248)	(0.0472)	(0.0296)
γ_{4j}	0.1094	-0.0527	0.0234	-0.0800
	(0.0394)	(0.0222)	(0.0296)	(0.0343)
β_i	-0.0610	-0.0245	0.0472	0.0383
	(0.0193)	(0.0105)	(0.0140)	(0.0106)
d_{1j}	0.1075	-0.0219	-0.0603	-0.0253
	(0.0340)	(0.0154)	(0.0234)	(0.0188)
d_{2j}	-0.0714	0.0101	-0.0208	0.0821
	(0.0433)	(0.0198)	(0.0320)	(0.0259)
d_{3j}	0.0211	0.0159	0.0689	-0.1059
	(0.0561)	(0.0253)	(0.0402)	(0.0329)
d_{4j}	0.1095	-0.0771	-0.0459	0.0135
	(0.0356)	(0.0155)	(0.0248)	(0.0192)
α_i	0.3554	0.4125	0.1590	0.0731
	(0.0367)	(0.0256)	(0.0283)	(0.0267)
R^2	0.75	0.97	0.96	0.82
DW	1.76	2.40	2.17	1.97

Note: Standard Errors are reported in parentheses

A main thrust of this analysis is the use of systemwise tests. The results of full system misspecification test are reported in Table 2. The misspecification testing strategy followed is broadly that suggested by McGuirk *et al* (1995) to ensure that the statistical assumptions concerning autocorrelation and heteroscedasticity in the system as a whole. The test for residual autocorrelation is a system equivalent of the Breusch-Godfrey (**BG**) test while for static heteroscedasticity test a multivariate Breusch-Pagan (**BP**) test was employed. Dynamic heteroscedasticity was tested using a system **ARCH** test. P-values evaluated using *F*-distribution associated with the appropriate likelihood ratio test adjusted for small sample (Bewley 1986). The hypotheses of first order autocorrelation, as well as first and second order static heteroscedasticity, were rejected for the whole system. Also, dynamic full system heteroscedasticity was rejected.

Table 2. Full system misspecification tests

	LRT	DF	5% Critical values	P-value	Conclusion
BG test (1st order)	9.25	9	16.919	0.089624	**Rejected**
BG test (1st order)	4.63	12	21.0261	0.027304	**Rejected**
BG test (2nd order)	4.47	12	21.0261	0.024870	**Rejected**
ARCH	9.02	16	26.2962	0.041397	**Rejected**

The values of the parameters that maximize the set of likelihood function defining the path of structural break is $\hat{t}_1 = 1969 - \hat{t}_2 = 1983$. These results suggest a rather gradual change begun the year 1969 and was completed in 1983 covering the most part of the increasing period of pork consumption before it started decreasing within the second regime. The structural break might have occurred due to the notable changes of pig and chicken meat rather than changes in beef and lamb and mutton. The sharp rise of pigmeat production was the consequence of an investment programme concerning buildings, productive animals and slaughtering during the colonels' dictatorship and especially after 1968. Also, in line with the increase of Pork production, the big governmental campaign for the consumption of *Pork* meat during the first years of 70's causes the significant increase of Pork consumption[2]. The production and trading of *Pork* meat in very low prices due to the governmental assistance in order to support this sector, influences negatively the consumption of *Chicken* which exhibited significant downward trends.

The structural change path represented by the estimated joint points and the adopted transition path does not necessarily rule out other structural change path. To investigate the significance of the structural break Table 3 reports likelihood ratio tests for the hypothesis of consistency of the parameter vectors over time. The hypothesis of no structural break in the intercept parameters is rejected at the 0.05 and 0.01significance level. In the same table the hypothesis of no dynamics and no dynamics and structural break in intercept parameters are also rejected at the 0.05 and 0.01significance level.

Table 3. Likelihood Ratio for Structural Break and Dynamics

Hypothesis	**Number of restrictions**	**Likelihood Ratio**	$x^2_{0.01}$	$x^2_{0.05}$
No structural Break in Intercept parameters	3	22.73	11.34	7.82
No dynamics	12	64.42	26.22	21.03
No stuctral changes and no dynamics	15	124.13	30.58	25.00

The Bias of structural break

The bias of the structural change is the change in expenditure share between the two regimes evaluating the shares at the sample mean of the right-hand side variables. If the structural change reduces the demand for good i, then it is biased against that good.

The values of the switching parameters (z_i) and the associated standard errors are reported in Table 4. By dividing the parameter value by the mean share for the entire period under examination, we find the bias of the structural change. The change is biased in favour of pork and chicken and against beef and lamb and mutton. The parameters for the four commodities are significant at 5% level of significance. The results obtained by Moschini and Meike (1989), Reynolds and Goddard (1991) and Rickertsen (1996) also suggests that the structural change was biased away from beef toward white meat (pork and chicken).

Table 4. Bias of Structural Break

	Mean Share for all period w_i	Mean Share before the structural change w_i^a	Mean Share after the structural change w_i^b	Bias
Beef	0.33	0.35	0.31	-0.2355
				(0.0810)
Lamb& Mutton	0.27	0.35	0.25	-0.1388
				(0.0431)
Pork	0.26	0.19	0.31	0.2493
				(0.0606)
Chicken	0.14	0.11	0.13	0.1250
				(0.0540)

Note: Standard Errors are reported in parentheses

Impact of Structural Break in Demand Elasticities

Another interesting point is to investigate if structural change affects significantly the estimated elasticities. The computed Marshallian price and expenditure elasticities and their standard errors are presented in Table 5. The reported elasticities are calculated for both periods, before and after the structural break. All the reported own-price and expenditure elasticities are at least twice the size of their standard errors for both regimes. The own-price elasticities for all goods in both regimes are found to be negative and thus the corresponding demand curves are downward sloping. Considering the sign of the estimated elasticities, none of the elasticities have changed considerable from the elasticities obtained before the structural change although they have changed in magnitude. The uncompensated own-price elasticities for all goods are elastic for both regimes but lamb and mutton. Considering the expenditure elasticities, thought still classified as necessity goods, both beef and lamb and mutton are now less elastic. The same is true also for pork and chicken, which though both are luxury goods, after the structural change are still luxury but less elastic. The compensated elasticities for all goods in both before and after the structural change are

Table 5. Estimated Marshallian Elasticities at the Sample Mean

	Price of			
	Beef	**Lamb& Mutton**	**Pork**	**Chicken**
Elasticities of	***Before Structural Break***			
Beef	**-1.562**	0.202	0.201	0.333
	(0.217)	(0.109)	(0.159)	(0.114)
Lamb& Mutton	0.164	**-0.959**	0.007	-0.142
	(0.087)	(0.086)	(0.073)	(0.062)
Pork	0.226	-0.099	**-1.474**	0.096
	(0.263)	(0.147)	(0.260)	(0.156)
Chicken	0.861	-0.594	0.145	**-1.756**
	(0.337)	(0.222)	(0.276)	(0.305)
Expenditure	**0.825**	**0.930**	**1.251**	**1.343**
	(0.055)	(0.030)	(0.075)	(0.095)
	After Structural Break			
Beef	**-1.633**	0.206	0.248	0.375
	(0.243)	(0.117)	(0.182)	(0.127)
Lamb& Mutton	0.226	**-0.953**	0.022	-0.198
	(0.123)	(0.117)	(0.105)	(0.087)
Pork	0.144	-0.045	**-1.310**	0.056
	(0.163)	(0.087)	(0.164)	(0.096)
Chicken	0.746	-0.478	0.089	**-1.651**
	(0.289)	(0.184)	(0.242)	(0.260)
Expenditure	**0.805**	**0.902**	**1.154**	**1.293**
	(0.062)	(0.042)	(0.046)	(0.082)

Note: Standard Errors are reported in parentheses

presented in Table 6. The sign of the own-price uncompensated elasticities are for all goods are in the right sign accomplishing the necessary but not the necessary and sufficient condition for negativity.

The elasticity effects of structural change are further illustrated in Table 6 which reports the Allen elasticities of substitution before and after the structural change. The substitution elasticities are defined as:

$$\sigma_{ii} = \gamma_{ii}/(w_i^a)^2 - 1/w_i^a + 1$$
$$\sigma_{ij} = \gamma_{ij}/(w_i^a w_j^a) + 1 \qquad (10)$$

Table 6. Estimated Hicksian Elasticities at the Sample Mean

	Price of			
	Beef	**Lamb& Mutton**	**Pork**	**Chicken**
	Before the Structural Break			
Beef	**-1.274**	0.492	0.357	0.425
	(0.231)	(0.095)	(0.151)	(0.113)
Lamb& Mutton	0.488	**-0.632**	0.182	-0.038
	(0.094)	(0.077)	(0.070)	(0.063)
Pork	0.662	0.341	**-1.239**	0.236
	(0.281)	(0.132)	(0.251)	(0.157)
Chicken	1.330	-0.121	0.398	**-1.606**
	(0.353)	(0.199)	(0.265)	(0.308)
	After the Structural Break			
Beef	**-1.381**	0.407	0.494	0.480
	(0.257)	(0.106)	(0.169)	(0.126)
Lamb& Mutton	0.509	**-0.727**	0.298	-0.080
	(0.133)	(0.108)	(0.099)	(0.089)
Pork	0.505	0.244	**-0.956**	0.207
	(0.173)	(0.081)	(0.154)	(0.097)
Chicken	1.151	-0.153	0.485	**-1.483**
	(0.302)	(0.170)	(0.227)	(0.263)

Note: Standard Errors are reported in parentheses

and as before, the elasticities before the structural change can be obtained substituting w_i^a with w_i^b. Table 7 shows no statistically significant complementarity relation. The strongest substitutability relationships are between beef and chicken and also between pork and chicken. None of the elasticities are different between the two regimes.

Concluding remarks

Results of the parametric test for structural change indicate that there has been a change in the demand for meat during mainly the 70's. There have been statistical shifts towards pork and chicken and away from beef and lamb and mutton. These shifts are consistent with previous results in other countries. The sources of structural change were not identified in this study. However, movements towards pork and chicken and against beef and lamb and mutton suggest that pork's advertisement campaign and big investments concerning the sector of poultry and pig meat may be responsible for the observed changes.

Table 7. Estimated Elasticities of Substitution at the Sample Mean

	Beef	Lamb& Mutton	Pork	Chicken
	Before the Structural Break			
Beef	**-3.650**	1.400	1.897	3.811
	(0.661)	(0.271)	(0.806)	(1.012)
Lamb& Mutton		**-1.447**	0.970	-0.345
		(0.269)	(0.375)	(0.567)
Pork			**-2.655**	2.116
			(1.496)	(1.411)
Chicken				**-14.408**
				(2.764)
	After the Structural Break			
Beef	**-4.413**	1.625	1.615	3.678
	(0.822)	(0.423)	(0.552)	(0.964)
Lamb& Mutton		**-2.209**	0.974	-0.612
		(0.529)	(0.323)	(0.680)
Pork			**-1.641**	1.586
			(0.565)	(0.741)
Chicken				**-10.695**
				(1.730)

Note: Standard Errors are reported in parentheses

Notes

1. The results referring to the value of the likelihood function for all the combinations are available by the author upon request.
2. Pork consumption per year per capita raised from 6Kgr within the decade of 60's to 25 Kgr during the decade of 70's (unpublished data of Bank of Agriculture)

References

Alessie, R. and Kapteyn A., (1991*),* Habit Formation, Interdependent Preferences and Demographic Effects in the Almost Ideal Demand system, *Economic Journal*, **101**, 404-19

Bewley, R. (1986). *Allocation Models: Specification, Estimation and Applications*, Cambridge Mass., Ballinger.

Chalfant, J., (1987) *A* Globally Flexible Almost Ideal Demand System, *Journal of Business and Economic Statistics*, **5**, 312-26

Deaton, A. and J., Muellbauer, (1980) An Almost Ideal Demand System, *American Economic Review*, **70**, 312-26

Goddard, D., (1983), An Analysis of Canadian Aggregate Demand for Food at Home and Away from Home, *Canadian Journal of Agricultural Economics*, **31**, 289-318.

McGuirk, A.M., Driscoll, P., Alwang, J. and Huang, H. (1995). System Misspecification Testing and Structural Change in the Demand for Meats, *Journal of Agricultural and Resource Economics*, **20**, 1-21.

Moschini G. (1995) Units of Measurement and the Stone Index in Demand Systems Estimation, American Journal of Agricultural Economics, **76**, 61-73

Moschini G. and Meilke, D., (1989), Modelling the Pattern of Structural Change in US Meat Demand, *American Journal of Agricultural Economics*, **71**, 253-61.

Moschini, G. and Moro, D. (1996), Structural change and Demand Analysis: A Cursory Review, *European Review of Agricultural Economics*, **23**, 239-261

Reynolds, A. and E. Goddard, (1991), Structural Change in Canadian Meat Demand, *Canadian Journal of Agricultural Economics*, **39**, 211-22

Rickertsen, K., (1996), Structural Change and the Demand for Meat and Fish in Norway, *European Review of Agricultural Economics*, **23**, 316-330

Xu, X. and Veeman M., (1996), Model choice and Structural Specification for Canadian Meat Consumption, *European Review of Agricultural Economics*, **23**, 301-15

Appendix

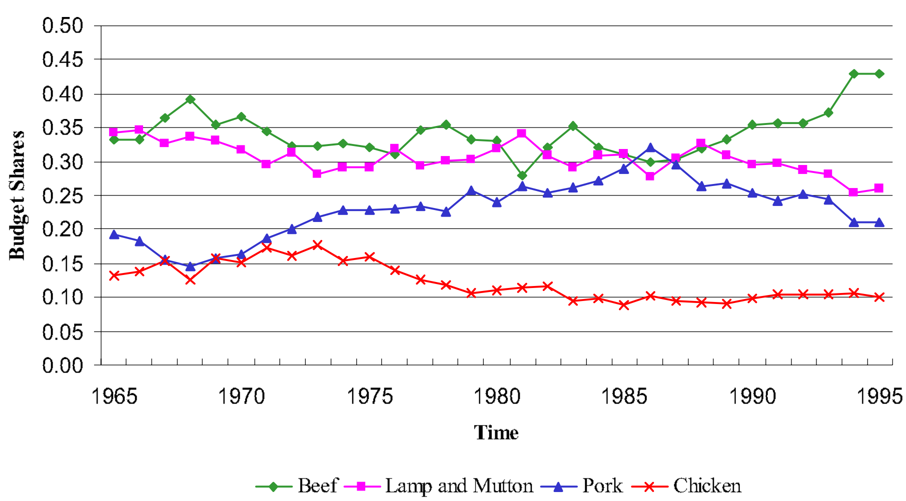

Figure 1. Evolution in Meat Expenditure shares over the data period