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Price Transmission, Market Power and Returns to Scale[1]

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Abstract: In this paper, we aim to model the vertical relation between retailers and suppliers in the food industry whereby retailers exercise seller power in their relation with consumers and buyer power in their relation with producers. We then evaluate the degree of price transmission, relative to the perfectly competitive benchmark, from the farm to the retail sector assuming a supply shock. With the view to evaluating the impact of market power's interaction with industry technology on the degree of price transmission, we assume industry technology to be characterised by variable input proportions and non-constant returns to scale. Our model predicts that, relative to that which obtains when markets are perfectly competitive and industry technology is characterised by constant returns to scale, the degree of price transmission when market power and industry technology interact cannot be unambiguously determined.

Keywords: price transmission, returns to scale, market power

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1 Introduction

In recent years, the issue of price transmission in vertically related food markets, where the farm and marketing inputs combine to produce the final product, has attracted a great deal of attention in academic and policy circles in Europe and North America. A plethora of theoretical and empirical studies in the price transmission literature and waves of government-commissioned inquiries into retail (supermarket) behaviour attest to the degree of attention the issue has attracted in these circles.

In the UK, the ascendancy of the issue owes much to public dissatisfaction with the pricing practices of retail (supermarket) multiples whose level of concentration has shown a dramatic increase in recent years. It is generally believed that they exercise market power in their relation with consumers such that in the event of any price reduction at the farm level consumers get little in benefit as the gains go to widen retailers' margin. It is also believed that they exercise buyer power over suppliers such that not only do they force farm price down to a level lower than the perfectly competitive benchmark but they also place vertical restraints on suppliers of the farm input. In general, there seems to be a popular belief which holds that retail concentration is bad for social welfare.

This popular belief seems to have found support in economic theory. For instance, Dobson (1997); Dobson (2001); and Dobson (2003) show that under special conditions, an increase in retail concentration may result in a net social welfare loss. Contrary to the popular belief that retail concentration is detrimental, however, economic theory also shows that under other special conditions, an increase in the level of retail concentration can produce benign social welfare effects. In this connection, Dobson and Waterson (1999) show that even though retail concentration reduces competition at all stages of the marketing chain, it can generate productive efficiency benefits that enhance consumer welfare.

Thus despite the popular negative perception of retail concentration, economic theory is ambiguous regarding the social welfare effects of such concentration. Given this ambiguity, it is not surprising that theory cautions against making hasty policy recommendations regarding the regulation of retail concentration on consideration of only the negative social welfare effects of such a concentration.

Indeed, it advises that any such recommendations involve consideration of a series of welfare trade-offs.

Indeed, these potential trade-offs seem to have influenced the recommendations of a series of commissioned inquiries into the behaviour of retail multiples in the UK. For instance, both the Competition Commission (2000) and the Monopolies and Mergers Commission (1981) identified many retail practices which stand to operate against the public interest. However, neither of these commissions made recommendations in favour of regulating the behaviour of retail multiples.

Clearly, the ambiguity surrounding the welfare effects of retail concentration points to the difficulty of making prior judgements regarding the degree of price transmission, relative to the perfectly competitive benchmark, which obtains when the retail market is concentrated. A priori, there is no way of telling whether any deviation from this benchmark results from a concentrated retail sector. The popular perception is, however, that any such deviations are due mainly to retail concentration which increases market power.

Against this background, theoretical work to date has focused on modelling vertical price transmission from the farm to the retail sector either allowing for seller power in the retail market as in Holloway (1991) and McCorriston et al. (1998) or allowing for both oligopoly (seller) power in the retail sector and oligopsony (buyer) power in the supply sector as in Weldegebriel (2004). These works suggest that the exercise of market power by retailers does not totally explain why farm price changes are not fully reflected as retail price changes. Indeed, they suggest that apart from the special cases where the retail demand and supply functions are linear, market power's impact on the degree of price transmission is often ambiguous.

Even though this ambiguity arises largely because results are determined by the functional forms of the retail demand and supply functions, there are indications that several other determinants of the degree of price transmission interact with market power to make its impact ambiguous. A recent work by McCorriston et al. (2001) has shown that, even assuming a linear retail demand function, allowing for non-constant returns to scale in industry technology makes market power's impact on the degree of price transmission ambiguous. Whereas decreasing returns to scale reinforce market power's impact on the degree of price transmission, increasing returns to scale weaken its impact.

As far as we are aware, there seems to have been no attempt in the literature to model the impact, on the degree of price transmission, of a possible interaction between market power both in the supply and retail sectors of the food industry and non-constant returns to scale in industry technology. In an attempt to bridge this gap, we develop a model whereby oligopoly power and oligopsony power interact with industry technology. We then evaluate the possible impact of such an interaction on the degree of price transmission from the retail to the farm sector assuming a supply shock in the farm sector. With this in view, we assume that the supply of marketing services is perfectly competitive and that the industry combines inputs in variable proportions.

We organise the paper as follows. In section 2, we present the theoretical framework whereby we extend the models of McCorriston et al. (2001) and of Weldegebriel (2004) allowing for the interaction between market structure and non-constant returns to scale. In section 3, we evaluate the degree of price transmission under alternative scenarios of market structure and industry technology. We finally present the conclusions in section 4.

2. The model

2.1 The theoretical framework

We develop a quantity-setting conjectural variations model of the degree of price transmission in the food industry when market structure is characterised by market power and industry technology is characterised by non-constant returns to scale. In building this model, we adopt several simplifying assumptions. Primarily, we assume that all firms in the industry produce a homogeneous final product. Secondly, following Kinnucan (2003) and Azzam and Pagoulatos (1990), we assume that when competing among themselves, firms take input quantities as strategic variables. This is consistent with short-run equilibrium whereby firms change only their variable inputs in maximising profit since capital is a quasi-fixed factor. Thirdly, we assume that the retail sector exercises oligopoly power in its relation with consumers and oligopsony power in its relation with suppliers of the farm product. For reasons that are detailed in Rogers and Sexton (1994), we assume that the retail sector exercises no oligopsony power over the marketing sector. Furthermore, we assume that the suppliers of the farm product and of marketing services exercise no oligopoly power over the retail sector. Finally, we assume that firms interact among themselves on the basis of conjectural variations

Consider an n-firm food industry which combines a farm product and a marketing input[2] to produce the final product sold directly to consumers. Given this vertical relation in the industry, initial equilibrium can be defined by the following six equations.

The inverse demand function of the processed product is given by

$$R = h(Q) \tag{1}$$

where R is the price of the processed product, Q is the level of quantity demanded of the food product.

The production function of the industry is given by:

$$Q = f(A, M) \tag{2}$$

where A and M represent the agricultural and marketing inputs respectively. To allow for non-constant returns to scale in industry technology, (2) is assumed to be homogeneous of degree ρ where $\rho = 1$ for constant returns to scale; $\rho < 1$ for decreasing returns to scale; and $\rho > 1$ for increasing returns to scale. Furthermore, it is assumed to combine the two inputs in variable proportions.

The input supply functions for A and M are given, respectively, in inverse form, as:

$$P = k(A, Z) \tag{3}$$

and

$$W = g(M) \tag{4}$$

where P and W are the prices of A and M respectively whereas Z is an exogenous farm supply shifter.

Finally, the aggregate input demand functions for A and M are given respectively as[3]:

$$R\left(1+\frac{\theta}{\eta}\right)f_A = P\left(1+\frac{\varphi}{\varepsilon}\right) \quad (5)$$

$$R\left(1+\frac{\theta}{\eta}\right)f_M = W \quad (6)$$

where η (which is normally negative) and ε (which is normally positive) represent the elasticities of industry level demand for the final food product and of the farm supply respectively, whereas θ and φ represent the elasticities of conjectural variations in the retail and farm sectors respectively. f_A and f_B are the marginal products of *A* and *M* respectively. The expressions θ/η and φ/ε represent the aggregate measures of the price mark-up and of the price mark-down in the retail and farm input markets respectively. For aggregation issues see Cowling (1976); and Bhuyan (1997).

These are derived from the first order conditions for a maximum of profit of a representative firm with respect to *A* and *M* which are then summed over *n*-firms to obtain the industry level input demands.

2.2 Equilibrium displacement following an exogenous supply shock

Displacement of initial equilibrium following a supply shock is achieved by totally differentiating the system of equations (1) - (6). Doing this and expressing percentage changes in logarithmic form yield

$$d\ln Q = \psi_A d\ln A + \psi_M d\ln M \quad (1.1)$$

$$d\ln Q = \eta d\ln R \quad (2.1)$$

$$d\ln P = \frac{1}{\varepsilon} d\ln A + td\ln Z \quad (3.1)$$

$$d\ln W = \gamma d\ln M \quad (4.1)$$

$$d\ln P = \frac{1+\mu}{1+\delta} d\ln R + \frac{1}{1+\delta}\left[(\rho-1) - \frac{1+\sigma(\rho-1)}{(1+\delta)\sigma\rho}\beta\right] d\ln A + \frac{1+\sigma(\rho-1)}{(1+\delta)\sigma\rho}\beta d\ln M \quad (5.1)$$

$$d\ln W = (1+\mu)d\ln R + \frac{1+\sigma(\rho-1)}{\sigma\rho}\alpha d\ln A + \left[(\rho-1) - \frac{1+\sigma(\rho-1)}{\sigma\rho}\alpha\right] d\ln M \quad (6.1)$$

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[2] Even though the marketing input is a combination of several variable inputs (e.g., labour, packaging, transport, etc.), for tractability, it is assumed to be a single input.

[3] These are derived from the first-order conditions for a maximum of profit of a representative firm with respect to A an M which are then summed over *n*-firms to obtain the industry level input demands

In (1.1), $\psi_A = \frac{(1+\varphi/\varepsilon)}{\rho(1+\theta/\eta)} * S_A; \psi_M = \frac{1}{\rho(1+\theta/\eta)} * S_M$ denote value shares of *A* and *M* respectively when the market structure is characterised by market power and industry technology by non-constant returns to scale. In equilibrium and assuming constant returns to scale, they add up to 1 and, in the absence of market power, reduce to the cost shares of *A* and *M* denoted by S_A and S_M respectively. The parameter "*t*" in (3.1) represents the elasticity of farm supply to changes in the exogenous supply shock. In (4.1), the parameter γ denotes the partial inverse marketing supply elasticity. Finally, σ in (5.1) and (6.1) denotes the elasticity of substitution between the farm and marketing inputs. Given $\varpi = \partial \ln\eta / \partial \ln R$, the parameter $\mu = -\varpi\theta/(\eta+\theta)$ represents changes in the mark-up following an exogenous supply shock. On the other hand, for $\lambda = \partial \ln\varepsilon / \partial \ln P$, the parameter $\delta = -\lambda\varphi/(\varepsilon+\varphi)$ represents a change in the mark-down which follows an exogenous supply shock.

The percentage changes in the six endogenous variables (Q, A, M, R, P and W) can be solved in terms of the percentage changes in the exogenous variable Z. This can be done by substituting equations (1.1), (3.1) and (4.1) into (2.1), (5.1) and (6.1) respectively. Doing this produces the following three-equation system.

$$-\eta d\ln R + \alpha\varepsilon d\ln P + \frac{\beta}{\gamma} d\ln W = \alpha\varepsilon t d\ln Z \qquad (7a)$$

$$\left(\frac{1+\mu}{1+\delta}\right) d\ln R + \left[\frac{\sigma\rho(\rho-1)-[1+\sigma(\rho-1)]\beta}{(1+\delta)\sigma\rho}\varepsilon - 1\right] d\ln P$$
$$\left[\frac{1+\sigma(\rho-1)}{(1+\delta)\sigma\rho\gamma}\right] d\ln W = \frac{\sigma\rho(\rho-1)-[1+\sigma(\rho-1)]\beta}{(1+\delta)\sigma\rho}\varepsilon t d\ln Z \qquad (7b)$$

$$(1+\mu) d\ln R + \left[\frac{1+\sigma(\rho-1)}{\sigma\rho}\right]\alpha d\ln P +$$
$$\left[\frac{\sigma\rho(\rho-1)-[1+\sigma(\rho-1)]\alpha}{} - 1\right] d\ln W = \frac{[1+\sigma(\rho-1)]\alpha}{\sigma\rho}\varepsilon t d\ln Z \qquad (7c)$$

Using the percentage changes in R and P, one can then derive the elasticity of price transmission from the farm to the retail sector. This is defined as (*d* ln *R* / *d* ln *Z*) (*d* ln *P* / *d* ln *Z*) and is given by:

$$\tau^{P\to R} = \frac{\rho\psi_A(1+\delta)(1+\sigma\gamma)}{(1+\psi_A\sigma\gamma)\left[(1+\mu)\rho+\eta(\rho-1)\right]-(1-\psi_A)\eta\gamma} \tag{8}$$

3. The elasticity of price transmission when market power and the returns to scale measure interact

Clearly, the transmission elasticity in (8) is determined, among other things, by the returns to scale and market power parameters. The impact of the returns to scale measure on the elasticity of price transmission can be evaluated by differentiating (8) with respect to ρ .

$$\frac{\partial\tau}{\partial\rho} = \frac{-\psi_A(1+\delta)(1+\sigma\gamma)\left[(1+\psi_A\sigma\gamma)\eta\gamma\right]}{\{(1+\psi_A\sigma\gamma)\left[(1+\mu)\rho+(\rho-1)\eta\right]-(1-\psi_A)\eta\gamma\}^2} \tag{9}$$

As (9) clearly indicates, *a priori*, the impact of the returns to scale measure on the degree of price transmission cannot be determined. The reason is because δ is signed differently for different functional forms. To see the signature of δ for different functional specifications, see Weldegebriel op cit. For the purpose at hand, assume a linear supply function. Given this specification, $\delta<0$ for inelastic supply (i.e., $0<\varepsilon \leq 1$) and $\delta \geq 0$ either for elastic supply (i.e., $\varepsilon >1$) or for unitary elastic supply.

Now assume, for convenience and without any loss of generality, a perfectly elastic marketing supply, i.e., $\gamma = 0$. Then,

$$\frac{\partial\tau}{\partial\rho_{\gamma=0}} = \frac{-\psi_A(1+\delta)\eta}{[(1+\mu)\rho+(\rho-1)\eta]^2} \Rightarrow \begin{cases} >0 & \forall\delta>0 \\ <0 & \forall\delta<0 \end{cases} \tag{9.1}$$

Given (9.1) and noting that η is normally negative, and the denominator is always positive, τ increases with the returns to scale measure, ρ , for $\delta \geq 0$; i.e., for an elastic supply. For $\delta <0$, implying inelastic supply, on the other hand, τ decreases with ρ.

In the presence of market power and non-constant returns to scale, it is difficult, a priori, to evaluate the deviation of the price transmission elasticity from that in the perfectly competitive benchmark. The reason is because not only is the outcome of the interaction between oligopoly power in the retail sector and oligopsony power in the farm sector ambiguous but the presence of non constant returns to scale in industry technology complicates this interaction.

To see this clearly, first consider the price transmission elasticity in the perfectly competitive benchmark which is given by[4]:

$$\tau^{c} = \frac{S_A(1+\sigma\gamma)}{(1+S_A\sigma\gamma)-(1-S_A)\eta\gamma} \tag{10}$$

Next divide (10) by (9) to obtain,

$$\frac{\tau^{c}}{\tau} = \frac{[\rho(1+\theta/\eta)+(1+\varphi/\varepsilon)S_A\sigma\gamma][(1+\mu)\rho+\eta(\rho-1)]-S_M\eta\gamma}{\rho(1+\delta)(1+\varphi/\varepsilon)[1+S_A\sigma\gamma)-(1-S_A)\eta\gamma]} \tag{11}$$

which, on assuming γ=0, can be simplified to:

$$\frac{\tau^{c}}{\tau} = \frac{(1+\theta/\eta)[(1+\mu)\rho+(\rho-1)\eta]}{(1+\varphi/\varepsilon)(1+\delta)} \tag{11.1}$$

To separate the role of returns to scale, assume θ = □ = 0 (so that $\mu = \delta = 0$) and obtain results similar to those of McCorriston et al. (2001):

$$\frac{\tau^{c}}{\tau} = \rho+\eta(\rho-1) \Rightarrow \begin{cases} >1 & \forall\rho<1 \\ =1 & \forall\rho=1 \\ <1 & \forall\rho>1 \end{cases} \tag{11.1a}$$

Relative to the price transmission elasticity in the perfectly competitive benchmark, the transmission elasticity in imperfectly competitive markets is smaller when industry technology is characterised by decreasing returns to scale and greater when the technology is characterised by increasing returns to scale.

Now, to separate the role of market power, set ρ = 1 and obtain:

[4] This can be derived by setting μ=0 and δ=0 implying $\theta=\varphi=0$ and assuming ρ=1

$$\frac{\tau^c}{\tau}=\frac{(1+\theta/\eta)}{(1+\varphi/\varepsilon)}*\frac{(1+\mu)}{(1+\delta)} \qquad (11.1b)$$

As (11.1b) makes evident, the extent of deviation of the price transmission elasticity from the competitive benchmark is determined not only by the initial magnitudes of the mark-up and the mark-down but also by the changes in these magnitudes in response to an exogenous shock. Without a prior knowledge of the retail food demand and farm supply functions, it is difficult to tell how the transmission elasticity in the presence of market power compares with that in the competitive benchmark.

For convenience, and with an eye for tractability, normalise the expression $(1+\theta/\eta)/(1+\varphi/\varepsilon)$ to 1. This assumption is not far fetched given that, in their bid for rivalry, dominant firms which exercise market power, may operate with a zero (or a magnitude close to zero) mark-up and mark-down Vickers (2005)[5]. However, this does not mean that they do not change their margins in response to an exogenous supply shock. Thus explaining the deviation of the price transmission elasticity relative to the perfectly competitive benchmark only with reference to changes in the mark-up and in the mark-down is justified.

Applying this normalisation, equation (11.1b) can then be written as:

$$\frac{\tau^c}{\tau}=\frac{1+\mu}{1+\delta}\begin{cases} >1\forall\mu>\delta \\ =1\forall\mu=\delta=0 \\ <1\forall\mu<\delta \end{cases} \qquad (11.c)$$

As (11.c) makes clear, whether there is "under-shifting" or "over-shifting" in the degree of price transmission relative to the perfectly competitive benchmark depends on the relative magnitudes of changes in the mark-up μ and in the mark-down φ. If, relative to φ, μ is greater, there will be under-shifting. If, relative to μ, φ is greater, there will be "over-shifting". If, on the other hand, μ=φ=0 there will not be a shift in the degree of price transmission relative to the perfectly competitive benchmark.

This suggests that in the presence of oligopoly power in the retail sector and oligopsony power in the farm sector, the degree of price transmission relative to the perfectly competitive benchmark cannot be unambiguously determined as it can either be greater, smaller or identical to that in the perfectly competitive benchmark. The presence of non-constant returns to scale in industry technology adds weight to this ambiguous outcome. Whereas, in certain instances, increasing returns to scale and market power can complement each other to enhance the degree of price transmission relative to the perfectly competitive benchmark, in other instances they may counter each other's impact. Similarly, whereas in some instances decreasing returns to scale and market power can complement each other to dampen the degree of price transmission relative to the perfectly competitive benchmark, in other instances they may counter each other's impact.

4. Conclusion

In this paper we have explored the impact of market power on the degree of price transmission allowing for the interaction between oligopoly power in the food retail sector and oligopsony power in the farm sector when industry technology is characterised by non-constant returns to scale. The major conclusion is that the impact of the interaction between market power and 16industry technology is ambiguous. Consequently, the outcomes for the degree of price transmission are inconclusive. Firstly, increasing returns to scale technology and market power can either complement each other to enhance the degree of price transmission relative to the perfectly competitive and constant returns to scale benchmark or counter each other's impact. Secondly, decreasing returns to scale technology and market power can either complement each other to weaken the degree of price transmission relative to the perfectly competitive and constant returns to scale benchmark or counter each other's impact.

The key to these inconclusive outcomes lies in the functional forms of retail demand and farm input supply on the one hand and in the relative magnitudes of changes in the mark-up and in the mark-down on the other. The policy implication seems to be that without prior knowledge of changes in the mark up and in the mark-down no conclusions can be drawn regarding the interaction between market power

[5] This is the same as saying that, given constat returns to scale, the value share of the farm input in an imperfectly competitive market, Ψ_A and its cost share in a perfectly competitive market, S_A are identical

and industry technology. Therefore caution needs to be applied when making inferences regarding industry structure based on empirical estimates of the price transmission elasticity alone.

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