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Price and quantity adjustment in a dual character market
The case of the Greek poultry sector

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ABSTRACT

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In this paper we set up, estimate and test a short-run model for the poultry sector in Greece. The model allows for the simultaneous existence of a monopolistically competitive and a competitive segment, and determines producer and consumer prices, and the quantity consumed. We provide evidence on steady-state parameters such as demand and supply elasticities, as well as on speeds of adjustment of prices and quantities. The evidence suggests that adjustment is very rapid, although quantities appear to be adjusting more quickly than prices. The model is used to examine the dynamics of adjustment to demand and supply-side disturbances.

1. INTRODUCTION

The object of this study is the examination of the short-run determination of prices and quantities in the poultry sector in Greece. Contrary to most previous studies (e.g. Sakellis, 1982; Jones and Alexopoulos, 1986; Baltas and Apostolou, 1988) we do not rely on a model of perfect competition, but on a model which recognizes that some firms in the industry may have market power.

The poultry market in Greece is characterized by the presence of three large producers, whose market shares range from 15.5% to about 12%.

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Alongside them, there is a large number of small producers. A pure oligopoly model would probably be inappropriate, as a large share of the market appears to be served by these small producers. On the other hand, the combined market share of the three largest producers exceeds 40%. It is for these reasons that we use a mixed model of monopolistic and perfect competition.

The analysis focuses on the speed of adjustment of prices and quantities to changes in the determinants of supply and demand. In particular, we test whether price adjustment is quicker than quantity adjustment, or vice versa. The estimated model is also used to examine alternative policy scenarios.

The rest of the paper is organized as follows: in Section 2 we present the model. Econometric estimates and tests are presented in Section 3, which also contains dynamic simulations. The final section summarizes our conclusions.

2. THE MODEL

The market is assumed to be served by two types of producers. One set, whose combined share of the market we denote by α, acts as monopolistic competitors (Dixit and Stiglitz, 1977), while the other set, whose share is $1-\alpha$, acts in a competitive fashion. The market is segmented, in that the monopolisistic competitors, by virtue of the 'brand' recognition of their products, face a different demand elasticity for their products, and therefore charge a different price.

2.1. *Determination of prices*

The optimal price for the monopolistic competitors is given by:

$$P^{\mathrm{o}} = W(1+\mu) \tag{1}$$

where P^{o} is the price of poultry in their segment of the market, W is their variable cost of production, and μ is the price markup, which is equal to $1/\eta$-1, where η is the elasticity of demand in the monopolistically competitive sector.

Prices in the competitive sector depend on expected excess demand:

$$P^{\mathrm{c}} = \bar{P}(C/Y)^{\beta} \tag{2}$$

where P^{c} is the price of poultry in the competitive sector, $\bar{P}$ is the trend price in the sector, C is consumption, and Y is the productive capacity of the firms in the sector; β is the elasticity of demand for the product of the competitive sector.

Log-linearizing (1) and (2), we get:

$$p^{o} = w + \ln(1 + \mu) \tag{3}$$

$$p^{c} = \bar{p} + \beta(c - y) \tag{4}$$

where lowercase letters denote the natural logarithms of the corresponding uppercase variables.

The average price is given by the weighted average of the prices in the two sectors:

$$p^{p} = \alpha_{o} + \alpha w + (1 - \alpha)\beta(c - y) \tag{5}$$

where p^{p} denotes the log of average producer prices, and $\alpha_{o} = \alpha\bar{p} + (1 - \alpha)\ln(1 + \mu)$.

A special case of (5) occurs when the elasticity of the competitive price with respect to excess demand is equal to unity. In that case:

$$p^{p} = \alpha_{o} + \alpha w + (1 - \alpha)(c - y) \tag{5'}$$

The next step is to go from producer to consumer prices. We shall assume that the retail food sector is characterized by monopolistic competition. Thus, the consumer price is a multiple of the producer price:

$$P = (1 + \lambda)P^{p} \tag{6}$$

where P is the average consumer price, and λ is the markup of retailers. As before, $\lambda = 1/\theta - 1$, where θ is the elasticity of demand of final consumers for the composite 'bundle' of branded and unbranded products. Log-linearizing (6) we get:

$$p = \ln(1 + \lambda) + p^{p} \tag{7}$$

The combination of equations (5) and (7) determines producer and consumer prices as a function of cost and demand factors. We can now turn to the determination of demand.

2.2. Demand side

We assume that the demand for poultry is a negative function of their price relative to that of their close substitutes (other types of meat). We also assume that demand is a positive function of disposable income.

Thus:

$$c = \gamma_{o} - \gamma_{1}(p - p_{m}) + \gamma_{2}y_{d} \tag{8}$$

where p_{m} is the log of the weighted average of prices of other types of meat, and y_{d} is the log of the permanent disposable income of consumers.

An alternative form of (8) arises if we assume that meat consumption is separable in the preferences of consumers, in which case the demand function takes the form:

$$c = \gamma_o - \gamma_1(p - p_m) + \gamma_2 y_m \tag{8'}$$

where y_m is the log of total expenditure for meat.

2.3. Equilibrium

Clearly, the market is in equilibrium when the pricing decisions of firms are consistent with the demand decisions of consumers. Equilibrium can be found by solving (5), (7) and (8) simultaneously. The equilibrium is unique. If one assumes that out of equilibrium producers adjust prices and consumers adjust quantities, then the equilibrium is also stable. The nature of the dynamic path will depend on the relative speeds of adjustment of prices and quantities. Adjustment could be cyclical, or monotonic. If consumption adjust immediately, the demand curve also becomes the adjustment path. If prices adjust immediately, then the adjustment path is the price equation. If both quantities and prices adjust immediately, then the market will be in continuous equilibrium.

Comparative statics exercises are straightforward. An increase in disposable income will cause an increase in both quantities and prices, while an increase in variable costs will increase prices but will reduce quantities.

We can now turn to estimation and testing.

3. ECONOMETRIC ESTIMATES AND TESTS

In order to proceed to econometric estimation of the model, we shall need to be explicit about the adjustment hypotheses. We shall assume that, out of equilibrium, producers and retailers partially adjust prices, while consumers partially adjust quantities.

Let us start with the producer price equation (5). According to the model, the desired producer price is a positive function of the variable costs of production, and of excess demand. Thus:

$$\bar{p}_t^{\mathrm{p}} = \alpha_o + \alpha w_t + (1 - \alpha)\beta(\mathrm{c}_t - y_t) + u_{1t} \tag{9}$$

where a bar denotes a desired steady-state value, the subscript t denotes time, and u_{1t} is a random error.

In the short run, because of costs of adjustment, actual producer prices p_t^{p} adjust only partially towards their desired steady-state value:

$$\Delta p_t^{\mathrm{p}} = (1 - \delta_1)(\bar{p}_t^{\mathrm{p}} - p_{t-1}^{\mathrm{p}}) + \epsilon_{1t} \tag{10}$$

where $1-\delta_1$ is the degree of adjustment. If δ_1 is equal to zero, adjustment will be immediate and full, while if δ_1 is equal to unity, prices follow a random walk and never adjust. In general, $0<\delta_1<1$, in which case we have partial adjustment. ϵ_{1t} is an independent random error.

Substituting (9) in (10) and solving for p_t^{p}, we get:

$$p_t^{\mathrm{p}} = (1-\delta_1)\alpha_{\mathrm{o}} + \delta_1 p_{t-1}^{\mathrm{p}} + (1-\delta_1)\alpha w_t + (1-\delta_1)(1-\alpha)\beta(c_t - y_t) + v_{1t} \tag{11}$$

where $v_{1t} = (1-\delta_1)u_{1t} + \epsilon_{1t}$.

If we follow exactly the same procedure for the other two equations, we shall get:

$$p_t = (1-\delta_2)\beta_{\mathrm{o}} + \delta_2 p_{t-1} + (1-\delta_2)p_t^{\mathrm{p}} + v_{2t} \tag{12}$$

$$c_t = (1-\delta_3)\gamma_{\mathrm{o}} + \delta_3 c_{t-1} + (1-\delta_3)\gamma_1(p-p_{\mathrm{m}})_t + (1-\delta_3)\gamma_2 y_{\mathrm{d}} + v_{3t} \tag{13}$$

where $\beta_0 = \ln(1+\lambda)$.

Equations (11), (12) and (13) are the basis of our estimated equations.

Estimates of the producer price equation (11) appear in Table 1. In column (I) we present estimates of an unrestricted form where the coeffi-

TABLE 1

2SLS estimates of producer price equations

	(I)	(II)	(III)	(IV)
Constant	1.89	2.30	2.26	2.06
	(1.35)	(0.54)	(0.54)	(0.50)
p_{t-1}^{p}	0.26	0.19	0.18	0.27
	(0.27)	(0.18)	(0.18)	(0.16)
w_t	0.48	0.49	0.44	0.40
	(0.18)	(0.17)	(0.16)	(0.08)
c_t	0.60	0.59	0.59	0.33
	(0.25)	(0.24)	(0.24)	(0.08)
y_t	−0.52	−0.59	−0.59	−0.33
	(0.31)	(0.24)	(0.24)	(0.08)
$(\mathrm{SRL})_t$	−0.10	−0.09	−0.06	−0.06
	(0.06)	(0.04)	(0.02)	(0.02)
$(\mathrm{SRL})_{t-1}$	0.04	0.03		
	(0.05)	(0.05)		
t	0.03	0.04	0.05	0.04
	(0.03)	(0.02)	(0.01)	(0.01)
R^2	0.997	0.997	0.997	0.997
s	0.043	0.042	0.042	0.041
DW	1.478	1.477	1.673	1.570
F		0.260	0.650	0.400
		(1.16)	(2.16)	(3.16)

Dependent variable: p_t^{p}. Sample: 1962–1985.

cients of c_t and y_t are not constrained to be the same. The equation contains an additional variable, real credit from the Agricultural Bank of Greece. In a regime of credit rationing like that in Greece, extra credit reduces financial costs, and contributes to lower prices. A time trend is also included to capture technological change, as well as the trend price in the competitive sector. The equation in column (II) incorporates the restriction that c and y have the same coefficient with opposite signs. This restriction is not rejected by the relevant F statistic that is reported in the bottom of the Table. In column (III) we exclude lagged real credit, while in column (IV) we impose the restriction that $\beta = 1$. None of these restrictions is rejected when tested against the general equation. The relevant F-statistics at the bottom of the table are below their critical values at conventional significance levels.

From the preferred equation in column (IV) it appears that both the variable cost of production and excess demand affect prices in the short run. In addition, producer prices seem to adjust extremely quickly. The degree of sluggishness δ_1 is estimated at 27%, and is only significant at the 10% significance level. The mean lag in producer price adjustment appears to be about 4.5 months. The share of the monopolistically competitive sector is estimated at around one-half, which is not too far off the direct market shares of the three large firms reported in the introduction.

Consumer price equations are reported in Table 2. We have added a dummy variable for the period of direct price controls. It appears that

TABLE 2

2SLS estimates of consumer price equations

	(I)	(II)
Constant	−0.06	−0.12
	(0.37)	(0.03)
p_{t-1}	0.35	0.33
	(0.18)	(0.15)
p_t^{P}	0.63	0.67
	(0.27)	(0.15)
D_t	−0.08	−0.07
	(0.05)	(0.02)
t	0.01	0.007
	(0.01)	(0.002)
R^2	0.997	0.997
s	0.045	0.043
DW	1.974	1.935
F		0.030
		(1.19)

Dependent variable: p_t. Sample: 1962–1985.

TABLE 3

2SLS Estimates of demand function

	(I)	(II)	(III)	(IV)	(V)
Constant	−4.20	−4.70	1.47	0.16	−0.41
	(5.57)	(0.98)	(3.79)	(1.06)	(0.08)
c_{t-1}	0.28	0.28	0.15	0.16	0.15
	(0.15)	(0.15)	(0.10)	(0.10)	(0.10)
$(p - p_{\mathrm{m}})_t$	−0.95	−0.93	−1.07	−1.04	−0.98
	(0.31)	(0.23)	(0.19)	(0.17)	(0.14)
$y_{\mathrm{d}t}$	0.68	0.72	−0.14		
	(0.47)	(0.15)	(0.39)		
$y_{\mathrm{m}t}$			0.82	0.75	0.85
			(0.27)	(0.20)	(0.10)
t	0.02	0.02	0.03	0.03	0.023
	(0.02)	(0.01)	(0.01)	(0.01)	(0.004)
R^2	0.993	0.993	0.998	0.997	0.997
s	0.058	0.057	0.034	0.035	0.034
DW	2.501	2.500	2.138	2.195	2.084
F		0.050			0.250
		(1.19)			(1.19)

Dependent variable: c_t. Sample: 1962–1985.

these controls were effective in limiting the price markup of retailers. In column (II) we have imposed the restriction that the steady-state elasticity of consumer prices with respect to producer prices is equal to one. This restriction cannot be rejected at conventional significance levels by the reported F-statistic. The adjustment of retail prices to producer prices is quite rapid. In the short run, two-thirds of the change in producer prices is reflected in consumer prices. The mean lag is about 6 months, and there seems to be a small positive time trend in the markup by retailers.

Estimates of the demand function appear in Table 3. In columns (I) and (II) we use aggregate consumption as a measure of permanent disposable income, while in columns (IV) and (V) we use total consumption of meat, under the assumption of separability. The latter measure results in much better equations, and dominates aggregate consumption in the encompassing model reported in column (III). One cannot reject the hypothesis that the steady-state income elasticity of poultry demand is equal to unity (columns (II) and (V) respectively). Price elasticities are about -0.98 in the short run, and -1.15 in the steady-state. These numbers are from the preferred equation in column (V). Adjustment of consumption is extremely rapid, in fact far more rapid than prices, and the relevant sluggishness coefficient is only significant at the 10% level of significance. The mean lag is only two months.

TABLE 4

Comparison of 2SLS and 3SLS estimates of structural parameters, 1962–1985

	TSLS	3SLS
δ_1	0.27	0.23
	(0.16)	(0.13)
α	0.54	0.55
	(0.12)	(0.09)
δ_2	0.33	0.29
	(0.15)	(0.13)
δ_3	0.15	0.11
	(0.10)	(0.08)
$-\gamma_1$	-1.16	-1.18
	(0.06)	(0.05)

As a further check on the robustness of the results, we provide in Table 4 both the single equation (2SLS) and 3SLS estimates of the structural parameters. These estimates are for the version of the model for which β and γ_2 are set equal to unity. As we saw, these restrictions could not be rejected. The very small differences between the 2SLS and 3SLS estimates are another indication of the successful application of the model to the poultry market in Greece. As is well unknown, the method of 3SLS, like all systems methods, is very sensitive to specification errors, and such errors result in significant differences between 2SLS and 3SLS estimates.

To conclude, the estimates suggest that both prices and quantities adjust very quickly in the Greek poultry market. The income elasticity of demand is unity in the steady state, while the relative price elasticity is higher than one. The short-run demand elasticities are 0.85 for income, and -0.98 for relative prices. The short-run elasticity of producer prices with respect to variable costs is estimated at 0.40, while the short-run elasticity with respect to excess demand is equal to 0.33. The relevant steady-state elasticities are 0.54 and 0.46, respectively. Finally, the short-run elasticity of consumer prices with respect to producer prices is equal to 0.67, and the steady-state one is equal to one.

To get a better handle on the dynamic properties of the model we have used it to consider the short-run and steady-state effects of two disturbances. The first is an increase in the consumption of meat by 10%. This causes a shift in the demand function. The second disturbance we considered is a direct 10% subsidy of producer prices. This shifts the price equation. The results are in Table 5. An increase in meat consumption by 10% will cause a steady-state increase in poultry consumption by 6.5%, and an increase in the relative price of poultry by 2.9%. If this relative price were not to change, then the steady-state increase in poultry consumption

TABLE 5

Dynamic effects of alternative policies

	10% increase in meat demand						
	0	1	2	3	4	5	10
Poultry demand	0	7.1	6.9	6.6	6.6	6.5	6.5
Producer price	0	2.5	3.0	3.0	3.0	2.9	2.9
Consumer price	0	1.8	2.6	2.9	2.9	2.9	2.9
	10% subsidy of producer prices						
	0	1	2	3	4	5	10
Poultry demand	0	5.9	8.9	9.8	9.9	10.0	10.0
Producer price	0	−7.9	−8.7	−8.6	−8.5	−8.5	−8.5
Consumer price	0	−5.7	−7.8	−8.4	−8.5	−8.5	−8.5

would also be 10%. The short-run effects are very interesting, as the speed of adjustment of consumption is higher than that of prices. As a result, in the first few years consumption overshoots its steady-state increase, and so do producer prices, although their overshoot is much smaller.

A 10% subsidy of producer prices reduces consumer prices by 8.5% only in the steady-state, and this is because it increases demand and causes second-round increases of prices in the competitive sector. Adjustment is monotonic for consumption and consumer prices, although producer prices overshoot their fall in the second and third years.

4. CONCLUSIONS

This paper has investigated a short-run model for the poultry market in Greece. The model accounts for the simultaneous existence of both small competitive firms and firms with market power, and appears to have a very high explanatory power.

According to the estimates adjustment of both prices and quantities is very rapid, and the market quickly approaches equilibrium following various disturbances. However, the speed of adjustment of consumption is higher than the speed of adjustment of prices. If one uses the full model to study the nature of adjustment to equilibrium, it turns out that, although there are instances of overshooting, adjustment is so speedy that it is almost complete in the third year. The estimated elasticities of demand are of a similar order of magnitude as in previous studies.

Producer prices seem to depend primarily on the cost of production. Excess demand plays a secondary role, as the productive capacity of the sector seems to have been sufficient for most of the period.

The most significant technological innovations took place at the end of the 1950s, and were adopted by the new firms that were created during the 1960s. Thus, the time trend in our price equation seems to capture additional influences such as capital accummulation, and possible changes in market structure.

The price controls that were imposed in various periods seem to have had a dampening effect on consumer prices, limiting the profit margins of intermediaries. It must be added that there have also been been shifts in the distribution system, which are almost impossible to model.

The high relative price elasticities found are possibly due to the substitution possibilities between poultry meat and other kinds of meat, especially pork, which also belongs to the same category as poultry (white meats) and is a close substitute.

Consumption patterns and demographic changes must have had a significant effect on the share of poultry consumption, as the latter displays a strong trend. Thus, a policy of promotion of poultry consumption would possibly be effective, especially as consumption of poultry meat per head in Greece still falls short of that in other countries such as the US and Israel (15 kg per head, as opposed in 33 and 40 kg, respectively). An additional reason for promoting poultry meat is the deficit in Greece in other kinds of meat, especially beef for which self-sufficiency is only 40%. Beef is the most significant imported agricultural product, and a substitution away from it would also benefit the balance of payments.

Among the policy scenarios examined in the simulations, the first (10% subsidy of producer prices) is not very likely given the stipulations of the Common Agricultural Policy. The other, a 10% fall in the production capacity of the competitive sector, is more likely because of the stop put on long-term loans by the Agricultural Bank of Greece. According to our model, such a fall would result in a 2.1% fall in consumption in the first year, a 2.8% rise in producer prices, and a 2% rise in consumer prices. The steady-state effects are a 3.5% fall in consumption, and a 2.9% rise in producer and consumer prices.

DATA APPENDIX

The model has been estimated using annual data for the period 1961–85. Output data as well as consumer prices are published by the National Statistical Service of Greece. Prices for the various kinds of meat received by farmers are provided by the Greek Ministry of Agriculture. Data for short-term loans as well as the cost of production for poultry meat are from the Agricultural Bank of Greece. Production costs include the cost of baby chicks, plus feed, plus costs of processing, marketing, administration and financial costs. Data for total private consumption expenditure, which stands for personal disposable income, are from the National Accounts of Greece. Dummy variables take the value 1 for years in which the government fixed maximum consumer prices, and 0 for other years.

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