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MARKET STRUCTURE AND MARKET POWER IN MILK VALUE CHAIN: THE CASE OF INDIA

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Short Profile :

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ABSTRACT :
The recent rise in the prices of fluid milk has attracted significant media attention with allegations that fluid milk processors/retailers have colluded to raise prices . The attention is justified as milk constitutes an important commodity in the consumption basket of majority of households in India. In this note we propose an empirical framework derived from a structural model which is an extension of the new empirical industrial organization (NEIO) approach and allows for a estimation of market power exertion when firms on both sides have potential market power

Keywords:
new empirical industrial organization (NEIO), CPI, WPI, oligopoly, downstream and upstream firms.

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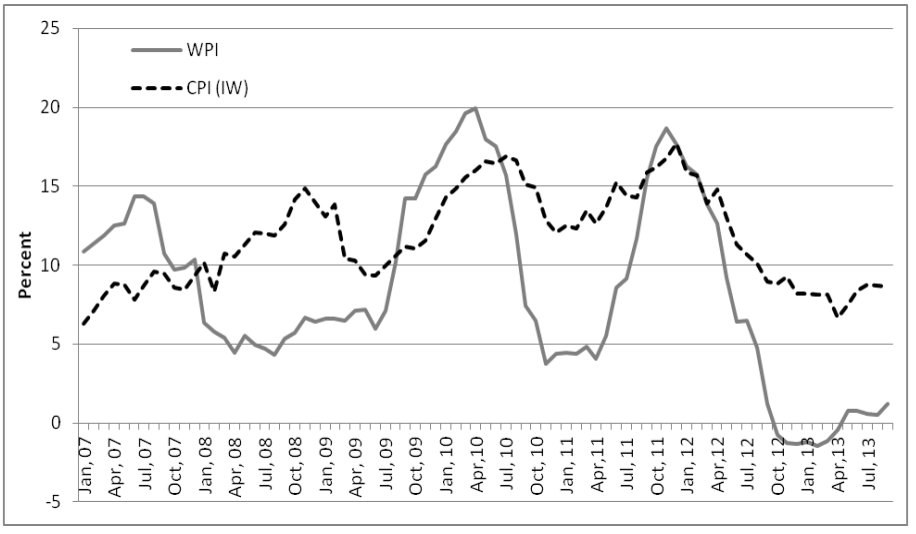
INTRODUCTION

The hike in milk prices has now come under scrutiny of the competition commission of India (CCI) which is considering an investigation to determine malpractice within milk value chain. Processors/retailers argue that they procure fluid milk through cooperatives and no producer is big enough to dictate prices. Cooperatives, who intermediate between livestock farmers and the processors/retailers, blame the "increased cost of cattle feed and fodder" as the main reason for price increase. Due to lack of any systematic study of the fluid milk Industry in India, there is little information about the market structure of the industry to give any credence to the claims of collusion by milk processors/retailers and/or cooperatives taking advantage of the market power and the vertical orientation of the milk value chain.

Figure 1: Trends in milk CPI-IW and WPI inflation



Source: WPI data from office of the economic advisor government of India (http://www.eaindustry.nic.in/). CPI-IW data from labour bureau government of India (http://labourbureau.nic.in/main2.html) and ministry of statistics and program implementation, government of India (http://164.100.34.62:8080/cpiindex/?status=1&menu_id=54).
Note: Inflation calculated as the percent difference between the index of a month in a particular year by the index of that same month in the subsequent year. WPI at base 2004-05=100 and CPI-IW at base 2001=100.

To get some idea of the general trend in fluid milk price inflation in India over the past few years, we plot the monthly inflation in wholesale price index (WPI) and consumer price for index industrial worker (CPI-IW) for fluid milk from January, 2007 to September, 2013. It is interesting to observe that the inflation in CPI-IW matches the upward movements in the WPI but does not follow the downward movements of WPI closely. This implies that although prise rise in WPI are transferred to CPI-IW, price falls are not. Given the value chain of fluid milk in India, where cooperatives and processors/retailers are the link between the livestock farmer and the consumers, figure 1 may probably be an artefact of the market structure and power of the two intermediaries.

In the light of recent price hikes of fluid milk and the peculiar pattern followed by inflation in the WPI and CPI-IW series, it is important to understand the market structure of the milk value chain in India. In this note we propose an empirical framework derived from a structural model which is an extension of the new empirical industrial organization (NEIO) approach and allows for a estimation of market power exertion when firms on both sides have potential market power (Raper, Love, and Shumway 2000; Villas-Boas and Hellerstein 2006).

Theoretical framework and empirical strategy

(a) Theoretical framework

While estimating the market power of intermediaries in fluid milk value chain, it is important to factor in the vertical orientation and the particularly long value chains in the fluid milk industry. The long value chains are a requirement of the unorganised structure of milk production and the highly perishable nature of the commodity. This particular aspect of fluid milk has important implication for the kind of market structure that may have emerged in the industry. We adopt the theoretical structure developed by Villas-Boas and Hellerstein (2006) who relax the conventional assumption that manufacturer set prices and that retailers act as neutral pass-through intermediaries. They define a model of successive oligopoly where both the upstream and downstream firms exercise market power in their respective output markets. The advantage of their structural model is that the parameters and the vertical model of manufacturers' and retailers' oligopoly-pricing behaviour can be identified with basic data on an industry's product prices, quantities, and input prices over time.

Let the inverse demand function that the downstream firms face in the retail market be defined as,

$$P^d = h(Q^d, Y) \qquad (1)$$

Where P^d and Q^d are the price and the quantity of the downstream firms, Y is the vector of demand shifters. Assume that the game is a sequential one where first upstream firms sets a price $\mathrm{P^u}$ first. All the quantity produced by the upstream firms goes as input in the production of the downstream firms i.e. $Q^u = Q^d = Q$. The price of the upstream firms goes as marginal cost in the maximization problem of the downstream firms which determines P^d. Therefore the marginal costs of the upstream and downstream firms can be defined as $C^u = C^u(V)$ and $C^d = P^u + C^d(W)$ where W and V are the exogenous cost shifters.

Following the backward induction argument, the profit maximization problem of the downstream firms is given as

$$Max_Q: \Pi^d = h(Q^d, Y)Q - (P^u + C^d(W))Q \qquad (2)$$

The first order condition given by the following expression

$$\frac{\partial \Pi^d}{\partial Q} = P^d + \frac{\partial Q^d}{\partial Q} h'(Q^d, Y)Q - \left(P^u + C^d(W)\right) = 0 \qquad (3)$$

Which gives us the supply function of the downstream firms.

$$P^d = P^u - \lambda^d h'(Q,Y)Q + C^d(W) \quad (4)$$

Where $\lambda^d = \frac{\partial Q^d}{\partial Q} \in [0,1]$ is the conjectural variation. Note that equation 4 also gives the inverse demand function of the upstream firms and the maximization problem of the upstream firm becomes.

$$Max_Q: \Pi^u = (P^d + \lambda^d h'(Q,Y)Q - C^d(W))Q - C^u(V)Q \quad (5)$$
$$P^u = C^u(V) - \lambda^u(h'(Q,Y)Q + \lambda^d h''(Q,Y)Q^2 + \lambda^d h'(Q,Y)Q) \quad (6)$$

The pricing equation for the downstream firm given by equation 4 can be written as.

$$\left(\frac{P^u + C^d(W)}{P^d}\right) = \left(1 + \frac{\lambda^d}{\eta^d}\right) \quad (7)$$
$$P^d = \left(1 + \frac{\lambda^d}{\eta^d}\right)^{-1}\left(P^u + C^d(W)\right) \quad (8)$$

η^d is the price elasticity of retail demand and $\left(1 + \frac{\lambda^d}{\eta^d}\right)^{-1} \in [1,\infty)$ measures downstream firms markup. Similarly assuming a linear demand schedule we can write the pricing equation for the upstream firm given by equation 6 as.

$$P^u = \left(1 + \frac{\lambda^u}{\eta^u}\right)^{-1} C^u(v) \quad (9)$$

Where $\eta^u = \left((1+\lambda^d)h'(Q)\frac{Q}{P^u}\right)^{-1}$ is the price elasticity of derived demand and $\left(1 + \frac{\lambda^u}{\eta^u}\right)^{-1} \in [1,\infty)$ Is the upstream firms' markup.

$$\eta^u = \frac{\eta^d}{(1+\lambda^d)}\frac{P^u}{P^d} \quad (10)$$

Equation 10 is revealing as it expresses derived demand elasticity η^u as a function of the upstream firms' demand elasticity, η^d, and the conduct parameter of the downstream firm, λ^d. Also, equation 10 implies that $|\eta^u| \leq |\eta^d|$.That is, under the assumption of linear demand and constant marginal cost, the derived demand is more inelastic than primary demand.

(a) Identification strategy

The system comprising the demand equation 1 and the pricing equations for downstream and upstream firms, equation 8 and 9 can be estimated simultaneously to obtain the estimates of the markups and the estimates of primary demand. Estimates of the conjectural elasticities and the elasticity of derived demand can then be estimated indirectly.

To set up an empirical model we assume a fluid milk retail demand function which differs across state or markets.

$$Q_{it} = \alpha_1 + \sum_{i=2}^{N} \alpha_i \times D_i + (\beta_1 + \sum_{i=2}^{N} \beta_i \times D_i) P_{it}^d + Y_{it}\gamma + \epsilon_{it} \quad (11)$$

Where *i* denote state or market centre and *t* denotes time. The model has a state or market specific dummy variable D_i to control for unobserved state specific time constant heterogeneity and ϵ_{it} is the error term. We interact the state or market specific dummy variable with the downstream firms' price P_{it}^d to allow the demand function to differ across state or markets. Y_{it} is the vector of demand shifters.

To complete the model we define the empirical counterpart of the two pricing equations.

$$P_{it}^d = \delta_0 + \delta_1 P_{it}^u + \delta_2 W_{it} + v_{it} \quad (12)$$

Where $\delta_1 = \left(1 + \frac{\lambda^d}{\eta^d}\right)^{-1}$ measures the downstream firms' markup is same for all state or markets but since the demand function varies with state or markets, we will have estimates of state or market specific conduct parameters.

$$P_{it}^u = \mu_0 + \mu_1 V_{it} + u_{it} \quad (13)$$

Where $\mu_1 = \left(1 + \frac{\lambda^u}{\eta^u}\right)^{-1}$ is the markup of the co-operatives or the upstream firms.

Data requirements

The main idea behind any market structure analysis is the identification of the market demand function. Due to limited availability of data most of the studies invoke industrial organisation theory and develop structural models to identify the market demand for the industry. This section details the data requirements for identification of the demand system described in the previous section. Table 1 lists the variables required and their possible sources for estimation. Since we plan to construct a state wise/market wise panel, the data on all variables is at state/market level.

The per capita milk consumption estimated by the National sample survey organization (NSSO) from the consumption expenditure surveys can be used as a representative of the household per capita demand for liquid milk. The problem with this data source is that since the survey rounds are conducted after a five year gap, the demand series will have time gaps.

The upstream and downstream price or the centre wise retail and wholesale price series for liquid milk are available from department of consumer affairs on annual basis. In case of gaps and inconsistency in this data it can be supplemented by commodities price data form directorate of economics and statistics, ministry of agriculture, government of India.

Table 1: Variables used in estimation and their possible sources

Variables		Possible sources	Frequency
Q_{it}	Demand for liquid milk	State wise consumption of liquid milk per capita from NSSO reports on consumption and expenditure on various household commodities in India (http://mospi.nic.in/Mospi_New/site/home.aspx)	1999-2000 (55th round), 2004-05 (61st round) and 2009-01(66th round)
P_{it}^{d}	Retail price of liquid milk	Department of consumer affairs, Ministry of consumer affairs, centre wise/state wise on retail and wholesale prices of basic commodities (http://fcainfoweb.nic.in/PMSver2/Reports/Report_Menu_web.aspx) and Directorate of economics and statistics, Ministry of agriculture GoI retail price information system (http://rpms.dacnet.nic.in/Bulletin.aspx)	2000-01 to 2009-10
P_{it}^{u}	Wholesale price of liquid milk	Department of consumer affairs, Ministry of consumer affairs, centre wise/state wise on retail and wholesale prices of basic commodities (http://fcainfoweb.nic.in/PMSver2/Reports/Report_Menu_web.aspx) and Directorate of economics and statistics, Ministry of agriculture GoI retail price information system (http://rpms.dacnet.nic.in/Bulletin.aspx)	2000-01 to 2009-10

Y_{it}	Butter price	State wise consumer price index extracted from statistical abstract of states and MoSPI archives on consumer price indices, MoSPI, GoI (http://164.100.34.62:8080/cpiindex/?status=1&menu_id=54)	2000-01 to 2009-10
	Ghee price	State wise consumer price index extracted from statistical abstract of states and MoSPI archives on consumer price indices, MoSPI, GoI (http://164.100.34.62:8080/cpiindex/?status=1&menu_id=54)	2000-01 to 2009-10
	Tea and/or coffee price	State wise consumer price index extracted from statistical abstract of states and MoSPI archives on consumer price indices, MoSPI, GoI (http://164.100.34.62:8080/cpiindex/?status=1&menu_id=54)	2000-01 to 2009-10
	Other beverages price	State wise consumer price index extracted from statistical abstract of states and MoSPI archives on consumer price indices, MoSPI, GoI (http://164.100.34.62:8080/cpiindex/?status=1&menu_id=54)	2000-01 to 2009-10
	Income per capita	State wise Gross Domestic Product (GDP) at constant prices from National Accounts Statistics and population data from national census (http://mospi.nic.in/Mospi_New/site/home.aspx)	2000-01 to 2009-10
	Demographics	State wise percent of 0-15 year old individuals in the total population national census	1999-2000, 2004-05 and 2009-01
V_{it}	Marginal cost of cooperatives (upstream firm)	National dairy development board (NDDB) Anand, Gujarat and pilot survey to be conducted	-
W_{it}	Marginal cost of retailer (downstream firm)	Pilot survey to be conducted	-

To identify the demand function we use price of related commodities like the state wise consumer price index of butter, ghee, tea, coffee and other beverages as demand shifters. The CPI data for related commodities can be extracted from state statistical abstracts and can be supplemented by the CPI archives maintained by the ministry of statistics and program implementation, government of India.

There has been significant growth in per capita incomes over the period of analysis which has led to diversification in diet of an average Indian to high value commodities like milk, meat, eggs, fruits and vegetables. Therefore it is important to control for the per capita income growth over the period of analysis. Per capita income can be calculated by dividing gross domestic product at constant prices, available from National Accounts Statistics (NAS), by the population estimated from national census. For the period of analysis, state wise population estimated from the national censuses of 2001 and 2011 can be used to calculate the compound annual growth rate, and the population series for the 10 year period from 2000-01 to 2009-10 can be imputed. Any change in state demographics and household composition will also affect the per capita demand for fluid milk therefore we include the percent of individuals between the age of 0 to 15 years to control for the effect of a relatively younger population on per capita milk demand.

To identify the supply function, our theoretically framework and empirical strategy relies on marginal cost information of the two intermediaries i.e. the cooperatives and the retailers. The data on marginal cost of both the upstream and downstream firms is not available. Marginal cost data for the two intermediaries is required to estimate the markup of the two intermediaries. The official source of such data is the National Dairy Development Board (NDDB), but due to strategic reasons they may not reveal this information. To acquire such information, a survey will have to be conducted to have some idea of the marginal cost of the retailer and the cooperatives. Note that to construct a panel data the marginal cost information of the two intermediaries will have to be collected for at least two time periods.

CONCLUSION

In this note we propose a simple framework to model the structure of fluid milk value chain in India and determine the degree of market power exerted by the two intermediaries. Due to the peculiar nature of milk value chain we propose a two stage game where, following backward induction, the demand curve facing the upstream firms is derived demand for the commodity by the downstream firms. This two stage structure implies that the markup and pricing decision of the upstream firm will depend upon the conduct of the downstream firm in the retail market. The main benefit of the proposed model is its minimum data requirements for estimation, most of which is readily available from government sources.

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