Linkages between Regulated and Unregulated Markets: the Case of Milk Supply in Kenya

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Abstract

Linkages between the regulated and unregulated dairy markets in Kenya were examined using an econometric model of the fluid milk intake for eight processing plants. Counter-intuitive results were obtained: an increase in the regulated price was significant in decreasing intake in the regulated market, indicating that a price increase in the regulated market also increased price and quantity supplied in the unregulated market. Lagged rainfall was a proxy for available feed and was highly significant in explaining milk intake in the regulated market.

Introduction

Regulated prices for agricultural products are prevalent in both centrally planned and market economies. The decision makers who set the prices attempt to set them high enough to encourage producers to maintain an adequate and stable supply, and yet not so high that inefficient production is encouraged. They must also be aware of equity principles in that producers should not benefit at the expense of consumers (Mansell et al., 1984). This balancing act between objectives is difficult and even more so in less developed countries that have interaction between the formal, regulated market, and the informal, unregulated market. Pricing policies may have an effect opposite of what is

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expected if the interaction between the two markets is overlooked or the strength of the unregulated market is underestimated. Thus, it is important to determine the relationship between the regulated and unregulated markets if government intervention in agricultural markets is to have its desired results.

This paper disusses an estimated supply response model for the regulated fluid milk market in Kenya. This model has counter-intuitive results that can be explained by the existence of a strong unregulated market that is driven by the regulated market and exogenous factors. While this model does not explicitly estimate the relationship between the regulated and unregulated markets, it does allow testing the hypothesis that an increase in a regulated price may actually decrease supply in the regulated market.

A short history of dairying in Kenya follows. A description of the theory underlying the model used in this study is next. The empirical model and data used, including the use of rainfall data as a significant proxy for available feed, is then discussed, followed by a summary and conclusions at the end of the paper.

Dairying in Kenya

Dairying has been part of Kenyan agriculture for generations, but commercial dairying with high-yielding European breeds was started by Europeans around 1912. A strong effective demand encouraged expansion of the dairy industry. The depression of the 1930's disrupted the dairy industry and led to the amalgamation of several small creameries into the Kenyan Cooperatives Creamery (KCC) (Ruigu, 1978). The KCC is supplied by large commercial dairies and cooperatives that each market the milk of about 200 smallholders (Von Stotz, 1979). Increased milk production in Kenya over the last 20 years has come in a large part from the smallholders, who produced an estimated 70% of the milk in Kenya in 1975, but accounted for only 37% of the deliveries to the KCC in that year (Minae, 1981). Smallholder deliveries to the KCC have been increasing, reaching 54% in 1982, and their production and deliveries to the KCC are expected to increase in both absolute terms and as a percentage of total production and deliveries (Kenya Central Bureau of Statistics, 1970–1983).

More than 60% of the smallholders in Kenya own at least one dairy cow. Milk production is primarily for home consumption, with any surplus marketed to the KCC through a local cooperative or 'over the fence' in the unregulated market. Cooperative and transportion fees make the price smallholders realize from sales to the KCC through the cooperatives less than the regulated KCC price that is paid to the large producers. The cooperative payments are also often delayed (Minae, 1981).

The smallholders do not purchase many inputs and so rely heavily on available feedstuffs, which in turn are dependent on rainfall. Even with several different ecological zones in the country, there is a definite dry season in January through April. The dry season severely limits available feedstuffs and results in a reduced supply of milk. The KCC has tried different methods to encourage a stable supply through the dry season, with a dry season bonus 25% above the regular price of milk the latest incentive.

Interaction between regulated and unregulated markets

Suppose there is an unregulated market that has a constant downward sloping demand curve, an upward sloping supply curve that has periodic exogenously caused changes in supply, and an adjoining but separate regulated market that will buy all output offered a price P_r, as shown in Fig. 1. If supply is S^1, then unregulated price is P_u and total production Q_u is sold on the unregulated market. If there is an exogenous change in supply to S^2 the regulated price, P_r, acts as a price floor for the producers. $Q_{u'}$ is sold in the unregulated market, and the amount sold to the regulated market is $Q_r = Q_t - Q_{u'}$. This graphical model is analogous to Kenyan milk supply in the dry (S^1) and wet (S^2) seasons.

The regulated market will buy all output at the regulated price, so P_r acts as a price floor for P_u, or:

$$P_u = g(P_r, Z) \quad \text{for } P_u > P_r \tag{1}$$

where Z are other factors in the local unregulated market, such as distance to the regulated market, local demand, and exogenous factors affecting supply in the unregulated market. P_r does not act as a price ceiling in the unregulated market: there are positive marketing costs of the final product which act as a

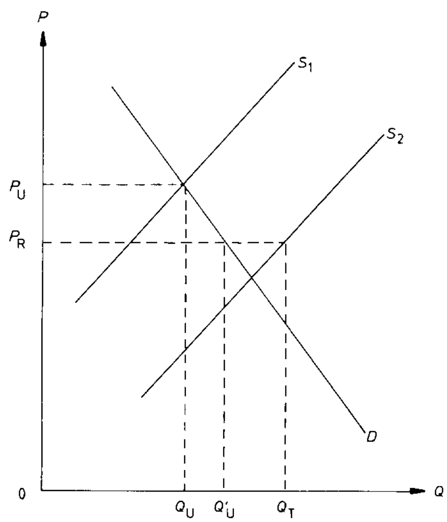

Fig. 1. Quanitity supplied when the regulated price acts as a price floor.

barrier between the regulated and unregulated markets. Thus, P_u increases with P_r, distance to the regulated market and local demand, and decreases with exogenous supply increases.

Supply on the regulated market is:

$$Q_r = f(P_r, P_u, X) \tag{2}$$

where X is other factors including exogenous supply shifters.

The response of a price change in the regulated market can be two-fold:

$$dQ_r/dP_r = (dQ_r/dP_r)\Big|_{g()=0} + (dQ_r/dP_u)(dP_u/dP_r) \tag{3}$$

The first term on the right-hand side is positive and the second term is negative. Elasticizing (3):

$$E_{Q_r} = \epsilon_{Q_rP_r} + \epsilon_{Q_rP_u}\epsilon_{P_uP_r} \tag{4}$$

Given the long production cycle in dairy, i.e., a decision about production today will result in an increase or decrease in milk supply 9 months from now, a very inelastic supply is expected, as found in most countries (e.g., Dahlgran, 1985). Hence, the first term on the right-hand side, the partial elasticity of quantity in the regulated market with respect to regulated price, is expected to be positive and very small. One can reasonably expect any increase in the regulated price to have an immediate effect on the unregulated price, so the last term is positive and close to 1. Thus, the impact of an increase in the regulated price on supply in the regulated market is determined by the relationship between the partial elasticities of quantity in the regulated market with respect to regulated and unregulated prices. If $|\epsilon_{Q_rP_r}| < |\epsilon_{Q_rP_u}|$, then an increase in the regulated price will have the opposite effect; i.e., the quantity supplied to the regulated market will decrease with an increase in the regulated price.

Empirical model

The above model appears to be substantiated by results of an econometric estimation of supply in the regulated fluid milk market in Kenya. The regulated fluid milk market in Kenya is the KCC, which is a government-regulated monopoly/monopsony. The unregulated market consists of many smallholders who sell any milk surplus to family needs 'over the fence'.

Supply to the regulated market was approximated as intake for eight KCC processing plants that account for 98% of total KCC intake. Table 1 lists the plants along with average intake and percentage of total intake for 1970 – 1980. Monthly intake for these plants was estimated as:

$$Q_r = P_r + \text{RFMA}(4) + \text{DPR} + \text{DS} + T \tag{5}$$

TABLE 1

Average KCC intake by factory, and nearest recorded rainfall station, 1970–1980

Factory[a]	Average intake (10^6 litres)	Percentage of total intake	Rainfall station
Eldoret	48.03	21	Eldoret
Kiganjo	24.68	11	Nyeri
Kitale	29.17	13	Kitale
Nairobi	24.59	11	Kiambu
Naivasha	23.87	11	Nakuru
Nakuru	49.05	22	Nakuru
Nyahururu	13.44	6	Nyahururu
Sotik	11.04	5	Kerichoo

[a]These eight factories account for 98% of KCC's intake. Left out are Kisumu, Mombasa (Kilifi), Mariakani, and Molo.

where P_r is the real regulated price for fluid milk, RFMA(4) 4-month moving average of rainfall, DPR a discrete variable indicating a nominal change in the KCC price for fluid milk, DS is a binary variable to indicate the dry season, and a trend variable, T, was included to capture disembodied technical change. The KCC price for fluid milk was deflated by the index of prices paid for consumer goods in rural areas to approximate the real price smallholders received for their milk. The discrete variable indicating a nominal price change, DPR, attempts to capture the affect a nominal change in the regulated price has on the unregulated price. The trend variable, T, tries to capture disembodied technical change including genetic improvement, improved management practices, and increased educational level of the producers.

Rainfall was used as a proxy for available feed. Smallholders do not purchase many inputs, if any, and so livestock feed is limited to whatever is available. Rainfall was modeled both lagged and as a moving average over various time periods to capture the effect that rain in period t has on feed availability in period t_+. Using a minimum distance criterion as approximated by a chi-square (Judge et al., 1982), a 4-month moving average was chosen to model rainfall.

Data

Monthly quantities of intake per plant were made available by the KCC. Price paid by the KCC, the index of prices paid in rural areas, and monthly rainfall for seven weather stations closest to the KCC plants came from the *Statistical Abstract for Kenya* (Kenya Central Bureau of Statistics, 1970–1983).

TABLE 2

Estimated KCC intake by plant, 1970-1982

Plant	Intercept	P_r	RFMA(4)	DPR	DS	T
Eldoret	972.7	2425	17.72***	−801.0***	229.8	22.85***
$R^2=0.58$	(623.0)[a]	(1038.81)	(1.50)	(160.8)	(159.1)	(6.53)
Kiganjo	1048	3062**	−6.66*	−19.13	−135.2	03.16
$R^2=0.44$	(742.2)	(633.6)	(1.59)	(91.91)	(108.0)	(3.82)
Kitale	3688**	−3623**	10.93**	−26.50	−233.56	−1.10
$R^2=0.73$	(695.6)	(483.8)	(1.06)	(19.60)	(98.82)	(85.21)
Nairobi	2586	−1151	4.77**	−518.3**	−144.0	9.25*
$R^2=0.72$	(1006)	(405.8)	(0.5624)	(59.67)	(59.36)	(2.39)
Naivasha	1514	−620.2	15.66***	−441.8**	−257.89*	18.04**
$R^2=0.52$	(987.6)	(624.34)	(0.89)	(66.24)	(72.22)	(2.64)
Nyahururu	1328**	2087*	4.81**	−83.49)	−220.85	15.89**
$R^2=0.70$	(232.1)	(463.7)	(0.80)	(69.09)	(80.97)	(2.79)
Sotik	−259.6	625.8	0.84	25.24	−84.21	11.01*
$R^2=0.73$	(279.4)	(354.0)	(0.54)	(53.19)	(58.26)	(2.15)
Nakuru	3431	−472.1	10.13***	−472.1**	−776.4**	14.46*
$R^2=0.70$	(2112)	(135.7)	(0.80)	(69.09)	(80.97)	(2.79)

[a]Standard errors of the estimate are in parenthese.
Significant at the 0.01 level***.
Significant at the 0.05 level**.
Significant at the 0.10 level*.

Results and discussion

Equation (4) was appended with an error term to account for unobserved stochastic variables and estimated for the eight KCC plants for 1970 - 1982. The estimation results are reported in Table 2. The explanatory power of the model ranges from explaining 44 to 73% of the variation in the reported KCC intake. Durbin–Watson tests for autocorrelation were inconclusive.

The coefficient of P_r was negative in half the models, and significant in only three of the models, indicating that real price was not a very important factor in KCC intake. Studies in the U.S.A. have also found the price of milk in a supply function to be not significant (Wilson and Thompson, 1967; Prato, 1973).

The coefficient of DPR is negative in all eight models and significant in four. The hypothesis that an increase in a regulated price may decrease supply in the regulated market is not rejected by these results: a nominal increase in the KCC price of milk resulted in decreased deliveries to the KCC. A linkage between the regulated and unregulated markets exists, with price increases in the regulated market being passed through to the unregulated market. The higher unregulated price then attracts more milk to 'over the fence' sales and decreases deliveries to the KCC.

The coefficient of RFMA(4) was positive, as one would expect, and significant in six of the models, and negative (and significant) in only one. Rainfall appears to be a good proxy for available feedstuffs in Kenya. Rainfall may not be as important in more developed countries where producers purchase most of their inputs, but in areas where few inputs are purchased rainfall is likely an important variable in supply studies. The importance of weather in KCC milk intake is reinforced by the coefficient of DS, which is negative in all eight models, though significant in only two, and indicates a definite decrease of supply in the dry season

The existence of disembodied technical change is supported by positive and significant trend variables in six of the models. The two trend parameters that are negative are also not significant.

The counter-intuitive result on nominal price increase has implications for policy makers in many less-developed countries. Price policies to increase supply to the regulated markets may produce results opposite of those desired. If there is a linkage between the regulated and unregulated markets such that an increase in the regulated price also raises the unregulated price, the increased prices may bid output to the unregulated markets and away from the regulated markets. Thus, raising the KCC price may cause more ‘over the fence’ sales and less KCC intake.

These results are for only one commodity in one country, but they do point out that if a government elects to intervene in a market, the results of that intervention may be opposite of what is expected or desired. This study points out that there is a need for further research into the interaction between regulated and unregulated markets in less-developed countries. Without an understanding of such a relationship intervention in a market may bring about results opposite of what was planned.

Summary

The hypothesis that an increase in a regulated price may decrease supply in the regulated market is supported by these results. A nominal increase in the KCC price of milk resulted in decreased deliveries to the KCC. The decreased deliveries indicate a linkage between the regulated and unregulated markets that is driven by the regulated price. The results also indicate that rainfall can be used as proxy for available feeds where feed inputs are not purchased. This study points out that there is a need for governments to determine the relationship between regulated and unregulated markets to reduce the risk that pricing policies will bring about results opposite of those planned and desired.

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