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EQUILIBRIUM EXCLUSIVE DEALING IN OLIGOPOLY

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by

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Abstract. This paper considers a setting in which upstream oligopolists delegate the retailing of their differentiated products to a set of undifferentiated retailing agents. The downstream market structure is assumed to consist of a set of independent agents that exclusively sell the product of a single manufacturer and a common agent that sells the product of many manufacturers. A three-stage game is considered. In the first stage the manufacturers decide whether or not to market their products using an independent agent or the common agent. In the second stage the manufacturers determine the terms of the two-part tariff contract offered to their respective agents. In the final stage the agents engage in either output or price competition with other retailing agents. If the agents engage in output competition then the model shows that it will either be the case that all manufacturers use independent agents or that they all use the common agent. Which of these two equilibria emerge depend on the degree of substitutability between products and on the number of manufacturers. If the agents engage in price competition then a third type of equilibrium also emerges in which some firms adopt the common agent and others adopt independent agents.

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1. Introduction

In a duopoly setting Lin (1990) has argued that one of the reasons that manufacturers prefer exclusive dealing to non-exclusive dealing is that it serves to dampen price competition[1]. The purpose of this paper is to show that the dampening of competition argument does not hold in market structure less concentrated than duopoly. Specifically this paper shows that firms that adopt exclusive dealing charge higher wholesale and retail prices than firms that adopt non-exclusive dealing. Secondly, when a firm *i* moves from non-exclusive dealing to exclusive dealing then firm *i* raises both retail and wholesale prices but the impact of the wholesale and retail prices of firm *i*'s rival is ambiguous. Thirdly, non-exclusive dealing arises in equilibrium if markets are sufficiently unconcentrated and/or goods are sufficiently close substitutes, regardless of whether retailers engage in price or output competition. Finally if retailers engage in price competition then the number of firms that adopt non-exclusive dealing rises as markets become less concentrated and/or goods become closer substitutes.

A motivation for this paper is to explain recent increases in common agency in both the retail car and gasoline markets. In particular the retail car industry has seen the emergence of common agency via the formation of dealership groups such as AutoNation in the US and Pendragon–Vardy in the UK. For example AutoNation which began in 1996 had acquired 302 new vehicle franchises and 232 stores by the end of 2008 and these stores sold 37 different brands of new vehicles from manufacturers such as Toyota,

[1] Other motivations for adopting exclusive dealing are to (i) foreclosure rivals or raise rivals costs or (ii) to prevent various conflicts between manufacturers and retailer such free-riding by manufacturers on the services (advertising, training, client lists) provided by a rival manufacturers (see Sass (2005) for a brief survey.

Honda, Nissan, GM, Daimler, BMW and Chrysler[2]. The UK dealer group Pendragon–Vardy controls 350 dealers and the percentage of UK dealerships controlled by these dealerships is 29% for Jaguar, 21% for Land Rover, 8% for Ford and 7% for GM/Vauxhall[3]. In the retail gasoline market a similar phenomenon has occurred via the emergence of chains of independent convenience store operators that sell gasoline. The most notable of these firms is Couche–Tard which is the largest convenience store operator in North America and about 70% of its stores sell gasoline. Many of Couche–Tard stores are co–branded with Irving Oil. In the last decade Couche–Tard has acquired convenience stores which sell branded gasoline such as Exxon, Shell, BP and Conoco–Phillips[4].

This paper considers a setting in which upstream oligopolists delegate the retailing of their differentiated products to a set of undifferentiated retailing agents. The downstream market structure is assumed to consist of a set of independent agents that exclusively sell the product of one manufacturer and a common agent that sells the product of many manufacturers. Manufacturers are assumed to extract the full surplus from their respective agents using a two-part tariff comprising a wholesale price and a fixed licensing fee. A three-stage game is considered. In the first stage the upstream manufacturers determine whether to market their product using and independent agent of the common agent. In the second stage the manufacturers determine the terms of the two-part tariff contract offered to their respective agents. The agents agree to market a product provided they at least break even at marketing that particular product. In the final

[2] AutoNation 2008 Annual Report.
[3] Feast (2006)
[4] http://en.wikipedia.org/wiki/Alimentation_Couche-Tard and http://www.couchetard.com/press-releases.html

stage the agents engage in either differentiated Cournot or differentiated Bertrand competition with other agents.

If the agents engage in differentiated Cournot competition then the model shows that it will never be an equilibrium for some firms to use the common agent when other firms use independent agents. In other words it will either be the case that all manufacturers use independent agents or they all use the common agent. Which of these two equilibria emerge depend on the degree if substitutability between products and on the number of manufacturers. If there are two firms then the model yields the results previously obtained by Lin (1990) namely that exclusive dealing (i.e. independent agents) dampens competition as compared with non-exclusive dealing (i.e. common agency) and is thus preferred by upstream manufacturers[5]. If there are between 3 and 7 manufacturers then the exclusive dealing regime continues to be an equilibrium for all parameter values but common agency also arises as an equilibrium provided products are sufficiently close substitutes. As the number of manufacturers increases beyond 7 then the set of parameter values for which the exclusive dealing (resp. common agency) regime emerges is reduced (resp. increased) and arises if products are sufficiently poor (resp. good) substitutes.

The retail price competition results differ from the retail output competition results in that the equilibrium number of firms adopting common agency is unique rather than non–unique and can take on values between 1 and rather than 1 or *n*. The second

[5] The result that exclusive dealing dampens competition and is thus preferred by upstream manufacturers holds for both linear and two-part tariffs. In the two-part tariff case a critical assumption is that the common agent requires break even on *each* product. If the two-part tariff is set so as to observe the *overall* break even constrain of the common agent then Bernheim and Whinston (1985) and O'Brien and Shaffer (1993) show that the dampening of competition is achieved by non-exclusive dealing (i.e. common agency) regimes and not by exclusive dealing regimes. As a result manufacturers prefer non-exclusive dealing provided this regime doe not bestow any countervailing power on the common agent.

result implies that a mixed equilibrium arises in which some firms adopt common agency and other adopt exclusive dealing. One similarity between the price and output competition results is that the extent of common agency increases as markets become less concentrated.

The intuition for these results is as follows. An increase in the size of the common agency serves to intensify wholesale price competition between products controlled by the common agent but serves to soften wholesale price competition from products not controlled by the common agent. As a result an increase in the common agency serves to dissipate oligopoly rents but serves to shift the reduced oligopoly rents away from the manufacturers who use independent agents and toward the manufacturers who employ the common agent. The extent to which rents shifting occurs depends on the number of remaining firms who continue to use independent agents. For example if there are only two firms and they decide to use a common agent there are no remaining firms who use independent agents from who rents can be shifted. As a result the common agency regime will not be adopted as it only results in rent dissipation without resulting in rent shifting. As the number of manufacturers increase the scope for rent shifting is increased and common agency thus emerges as an equilibrium phenomenon.

The paper is organized as follows. Section 2 introduces the model and derives the retail output competition results. Section 3 considers retail price competition. Section 4 offers some concluding remarks.

2. The Model

The model consists of n manufacturers. Each manufacturer produces a differentiated product at constant marginal cost c and zero fixed cost. If the output of product i is denoted q_i and the output of all products except firm i is denoted Q_{-i} then the inverted demand function for product i is now assumed to be given by

(1a) $$p_i(q_i, Q_{-i}) = a - q_i - \theta Q_{-i} \qquad i = 1,\ldots,n$$

(1b) where $0 < \theta \leq 1$

is the substitutability parameter. In particular if $\theta = 0$ then the products are completely unrelated whereas if $\theta = 1$ then the products are perfect substitutes. Each manufacturer delegates the retailing of their product to a downstream agent. The downstream agent is either an independent agent that sells the product of a single manufacturer of a common agent that sells the products of many manufacturers. The manufacturer's contract with the agent specifies a wholesale price w_i and a fixed fee F_i. If the first k products are sold by the common agent and the remaining $n – k$ products are sold by independent agents. The manufacturer's pay-off is given by

(2) $$M_i = (w_i - c)q_i + F_i \qquad i = 1,\ldots,n$$

The retailer's pay-off is given by

(3) $$R_i + \lambda_i \sum_{j=1, j\neq i}^{k} R_j \qquad i = 1,\ldots,n$$

where

(4) $$\lambda_i = \begin{cases} \lambda_C = 1 & i = 1,\ldots,k \\ \lambda_I = 0 & i = k+1,\ldots,n \end{cases}$$

is an indicator function which is 1 for the common agent (denoted C) and 0 for independent agents (denoted I) and where

(5) $$R_i = (p_i(q_i, Q_{-i}) - w_i)q_i - F_i \qquad i = 1,\ldots,n$$

represents the retail pay-off associated with product *i*. Now consider the following three-stage game that involves simultaneous choice in each stage. In the first stage each manufacturer chooses whether to use the common agent or an independent agent to market their product. In the second stage the manufacturer chooses the terms of the contract (w_i, F_i) and in the third stage the retailing agents chooses output q_i. The game is solved using backward induction.

Output stage. Substituting (1) and (5) into (3) and then differentiating with respect to q_i yields the following first order condition

(6) $$a - 2q_i - \theta Q_{-i} - \lambda_i \theta \sum_{j=1,\, j\neq i}^{k} q_j = w_i \qquad i = 1,\ldots,n$$

which indicates that the market power externality (i.e. $-\theta q_j$) internalised by the common agent is negative and proportional to output. In other words an increase in q_i lowers the price of product *j* and thus lowers the revenues from product *j* in proportion to q_j. Re-arrange (7) to obtain

(7) $$q_i = \tfrac{1}{2}\left(a - w_i - \theta Q_{-i} - \lambda_i \theta \sum_{j=1,\, j\neq i}^{k} q_j \right) \qquad i = 1,\ldots,n$$

which implies that the seller of product *i* is more prepared to cede market share to product *j* if they also sell product *j* ($\lambda_i = 1$) than if a rival seller sold product *j* ($\lambda_i = 0$). The reason for this result is that an increase in q_j induces a common agent to lower q_i not only because the marginal revenue of q_i has fallen but also because q_i now imposes a greater market externality on product j because q_j is higher. This result implies that a common agent will be more responsive to wholesale price competition than an independent agent.

Output stage comparative statics. Substituting (4) into (7) and then solving yields solutions denoted $q_i(\boldsymbol{w},\lambda)$ where $\boldsymbol{w} = (w_1,\ldots,w_n)$. In Appendix A equation (6) is used to derive that the comparative static effects of w_i are

(8a) $$\frac{\partial q_i}{\partial w_i} = -\frac{(2-\theta)[(2+\theta(n-2))(2-2\theta)+\theta(k-1)(2+\theta(n-k))]}{(2-2\theta)\nabla} \qquad i = 1,\ldots,k$$

(8b) $$\frac{\partial Q_{-i}}{\partial w_i} = \frac{\theta(2-\theta)[(n-1)(2-2\theta)+(k-1)(2+\theta(n-k))]}{(2-2\theta)\nabla} \qquad i = 1,\ldots,k$$

for those manufacturers that employ the common agent and by

(9a) $$\frac{\partial q_i}{\partial w_i} = -\frac{(2+\theta(n-2))(2+\theta(k-2))-k(k-1)\theta^2}{\nabla} \qquad i = k+1,\ldots,n$$

(9b) $$\frac{\partial Q_{-i}}{\partial w_i} = \frac{\theta[(n-1)(2+\theta(k-2))-k(k-1)\theta]}{\nabla} \qquad i = k+1,\ldots,n$$

for those manufacturers that employ independent agents, where $\nabla > 0$ is the determinant of the Jacobian matrix.

Contract stage. Let $\overline{A}$ represent the minimum return that the agent requires in order to sell the product of a manufacturer. An increase in the agent's bargaining power will increase the size of $\overline{A}$. It is assumed that $\overline{A}$ is not affected by the number of products of other manufacturers sold by an agent. Furthermore the bargaining between the manufacturer and agent[6] results in the fixed fee being set so as to achieve a return of $\overline{A}$ per product sold by an agent, i.e.

(10) $$F_i = (p_i(q_i(w), Q_{-i}(\boldsymbol{w})) - w_i)q_i(\boldsymbol{w}) - \overline{A} \qquad i = 1,\ldots,n$$

[6] Our bargaining assumption follows Lin (1990) and implies that the choice of whether to employ a common or independent agent has no affect on bargaining or on the ability of manufacturers to collude. In contrast O'Brien and Shaffer (1993) assume that the common agent achieves countervailing power by being able to reject the product of the manufacturer whereas Bernheim and Whinston (1985) assume that the fixed fees are set so as to satisfy the joint profit, thereby facilitating collusion between manufacturers.

And thus that the wholesale price is chosen so as to maximize the residual profit earned by the manufacturer. Substituting (10) into (2) yields that the manufacturer's residual profit is given by

$$M_i(\boldsymbol{w}) = (p_i(q_i(\boldsymbol{w}), Q_{-i}(\boldsymbol{w}) - c)q_i(\boldsymbol{w}) - \overline{A} \qquad i = 1,\ldots,n \tag{11}$$

Differentiating (11) with respect to w_i yields that the choice of w_i satisfies

$$\left[p_i(\cdot) + q_i(\boldsymbol{w})\frac{\partial P_i(\cdot)}{\partial q_i} - c\right]\frac{\partial q_i(\boldsymbol{w})}{\partial w_i} + q_i(\boldsymbol{w})\frac{\partial p_i(\cdot)}{\partial Q_{-i}}\frac{\partial Q_{-i}(\boldsymbol{w})}{\partial w_i} = 0 \qquad i = 1,\ldots,n \tag{12}$$

Now let

$$v_i = \left(\frac{\partial Q_{-i}}{\partial w_i}\right) \Big/ \left(\frac{\partial q_i}{\partial w_i}\right) \qquad i = 1,\ldots,n \tag{13}$$

denote the "effective conjectural variation (or ECV)" of firm i, then divide (12) by $\partial q_i / \partial w_i$ and substitute (13) into (12) to obtain

$$p_i(\cdot) + q_i\left(\frac{\partial p_i(\cdot)}{\partial q_i} + v_i\frac{\partial p_i(\cdot)}{\partial Q_{-i}}\right) - c = 0 \qquad i = 1,\ldots,n \tag{14}$$

Since $\partial p_i / \partial Q_{-i}$ is negative then (14) indicates that a firm becomes more aggressive (i.e. the marginal profitability of output expansions rise) as the ECV becomes more negative.

Substituting (8a) and (8b) or (9a) and (9b) into (13) yields an ECV equal to

$$v_i = v_C = \frac{-\theta[(n-1)(2-2\theta) + (k-1)(2+\theta(n-k)]}{(2+\theta(n-2))(2-2\theta) + \theta(k-1)(2+\theta(n-k))} \qquad i = 1,\ldots,k \tag{15a}$$

for manufacturers that employ the common agent and by

$$v_i = v_I = \frac{-\theta[(n-1)(2+\theta(k-2)) - k(k-1)\theta]}{(2+\theta(n-2))(2+\theta(k-2)) - k(k-1)\theta^2} \qquad i = k+1,\ldots,n \tag{15b}$$

for manufacturers employing independent agents. Comparing (15a) and (15b) reveals that

(16a) $\frac{-1}{\theta} < v_C < v_I < 0$ if $0 < \theta < 1$ and $2 \leq k < n-1$

(16b) $-1 = v_C < v_I < 0$ if $\theta = 1$ and $2 \leq k < n-1$

(16c) $\frac{-1}{\theta} < v_I < 0$ if $k = 1$

(16d) $\frac{-1}{\theta} < v_C < 0$ if $k = n$

(16a) and (16b) imply that the manufacturers who employ a common agent will be more aggressive than those that employ independent agents.

Let the symmetric equilibrium output be denoted as q_C if sold by a common agent and by q_I if sold by an independent agent. Substitute (1), $\alpha = a - c$ and $v_i = v_C$, $q_i = q_C$ for $i = 1,\ldots,k$ and $v_i = v_I$, $q_i = q_I$ for $i = k+1,\ldots,n$ into (14) and re-arrange to obtain

(17a) $$\alpha - 2q_C - \theta[(k-1)q_C + (n-k)q_I] - \theta v_C q_C = 0$$

(17b) $$\alpha - 2q_I - \theta[kq_C + (n-k-1)q_I] - \theta v_I q_I = 0$$

which can be solved to obtain

(18) $$q_i = \frac{\alpha[2-\theta(1-v_j)]}{[2+\theta(k-1+v_C)][2+\theta(n-k-1+v_I)] - k(n-k)\theta^2} \qquad i, j \in \{C, I\}, i \neq j$$

and which imply that the equilibrium price can be expressed as

(19) $$p_i = c + q_i(1+\theta v_i) \qquad i \in \{C, I\}$$

and thus that the manufacturers equilibrium profits are given by

(20) $$\pi_i = (1+\theta v_i)(q_i)^2 \qquad i \in \{C, I\}$$

Substituting (1) into (6) yields $w_i = p_i - q_i(1+\lambda_i\theta(k-1))$ which when combined with (19) implies that the equilibrium wholesale price is

(21) $$w_i = c + \theta q_i(v_i - \lambda_i(k-1)) \qquad i \in \{C, I\}$$

Proposition 1: The equilibrium outputs and prices are as follows

	(i)	*(ii)*	*(iii)*	*(iv)*
	$2 \le k \le n-1$, $0 < \theta < 1$	$2 \le k \le n-1$, $\theta = 1$	$k = 1$	$k = n$
(a)	$q_C > q_I > 0$	$q_C > 0, q_I = 0$	$q_I > 0$	$q_C > 0$
(b)	$p_I > p_C > c$	$p_I = p_C = c$	$p_I > c$	$p_C > c$
(c)	$w_C < w_I < c$	$w_C < c, w_I = c$	$w_I < c$	$w_C < c$

PROOF: See Appendix B.

Proposition 1 shows that manufacturers will set wholesale prices below marginal cost regardless of whether they employ an independent agent or a common agent. The reason for this result is two-fold. Firstly, manufacturers can use the fixed fee to recoup any losses that they incur as a result of selling below marginal cost. Secondly, by selling below marginal cost the manufactures induce their agents to increasing output which then serves to deter rival output and thereby shift more of the oligopoly rents from their rivals to themselves. Proposition 1 also shows that since common agents are more responsive to wholesale price competition (see (7)) than are independent agents then manufacturers that employ common agents are more aggressive in setting wholesale prices which then results in more output and lower retail prices for these manufacturers.

Choice of agent stage. If $1 < k < n$ represents the equilibrium number of manufacturers that choose to market their product using the common agent then k must satisfy

$$\pi_C(k) \ge \pi_I(k-1) \tag{22}$$

to ensure that none of the k manufacturers wishes to leave the common agency. Secondly k must satisfy

(23) $$\pi_I(k) \geq \pi_C(k+1)$$

to ensure than none of the $n - k$ manufacturers wish to join the common agency. For $k = 1$ to be an equilibrium only (23) needs to be satisfied whereas if $k = n$ is to be an equilibrium only (22) needs to be satisfied. Substituting (18), (20), (15a) and (15b) into (22) and (23) and then carry out numerical simulations yields the results in Table 1 which are summarized in Result 1.

<u>Result 1</u>: *Under retail output competition the equilibrium value of k is as follows*

(i) If n = 2 then k = 1 is unique.

(ii) If 3 ≤ n ≤ 7 then

(a) k = 1 is unique if the products are sufficiently poor substitutes

(b) otherwise k is non-unique and involves either k = 1 or k = n.

(iii) If n ≥ 8 then

(a) k = 1 is unique if the products are sufficiently poor substitutes,

(b) k = n is unique if the products are sufficiently close but not perfect substitutes

(c) otherwise k is non-unique and involves either k = 1 or k = n.

(iv) An increase in n reduces the set of θ values for which k = 1 occurs.

Table 1: Values of θ and n for which $k = 1$ and $k = n$[1] are possible equilibira ($0 < \theta \leq 1$)[2] under retail output competition

Number of Manufacturers (n)	$k = 1$	$k = 1$ or $k = n$	$k = n$
2	All	None	None
3	$\theta < .83$	$\theta > .83$	None
4	$\theta < .64$	$\theta > .64$	None
5	$\theta < .50$	$\theta > .50$	None
6	$\theta < .41$	$\theta > .41$	None
7	$\theta < .34$	$\theta > .34$	None
8	$\theta < .30$	$.30 < \theta < .82$ and $\theta > .95$	$.82 < \theta < .95$
9	$\theta < .26$	$.26 < \theta < .57$ and $\theta > .99$	$.57 < \theta < .98$
10	$\theta < .23$	$.23 < \theta < .42$ and $\theta > .99$	$.42 < \theta < .99$
20	$\theta < .11$	$.11 < \theta < .13$ and $\theta >$ ~1	$.13 < \theta <$ ~1
50	$\theta < .041$	$.041 < \theta < .044$ and $\theta >$ ~1	$.044 < \theta <$ ~1
100	$\theta < .0203$	$.0203 < \theta < .0209$ and $\theta >$ ~1	$.0209 < \theta <$ ~1

[1] $k = 1$ implies that all firms adopt exclusive dealing. $k = n$ implies that all firms employ the common agent.
[2] If $\theta = 0$ then products are unrelated. If $\theta = 1$ then products are perfect substitutes.

3. Price competition

If p_i denotes the price of product i and $P_{-i} = \sum_{j \neq i} p_j$ then the demand function for product i is assumed to be given by

(24a) $q_i(p_i, P_{-i}) = a - bp_i + dP_{-i}$ where $b = 1 + \gamma(1 - \frac{1}{n})$ and $d = \frac{\gamma}{n}$ $i = 1,\ldots,n$

and where $0 < \gamma < \propto$ denotes the substitutability parameter which is zero if goods are unrelated and approaches infinity when goods are perfect substitutes. The aforementioned restriction can be expressed as

(24b) $$0 < \theta < \tfrac{1}{n-1} \text{ where } \theta = \tfrac{d}{b}$$

The profits generated by product i are thus given by

(25) $$\pi_i = (p_i - c)q_i(p_i, P_{-i}) \qquad i = 1,\ldots,n$$

The retailer's pay-off for selling product i is given by

(26) $$R_i = (p_i - w_i)q_i(p_i, P_{-i}) - F_i \qquad i = 1,\ldots,n$$

Price stage. A general expression for the objective function of each retailer is given by (3). Substitute (24) and (26) into (3), differentiate with respect to p_i, divide by b and let and let $\theta = \frac{d}{b}$ to obtain the following first order condition

(27) $$\tfrac{a}{b} - 2p_i + \theta P_{-i} + w_i + \lambda_i \theta \sum_{j=1,\, j \neq i}^{k} (p_j - w_j) = 0 \qquad i = 1,\ldots,n$$

which indicates that the market power externality internalised by the common agent is positive and proportional to the retail mark-up. In other words an increase p_i raises the demand for product j and thus raises the profits for product j in proportion to the latter's mark-up. Re-arrange (27) to obtain

$$p_i = \tfrac{1}{2}\left(\tfrac{a}{b} + w_i + \theta P_{-i} + \lambda_i \theta \sum_{j=1, j\neq i}^{k} (p_j - w_j)\right) \qquad i = 1,\ldots,n \tag{28}$$

which implies that the seller of product i is less responsive to wholesale price competition from product j if they also sell product j ($\lambda_i = 1$) than if a rival seller sold product j ($\lambda_i = 0$). The reason for this result is that an increase in w_j will raise p_j but lower $p_j - w_j$. The increase in p_j shifts out the demand curve for product i and increases the marginal revenue associated with raising price for product i. If the seller of product i also sells product j then there is an offsetting effect due to the reduction in $p_j - w_j$ which reduces the size of the market power externality internalized by the seller of products i and j and which induces that seller to lower p_i. The market power externality effect only partially offsets the marginal revenue effect and thus results in the seller of products i and j raising p_i in response to an increase in w_j but by an amount less than they would if this seller only sold product i.

<u>*Contract stage*</u>. Following the output competition analysis yields that the price competition version of (14) is given by

$$q_i(\cdot) + (p_i - c)\left(\frac{\partial q_i(\cdot)}{\partial p_i} + v_i \frac{\partial q_i(\cdot)}{\partial P_{-i}}\right) - c = 0 \text{ where } v_i = \left(\frac{\partial P_{-i}}{\partial w_i}\right) \Big/ \left(\frac{\partial p_i}{\partial w_i}\right) \qquad i = 1,\ldots,n \tag{29}$$

denotes the ECV under price competition. Since $\partial q_i / \partial P_{-i}$ is positive then (29) indicates that a firm becomes less aggressive (i.e. the marginal profitability of price increases) as the ECV becomes more positive.

In Appendix C it is shown that the ECV is equal to

$$v_i = v_C = \frac{\theta(n-k)(2-\theta(k-1))}{(2-\theta(n-2))(2-\theta(k-1)) - k(k-1)\theta^2} \qquad i = 1,\ldots,k \tag{30a}$$

for manufacturers that employ the common agent and by

(30b) $$v_i = v_I = \frac{\theta[(n-1)(2-\theta(k-2))+k(k-1)\theta]}{(2-\theta(n-2))(2-\theta(k-2))-k(k-1)\theta^2} \quad i = k+1,\ldots,n$$

for manufacturers employing independent agents. Comparing (14a) and (15b) reveals that

(31a) $$0 < v_C < v_I < \tfrac{1}{\theta} \text{ if } 1 < k < n$$

(31b) $$0 < v_I < \tfrac{1}{\theta} \text{ if } k = 1$$

(31c) $$0 = v_C < \tfrac{1}{\theta} \text{ if } k = n$$

(31a) implies that the manufacturers who employ a common agent will be more aggressive than those that employ independent agents. In Appendix D it is shown that the (29) can be solved to obtain

(32) $$p_i - c = \frac{\alpha[2+\theta(1-v_j)]}{[2-\theta(k-1+v_C)][2-\theta(n-k-1+v_I)]-k(n-k)\theta^2} \qquad i, j \in \{C, I\}, i \neq j$$

(29) also implies that the equilibrium quantity can be expressed as

(33) $$q_i = b(p_i - c)(1-\theta v_i) \quad i \in \{C, I\}$$

and thus that the manufacturers equilibrium profits are given by

(34) $$\pi_i = b(1-\theta v_i)(p_i - c)^2 \quad i \in \{C, I\}$$

Substituting (24a) into (27) yields $w_i - c = p_i - c - \frac{q_i}{b(1-\lambda_i\theta(k-1))}$ which when combined with (33) implies that the equilibrium wholesale price is

(35) $$w_i - c = \frac{(p_i - c)\theta(v_i - \lambda_i(k-1))}{1-\lambda_i\theta(k-1)} \qquad i \in \{C, I\}$$

Proposition 2: The equilibrium outputs and prices are as follows

	(i) $2 \le k \le n - 1$	(ii) $k = 1$	(iii) $k = n$
(a)	$p_I > p_C > c$	$p_I > c$	$p_C > c$
(b)	$q_C > q_I > 0$	$q_I > 0$	$q_C > 0$
(c)	$w_I > \{w_C, c\}$	$w_I > c$	$w_C < c$

PROOF: See Appendix E.

Choice of agent stage. Substituting (32), (34), (30a) and (30b) into (22) and (23) and then carry out numerical simulations yields the results in Table 2 which are summarized in Result 2.

Result 2: Under retail price competition the unique equilibrium value of k is as follows

(i) If $n = 2$ or 3 then $k = 1$.

(ii) If $4 \le n \le 7$ then

(a) $k = 1$ if the products are sufficiently poor substitutes

(b) otherwise $2 \le k \le n - 1$ and k rises as products become closer substitutes.

(iii) If $n \ge 8$ then

(a) $k = 1$ if the products are sufficiently poor substitutes

(b) otherwise $2 \le k \le n$ and k rises as products become closer substitutes.

(iv) An increase in n reduces the set of θ values for which $k = 1$ occurs.

Table 2: Values of $\hat{\theta} = (n-1)\theta$ and n for which various values of k are an equilibrium under retail price competition ($0 < \hat{\theta} < 1$)[1]

Number of Manufacturers (n)	$k = 1$	$2 \le k \le n-1$[2]	$k = n$
2	All	None	None
3	All	None	None
4	$\hat{\theta} < .84$	$\hat{\theta} > .84$	None
5	$\hat{\theta} < .79$	$\hat{\theta} > .79$	None
6	$\hat{\theta} < .77$	$\hat{\theta} > .77$	None
7	$\hat{\theta} < .75$	$\hat{\theta} > .75$	None
8	$\hat{\theta} < .74$	$.74 < \hat{\theta} < .98$	$\hat{\theta} > .98$
9	$\hat{\theta} < .73$	$.73 < \hat{\theta} < .96$	$\hat{\theta} > .96$
10	$\hat{\theta} < .72$	$.72 < \hat{\theta} < .95$	$\hat{\theta} > .95$
20	$\hat{\theta} < .69$	$.69 < \hat{\theta} < .91$	$\hat{\theta} > .91$
50	$\hat{\theta} < .67$	$.67 < \hat{\theta} < .88$	$\hat{\theta} > .89$
100	$\hat{\theta} < .67$	$.67 < \hat{\theta} < .88$	$\hat{\theta} > .88$

[1] If $\hat{\theta} = 0$ then products are unrelated. If $\hat{\theta} = 1$ then products are very close substitutes.

[2] In this range the value of k is unique and rises from 2 to $n - 1$ as $\hat{\theta}$ rises (i.e. as the products become closer substitutes).

4. Concluding remarks

The majority of papers that use the dampening of competition framework for analyzing the incidence and effects of exclusive and non–exclusive dealing assume duopoly[7]. The current paper departs from the literature in that it considers more than two firms and is thus able to show that the effects of exclusive dealing (i.e. higher wholesale and retail prices) are invariant to market structure but that the incidence of exclusive dealing varies dramatically with market structure. Specifically the paper show that exclusive dealing becomes less prevalent (common agency becomes more prevalent) as markets become less concentrated. Our results thus provide alternate explanations for some of the observations made in the empirical literature on exclusive dealing[8].

[7] Chang (1992), Dobson and Waterson (1997), Lin (1990), Mauleon, Sempere–Monerris and Vannetelbosch (2005), Moner–Colonques, Sempere–Monerris and Urbano (2004), Mycielski, Riyanto and Wuyts (2000), O'Brien and Shaffer (1993).

[8] See results and a literature review in Sass (2005).

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AUTONATION ANNUAL REPORT FOR 2008

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Appendix A: Derivation of output stage comparative statics

Let $Q_C = \sum_{j=1}^{k} q_j$ and note that $\sum_{i=1}^{n} Q_{-i} = (n-1)Q$ and $\sum_{i=1}^{k}\sum_{j=1, j\neq i}^{k} q_j = (k-1)Q_C$. Substitute $\lambda_i = 0$ and $Q_{-i} = Q - q_i$ into (6) to get (A1). Substitute (4) into (6), sum (6) over all $i = 1,\ldots,n$ to get (A2), and over all $i = 1,\ldots,k$ to get (A3).

(A1) $$a - (2 - \theta)q_i - \theta Q = w_i \qquad i = k+1,\ldots,n$$

(A2) $$na - (2 + \theta(n-1))Q - \theta(k-1)Q_C = \sum_{j=1}^{n} w_j$$

(A3) $$ka - k\theta Q - (2 + \theta(k-2))Q_C = \sum_{j=1}^{k} w_j$$

Totally differentiate any one of the n–k equations given in (A1) to obtain (A4) and then totally differentiate (A2) and (A3) to obtain (A5) and (A6) respectively

(A4)
(A5)
(A6)
$$\begin{bmatrix} \theta & 0 & 2-\theta \\ 2+\theta(n-1) & \theta(k-1) & 0 \\ k\theta & 2+\theta(k-2) & 0 \end{bmatrix}\begin{bmatrix} dQ \\ dQ_C \\ dq_i \end{bmatrix} = -\begin{bmatrix} dw_i \\ \sum_{j=1}^{n} dw_j \\ \sum_{j=1}^{k} dw_j \end{bmatrix} \qquad i \in \{k+1,\ldots,n\}$$

Let ∇ be the determinant of the LHS matrix and then solve the above to get (9a) and

(A7) $$\frac{\partial Q}{\partial w_i} = -\frac{(2-\theta)^2}{\nabla} \qquad i = 1,\ldots,k$$

(A8) $$\frac{\partial Q}{\partial w_i} = -\frac{(2-\theta)(2+\theta(k-2))}{\nabla} \qquad i = k+1,\ldots n$$

(A9) $$\frac{\partial Q_C}{\partial w_i} = -\frac{(2-\theta)(2+\theta(n-k-1))}{\nabla} \qquad i = 1,\ldots,k$$

(A8) minus (9a) yields (9b). $Q_{-i} = Q - q_i$, $\sum_{j=1, j\neq i}^{n} q_j = Q_C - q_i$, $\lambda_i = 1$ into (6) yields

(A10) $$a - (2-2\theta)q_i - \theta Q - \theta Q_C = w_i \qquad i = 1,\ldots,k$$

Implicit differentiation yields

(A11) $$\frac{\partial q_i}{\partial w_i} = -\left(\frac{1}{2-2\theta}\right)\left(\theta\left(\frac{\partial Q}{\partial w_i} + \frac{\partial Q_C}{\partial w_i}\right)+1\right) \qquad i = 1,\ldots,k$$

Substitute (A7) and (A9) into (A11) to get (8a). Subtract (8a) from (A7) to get (8b).

Appendix B: Proof of Proposition 1

$0 < \theta \leq 1$, $1 \leq k \leq n - 1$, (16a), (16b) and (16c) imply

(B1) $$(2 + \theta(k - 1 + v_C))(2 + \theta(n - k - 1 + v_I)) - k(n - k)\theta^2 > 0$$

a. From (18) if follows that

(B2) $$q_C - q_I = \frac{\alpha(v_I - v_C)}{[2+\theta(k-1+v_C)][2+\theta(n-k-1+v_I)]-k(n-k)\theta^2}$$

(i) & (ii) Follow from (B2), (B1), (16a) or (16b), (18), (1b) or $\theta = 1$. *(iii) & (iv)* Follow from (18), (B1), (16c) or (16d), (1b).

b. Substitute $Q_{-i} = Q - q_i$ into (1a) to obtain that the difference in retail prices is

(B3) $$p_I - p_C = (1 - \theta)(q_C - q_I)$$

(i) Follows from (B3), (1b), $q_C > q_I > 0$, (19), (16a). *(ii)* Follows from (19), $q_I = 0$ or (16b). *(iii)* & *(iv)* Follow from (19), (16c) or (16d), $q_I > 0$ or $q_C > 0$.

c. Substitute (4) and $Q_{-i} = Q - q_i$ into (6) to get that the difference in wholesale prices is

(B4) $$w_C - w_I = -[(2 - \theta)(q_C - q_I) + (k - 1)\theta q_C]$$

(i) & (ii) Follow from (B4), $q_C > q_I > 0$ or $q_C > q_I = 0$, (1b) or $\theta = 1$, (21), (4), (16a) or (16b). *(iii) & (iv)* Follow from (21), $q_I > 0$ or $q_C > 0$, (4), (16c) or (16d).

Appendix C: Derivation of comparative statics and ECV under price competition

Let $P_C = \sum_{j=1}^{k} p_j$, $P = \sum_{j=1}^{n} p_j$. Use (27) and follow the analysis in Appendix A to obtain

$$\begin{array}{l} \text{(C1)} \\ \text{(C2)} \\ \text{(C3)} \end{array} \begin{bmatrix} -\theta & 0 & 2+\theta \\ 2-\theta(n-1) & -\theta(k-1) & 0 \\ -k\theta & 2-\theta(k-2) & 0 \end{bmatrix} \begin{bmatrix} dP \\ dP_C \\ dp_i \end{bmatrix} = \begin{bmatrix} dw_i \\ (1-\theta(k-1)\ \sum_{j=1}^{k} dw_j + \sum_{m=k+1}^{n} dw_m \\ (1-\theta(k-1)\sum_{j=1}^{k} dw_j \end{bmatrix} \quad i \in \{k+1,\dots,n\}$$

Let ∇ be the determinant of the Jacobian matrix and then solve the above system to get

(C4) $$\frac{\partial P}{\partial w_i} = \frac{(1-\theta(k-1))(2+\theta)^2}{\nabla} \qquad i = 1,\dots,k$$

(C5) $$\frac{\partial P}{\partial w_i} = \frac{(2+\theta)(2-\theta(k-2))}{\nabla} \qquad i = k+1,\dots,n$$

(C6) $$\frac{\partial P_C}{\partial w_i} = \frac{(1-\theta(k-1))(2+\theta)(2-\theta(n-k-1))}{\nabla} \qquad i = 1,\dots,k$$

(C7) $$\frac{\partial p_i}{\partial w_i} = \frac{(2-\theta(n-2))(2-\theta(k-2))-k(k-1)\theta^2}{\nabla} \qquad i = k+1,\dots,n$$

(C5) minus (C7) yields (C8). (C8) divided by (C7) yields (30b).

(C8) $$\frac{\partial P_{-i}}{\partial w_i} = \frac{\theta\mathbf{[}(n-1)\mathbf{(}2-\theta(k-2)\mathbf{)}+k\mathbf{(}k-1\mathbf{)}\theta\mathbf{]}}{\nabla} \qquad i = k+1,\dots,n$$

Substitute $P_{-i} = P - p_i$, $\sum_{j=1, j\neq i}^{n} p_j = P_C - p_i$, $\lambda_i = 1$ into (27) and implicitly differentiate to get

(C9) $$\frac{\partial p_i}{\partial w_i} = \left(\frac{1}{2+2\theta}\right)\left(\theta\left(\frac{\partial P}{\partial w_i} + \frac{\partial P_C}{\partial w_i}\right)+1\right) \qquad i = 1,\dots,k$$

Substitute (C4) and (C6) into (C9) to get

(C10) $$\frac{\partial p_i}{\partial w_i} = \frac{\mathbf{(}2+\theta\mathbf{)[(}2-\theta\mathbf{(}n-2\mathbf{))(}2-\theta\mathbf{(}k-1\mathbf{))}-k\mathbf{(}k-1\mathbf{)}\theta^2\mathbf{]}}{2\nabla} \qquad i = 1,\dots,k$$

Subtract (C10) from (C4) to get (C11). (C11) divided by (C10) yields (30a).

(C11) $$\frac{\partial P_{-i}}{\partial w_i} = \frac{\theta(2+\theta)(n-k)(2-\theta(k-1))}{2\nabla} \qquad i = 1,\dots,k$$

Appendix D: Derivation of price competition solutions

Let the symmetric equilibrium prices from common and independent agents be denoted p_C and p_I respectively. Substitute (24a), $v_i = v_C$, $p_i = p_C$ for $i = 1,\ldots,k$ and $v_i = v_I$, $p_i = p_I$ for $i = k+1,\ldots,n$ into (29). Now divide by b, add and subtract c, add and subtract $\theta(n-1)c$ and then let $\alpha = \frac{a}{b} - c + c\theta(n-1)$, $\theta = \frac{d}{b}$, $\hat{p}_C = p_C - c$ and $\hat{p}_I = p_I - c$ to get

(D1) $$\alpha - 2\hat{p}_C + \theta[(k-1)\hat{p}_C + (n-k)\hat{p}_I] + \theta v_C \hat{p}_C = 0$$

(D2) $$\alpha - 2\hat{p}_I + \theta[k\hat{p}_C + (n-k-1)\hat{p}_I] + \theta v_I \hat{p}_I = 0$$

which can be solved to obtain (32).

Appendix E: Proof of Proposition 2

$0 < \theta < \frac{1}{n-1}$, $1 \leq k \leq n$, (31a) and (32b) imply

(E1) $$(2 - \theta(k - 1 + v_C))(2 - \theta(n - k - 1 + v_I)) - k(n - k)\theta^2 > 0$$

a. From (32) if follows that

(E2) $$p_I - p_C = \frac{\alpha\theta(v_I - v_C)}{[2-\theta(k-1+v_C)][2-\theta(n-k-1+v_I)] - k(n-k)\theta^2}$$

(i) & (ii) Follow from (E2), (E1), (31a) or (31b), (32), (24b). *(iii)* Follows from (32), (31c), (24b).

b. Substitute $P_{-i} = P - p_i$ into (24a) to obtain that the difference in output is

(E3) $$q_C - q_I = b(1 + \theta)(p_I - p_C)$$

(i) Follows from (E3), $p_I > p_C > c$, (24a), (33), (31a). *(ii)* & *(iii)* Follow from (33), $p_I > c$ or $p_C > c$, (31b) or (31c).

c. Substitute $\lambda_i = 1$, $p_i - w_i = p_C - w_C$ for $i = 1,\ldots,k$ and (24a) into (27) to obtain

(E4) $$p_i - w_i = p_C - w_C = \frac{1}{b}\frac{1}{1-\theta(k-1)} q_C \qquad i = 1,\ldots,k$$

Substitute (4), (E4) and $P_{-i} = P - p_i$ into (27) to get that the wholesale price difference is

(E5) $$w_I - w_C = [(2 + \theta)(p_I - p_C) + (k - 1)\tfrac{1}{b}\tfrac{1}{1-\theta(k-1)}\theta q_C]$$

(i) Follows from (E4), (24b), $p_I > p_C > c$, $q_C > 0$. *(ii) & (iii)* Follow from (35), (4), (24b), $p_I > c$ or $p_C > c$, (31b) or (31c).