CAHIER DE RECHERCHE #1308E
Département de science économique
Faculté des sciences sociales
Université d'Ottawa

WORKING PAPER #1308E
Department of Economics
Faculty of Social Sciences
University of Ottawa

Downstream Competition and the Effects of Buyer Power[*]

Zhiqi Chen [†], Hong Ding[‡]

December 2013

[*] For comments we thank Gamal Atallah, Rose Anne Devlin, Can Erutku, Patrick Rey, Anindya Sen, Roger Ware and the participants at the 2012 EARIE conference. Financial assistance from the Social Sciences and Humanities Research Council of Canada is gratefully acknowledged.
[†] Chen: Department of Economics, Carleton University, 1125 Colonel By Drive, Ottawa, Ontario, Canada K1S 5B6; zhiqi.chen@carleton.ca.
[‡] Ding: Department of Economics, University of Ottawa, 120 University Private, Ottawa, Ontario, Canada, K1N 6N5; hding007@uottawa.ca.

Abstract

To examine the interaction between buyer power and competition intensity in a downstream market, we construct a model in which oligopolistic retailers compete in quantity in the downstream market and one of them is a large retailer that has its own exclusive supplier. We demonstrate that an increase in the buyer power of the large retailer against its supplier leads to a fall in retail price and consequently an improvement in consumer surplus, and this is true even in the extreme case where the large retailer is a monopoly in the downstream market. More interestingly, we find that the beneficial effects of an increase in buyer power are large when the intensity of downstream competition is low, with the effects being the largest in the case of downstream monopoly. Our findings suggest that the traditional approach to merger reviews, under which an antitrust agency focuses primarily on maintaining competition in local retail markets, can work reasonably well even in a situation where the merger enhances the buyer power of the merged entity.

Key words: *Buyer power, downstream competition, antitrust policy.*

JEL Classification: L1, L4, L810.

Résumé

Pour examiner l'interaction entre le pouvoir d'achat et l'intensité de la concurrence du marché en aval, nous construisons un modèle dans lequel les détaillants oligopolistiques sont en ardente compétition dont l'un est un grand détaillant ayant en exclusivité son propre fournisseur. Nous signalons que l'augmentation du pouvoir d'achat de grand détaillant versus son fournisseur se traduit par une baisse des prix de détail et par ricochet à une amélioration excédentaire pour le consommateur, et cela s'avère véridique même dans le cas extrême où la grande distribution est un monopole du marché. Plus intéressant encore, nous constatons que les effets bénéfiques de l'augmentation du pouvoir d'achat sont considérables quand l'intensité de la concurrence en aval est faible, les effets étant plus grands, plus importants dans le cas de monopole en aval. Nos observations dénotent que l'approche traditionnelle de fusion, en vertu de laquelle un organisme antitrust se concentre principalement sur le maintien de la concurrence sur les marchés de détail locaux, peut fonctionner raisonnablement bien, même dans une situation où la fusion améliore la puissance d'achat de l'entité fusionnée.

Mots clés: *pouvoir d'achat, concurrence en aval, politique antitrust*

Classification JEL: L1, L4, L810.

I. Introduction

Increased concentration in the retail industry and the tremendous success of giant retailers, such as Wal-Mart, Carrefour and Tesco, has raised awareness and concerns regarding the impact of buyer power. One of the main issues that competition authorities in Europe and North America have been trying to understand is whether the success of these retailers lessens or distorts competition at the retail and/or production level. This is reflected through the three roundtables held by the OECD to examine the impact of buyer power on competition (OECD 1998, 2004 and 2008). In the UK, there was an unprecedented level of scrutiny of retail industry by the Office of Fair Trading (2007) and the Competition Commission (2000 and 2008). Responding to the policy concerns in North America, the American Antitrust Institute held two symposia on buyer power in 2004 and 2007, respectively.

In the literature, a number of authors have analyzed the effects of buyer power on consumer prices and social welfare.[1] In particular, von Ungern-Sternberg (1996) and Dobson and Waterson (1997) show that larger retailer buyer power, as reflected through an increase in concentration at the retail level, leads to reduced consumer prices and consequently higher social welfare only if the competition at the retail level is fierce. More specifically, von Ungern-Sternberg (1996) compares two theoretical models: one model where an upstream supplier sells to Cournot oligopoly retailers and the other model with perfect competition in the retail market. He finds that only in the model of perfect competition does a decrease in the number of retailers lead to lower consumer prices. Dobson and Waterson (1997) use a similar model where a monopoly supplier negotiates with Bertrand oligopoly retailers who offer differentiated services.

[1] They include von Ungern-Sternberg (1996), Dobson and Waterson (1997), Chen (2003), Erutku (2005), Smith and Thanassoulis (2009), Mills (2010), and Inderst and Valletti (2011). Also of relevance to the present paper are the analyses of the long term impact of buyer power on innovation, product quality and production capacity (Battigalli *et al*. 2007, Viera-Montez 2007, Inderst and Wey 2007 and 2011, Chen 2013).

Their analysis shows that consumer prices fall with a reduction in the number of retailers only if retailers are considered by consumers as very close substitutes. Since Bertrand competition in the case of homogeneous firms leads to the same equilibrium as perfect competition (with price equalling marginal cost), this finding by Dobson and Waterson can be viewed as a generalization of von Ungern-Sternberg (1996).

As pointed out by Chen (2003), the analyses in von Ungern-Sternberg (1996) and Dobson and Waterson (1997) capture the combined effects of both buyer power and seller power of retailers as increased concentration in the retailer market enhances both types of market power simultaneously. To identify more precisely the effects of buyer power, Chen (2003) examines a situation where a single upstream supplier sells to a group of retailers consisting of a dominant firm and a large number of price-taking fringe firms. He demonstrates that the presence of downstream competition by fringe retailers is crucial in driving the welfare effects of buyer power. Specifically, he shows that as the dominant retailer gains more buyer power, the retail price will decrease but the welfare effects depend on the market share of the dominant retailer and the difference in the costs among the retailers. When the number of fringe retailers is sufficiently large, the social welfare will improve as a result of increased buyer power.

A common theme in the studies reviewed above is that the presence of competition in the downstream retail market is necessary for buyer power to (possibly) benefit consumers and improve welfare. What is less clear, however, is how the welfare consequences of buyer power are affected by changes in the intensity of downstream competition. For example, is it the case that buyer power is more likely to be beneficial to consumers and social welfare when the downstream competition is more intense? The answer to such a question will be of great assistance to competition authorities charged with assessing the effects of rising buyer power (Chen 2007).

In this regard, one issue that is of particular relevance is how a competition authority should deal with cases where a merger between two retailers or a conduct by a large retailer does not significantly increase the concentration of the retailer market but enhances the buyer power of the retailer(s). This issue may arise in a situation where the two merging retailers sell in different geographic markets.[2] Even in a case where the merging retailers have some overlaps in geographic markets, a competition authority typically would either reject the merger or require divestiture by the merging retailers in those geographic markets where post-merger concentration is deemed too high.[3] What this means is that, in practice, buyer power becomes an issue in competition analysis only after the concerns over retail concentration have already been dealt with. In such cases, a competition authority may want to know the answer to questions such as, "will competition in the retail markets ensure that post-merger exercise of buyer power does not harm consumers?", or in a case where the pre-merger concentration in the retail markets is high, "should we still be concerned about the exercise of buyer power even though the merger does not increase the concentration of each retail market?"

In this paper, we examine the interaction between buyer power in an upstream market and competition intensity in a downstream market, with the aim to shed some light on the

[2] For example, the consolidation in European retail markets involved a significant number of cross-border mergers (Inderst and Shaffer 2007 p45). In particular, Wal-Mart entered several EU countries via a string of acquisitions, including that of Asda (UK) and Wertkauf (Germany).

[3] In 1999, for example, Canada's Competition Bureau approved two mergers of grocery retail chains after the merging parties agreed to divest certain stores in those local markets where they had significant overlaps. In each case, the two retail chains operated primarily in separate parts of the country and they overlapped in only a small number of local markets before the merger. See Competition Bureau (2009a and 2009b) for details about the Bureau's review of these two mergers. In the United Kingdom, the Competition Commission approved the acquisition of Safeway by Wm Morrison Supermarkets conditional on the divestiture of 48 one-stop grocery stores and five smaller stores to address adverse competition effects of the merger in various local retail markets (Competition Commission 2003).

questions posed above. To do so, we construct a model similar to those of von Ungern-Sternberg (1996) and Dobson and Waterson (1997) in that oligopolistic retailers compete in a downstream market where retail services are either homogeneous or differentiated, and each retailer pays a linear wholesale price for its supplies. Different from von Ungern-Sternberg (1996) and Dobson and Waterson (1997), however, we separate the buyer power from the intensity of downstream competition by assuming that only one of those retailers is in a bilateral monopoly relationship with its supplier and they negotiate the wholesale price *à la* the generalized Nash bargaining (Harsanyi and Selton 1972). The buyer power of this large retailer is then modelled as its bargaining power against the supplier. As such, the retailer's buyer power is independent of the intensity of downstream competition.[4] This allows us to isolate the effects of retailer buyer power from those associated with a change in the intensity of downstream competition, and thus to address the questions raised in the preceding paragraph.

Our analysis shows that the wholesale and retail prices indeed fall and consequently consumer welfare improves following an increase in the buyer power of the large retailer. This is true even in the case where the large retailer is a monopoly in the downstream market. This result is in sharp contrast to von Ungern-Sternberg (1996) and Dobson and Waterson (1997) where stronger buyer power reduces retail prices only if the competition in the downstream market is sufficiently intense. Moreover, our analysis suggests that increased downstream competition brings more benefits to consumers when buyer power is present. In addition to reducing retailers' markups, increased competition among retailers forces the large retailer to bargain harder with its supplier to obtain a lower wholesale price, which drives down retail prices even further. Surprisingly, though, it is not the case that increased buyer power is more beneficial to consumers when the downstream competition is more intense. To the contrary, we

[4] We will discuss the empirical justifications for our modelling approach in section II.

find that the marginal effects of an increase in buyer power are large when the intensity of downstream competition is low, with the effects being the largest in the case of downstream monopoly. This suggests that buyer power and downstream competition can be viewed as substitutes.

This last result is reminiscent of Galbraith's countervailing power hypothesis. In his controversial book on American capitalism, Galbraith (1952) argued that buyer power was a substitute for competition. In his own words, "in the typical modern market of few sellers, the active restraint [on the exercise of private economic power] is provided not by competitors but from the other side of the market by strong buyers" (Galbraith 1952 p119). However, Galbraith's hypothesis has received little support from the existing theoretical analyses of buyer power. Therefore, one contribution of the present analysis is that it identifies a setting where buyer power and competition can indeed be viewed as substitutes.

Our analysis provides an answer to the policy questions posed earlier. First, it suggests that the traditional approach to merger reviews, under which the focus of a competition authority is on maintaining competition in the local retail markets, can work reasonably well even in a situation where the merger enhances the buyer power of the merged entity in the upstream market. By preventing the downstream market from becoming more concentrated, the competition authority can ensure that post-merger retail prices will not rise and may possibly fall. Second, the competition authority does not necessarily have to be more concerned about the effects of buyer power in a more concentrated retail market. A concentrated retail market is not desirable, but a merger that that enhances the buyer power of the merged entity without increasing the concentration in such a retail market can partially offset the negative effects of high concentration. Third and finally, it is not necessarily the case that an increase in buyer power is more beneficial to consumers and social welfare when the downstream competition is more intense. In our model, the opposite is true; that is, the beneficial effects of an increase in buyer power are larger when the downstream competition is less intense.

The paper is organized as follows. A basic model with n homogeneous retailers is specified in section II, and the equilibrium is derived in section III. The effects of buyer power and the role of downstream competition are studied in section IV. Section V examines the robustness of our results by revising the basic model to consider, respectively, a monopoly retailer, differentiated retailers, and the use of a non-linear contract. Section VI concludes.

II. The Model

There are two levels of markets. In the downstream market are a group of n (> 2) retailers who compete in quantity, denoted by q_i (i = 1, 2, … n). From the upstream market these retailers purchase the supplies of the product. Following von Ungern-Sternberg (1996) and Dobson and Waterson (1997), we consider a simple case of linear market demand function. In the basic model, we assume that retail services are homogeneous, and accordingly the demand facing all n retailers is represented by the function $p(Q) = a - bQ$, where Q is the total demand ($Q = \sum_{i=1}^{n} q_i$).

In section V.2, we will extend the basic model to incorporate product differentiation among retailers.

To separate the effects of buyer power from those of downstream competition, we assume that one of the n retailers, retailer R_1, is in a bilateral monopoly relationship with its supplier, while the remaining retailers obtain their supplies in a competitive market. The idea here is that R_1 is a large chain store that sells in many geographic markets, one of which is the focus of the present analysis. Because of its large scale, this chain retailer is able to induce a supplier to be its exclusive source of supply. The motivation for this exclusive relationship is that it generates efficiency gains that lower the supplier's unit cost of production. For example, consider a situation where production capacity has to be built in advance of the actual production and the supplier's unit cost of production is a decreasing function of its capacity. The commitment by the large retailer to purchase its entire volume exclusively from the supplier enables the latter to invest with confidence in a large production capacity that entails a low unit cost of production. In the absence of the exclusive contract, on the other hand, the supplier would sell its output in the competitive market, and without the guarantee of a large volume, it would rationally choose a small production capacity with a high unit cost of production.[5]

Each retailer incurs two types of costs: the wholesale price of purchasing the good from its supplier and a constant marginal cost of providing retailing services. The latter is normalized to zero.

On the suppliers' side, suppose that total production cost of retailer R_1's supplier is $C_s(q_1) = c_s q_1$, where $c_s > 0$ is the marginal cost of production. On the other hand, the competitive wholesale price at which other retailers purchase their supplies is equal to c. Since the exclusive relationship between R_1 and its supplier generates efficiency gains, we assume $c_s < c$.

The firms in this model play a two-stage game. At stage one, the large retailer R_1 negotiates with its supplier over the wholesale price w for the units sold in this market. We assume that the outcome of the negotiation is determined by the generalized Nash bargaining

[5] See Horn and Wolinsky (1988 p408) for a discussion about other possible sources of bilateral monopoly.

solution (Harsanyi and Selton 1972). At stage two, all retailers compete in quantity in the downstream market.

Let π_1 and π_s denote the profits of retailer R_1 and its supplier, respectively. Because of their exclusive relationship, their disagreement payoffs (*i.e.*, their inside options) are both zero. The supplier has the outside option of producing and selling the good in the competitive market. But in doing so, the supplier would lose the efficiency gains associated with the exclusive relationship and thus it would be just like other suppliers with marginal cost *c*. The outside option of retailer R_1 is to purchase the good in the competitive market at the price *c*.[6]

Taking into consideration the "outside option principle" (Binmore *et al*. 1986), we write the generalized Nash bargaining problem as:

$$\underset{w}{Max}\,\pi_1^{\gamma}\pi_s^{1-\gamma} \quad \text{subject to } c_s \leq w \leq c\,, \tag{1}$$

where $\gamma \in (0,1)$ measures the retailer's relative bargaining power. As will be elaborated below, we treat γ as the measure of the retailer's buyer power against its supplier.

Before proceeding to solve this model, we pause to discuss the motivations for a number of assumptions in this model. First, by treating γ as the measure of the retailer's buyer power, we are assuming that an increase in the retailer's buyer power is equivalent to an improvement in its bargaining power. We can offer three justifications for this assumption. The first justification is based on the well-known observation that the generalized Nash bargaining solution can be derived from the equilibrium in the Rubinstein bargaining game in the limiting case where the duration between offers and counter-offers is infinitesimally small.[7] The players' relative

[6] Strictly speaking, inside options and outside options are concepts in non-cooperative bargaining theory. However, as explained in Muthoo (1999), inside option point corresponds to the disagreement point, and the outside option point constrains the set of possible agreements in the Nash bargaining problem. The latter result is referred to as the "outside option principle".

[7] See, for example, Muthoo (1999), for a detailed discussion of this result.

bargaining power is then a function of their time discount rates. It seems plausible that as a retailer becomes larger, it will be able to access the capital market at a lower rate of interest, which will strengthen its bargaining power in the Rubinstein bargaining game. Next, as shown in Chen (2013), a larger retailer has a stronger incentive to invest in the quality of its negotiation team, thus leading to stronger bargaining power. Finally, even if the buyer power manifests itself through other channels, it ultimately increases the retailer's "slice of the pie". Thus, a larger γ is a reasonable approximation for an increase in buyer power in such situations.

Second, we have assumed that the amount of buyer power (as measured by γ) is independent of the market concentration in the downstream market (as measured by n). Here we have in mind a situation where the buyer power of a large retailer comes from being in a large number of markets rather than being large in a particular market. This is motivated, in part, by the observation that the colossal scale of retailers such as Wal-Mart is driven more by the fact it operates in a large number of geographic markets worldwide than from having a large market share in any particular local market. Indeed, the early examples of retailer power given by Galbraith (1952) were the major chain stores in the first half of the twentieth century, such as A&P and Sears, Roebuck. In these examples, it was their large sizes stemming from selling in many local markets that conferred these retailers the power to obtain lower prices from their suppliers.[8]

Third and finally, we have assumed in (1) that the supplier and the retailer negotiate over a linear wholesale price w. In so doing, we are following the common approach in many existing models, such as von Ungern-Sternberg (1996), Dobson and Waterson (1997), and Inderst and Valletti (2011). In reality, the contracts between retailers and suppliers are often more complex.

[8] According to Galbraith (1952 p131), the passage of the Robinson-Patman Act in 1936 was designed to limit the exercise of buyer power by the major chain stores.

We treat the linear price as an approximation to situations where the supplier and the retailer have a conflict of interests over the level of the wholesale price, with the supplier preferring a higher wholesale price and the retailer preferring the opposite. As will be discussed in more detail in section V.3, our results are still relevant to situations of non-linear contracts as long as such a contract does not perfectly align the interests of the supplier and the retailer with regard to the wholesale price.

III. Equilibrium

To solve the model, we start with the second stage of the game where each retailer chooses simultaneously the quantity to sell given the wholesale prices. Their profit-maximization problems are:

$$\underset{q_1}{Max}\,\pi_1 = (a - bQ)q_1 - wq_1 \tag{2}$$

for retailer R_1, and

$$\underset{q_i}{Max}\,\pi_i = (a - bQ)q_i - cq_i \tag{3}$$

for other retailers R_i (i = 2, 3, …n). The first-order conditions of these two optimization problems are:

$$a - bq_1 - bQ - w = 0\,, \tag{4}$$

$$a - bQ - bq_i - c = 0\,. \tag{5}$$

Since all retailers other than R_1 are identical, they sell the same quantity in equilibrium. Setting $q_i = q$ for $i \neq 1$, we solve the above equations for q_1 and q as functions of, among other things, w and n:

$$q_1 = \frac{a + (n-1)c - nw}{(n+1)b}, \tag{6}$$

$$q = \frac{a - 2c + w}{(n+1)b}. \tag{7}$$

Note from (7) that $q > 0$ if and only if $a - 2c + w > 0$. Since the supplier of R_1 cannot make a negative profit in equilibrium, we have $w \geq c_s$. Accordingly, we assume $a - 2c + c_s > 0$ to ensure that all other retailers are active in equilibrium.

Using (6) we can write the profits of retailer R_1 and its supplier as

$$\pi_1 = (p - w)q_1 = \frac{(p - w)(a + (n-1)c - nw)}{(n+1)b}, \tag{8}$$

$$\pi_s = (w - c_s)q_1 = \frac{(w - c_s)(a + (n-1)c - nw)}{(n+1)b}. \tag{9}$$

Substituting (8) and (9) into (1), we can solve the generalized Nash bargaining problem. We do so in two steps. First, we suppose that the constraints in (1) are not binding and derive the following first-order condition:

$$d\left[(a + (n-1)c)(1-\gamma) - 2nw\right] + bc_s(1+\gamma)n = 0. \tag{10}$$

Solving (10), we obtain the Nash bargaining solution under the assumption that $c_s < w < c$:

$$w^N = \frac{1-\gamma}{2n}\left(a + (n-1)c\right) + \frac{(1+\gamma)c_s}{2}. \tag{11}$$

Second, we investigate whether the solution satisfies this assumption. Using (11), we can verify that $w^N > c_s$, suggesting that the supplier's outside option is not binding in equilibrium. On the other hand, $w^N < c$ implies that $\gamma > \gamma_L$, where

$$\gamma_L = \frac{a - c - n(c - c_s)}{a - c + n(c - c_s)}. \tag{12}$$

Thus, retailer R_1's outside option is not binding only if its buyer power exceeds the threshold given in (12).[9] In the case where its buyer power is at or below this threshold, the Outside Option Principle implies that negotiated wholesale price would be $w^N = c$.

To obtain the equilibrium quantities of the retailers in the case where $\gamma \geq \gamma_L$, we substitute (11) into (6) and (7):

$$q_1 = \frac{(1+\gamma)[a+(n-1)c-nc_s]}{2(n+1)b}, \tag{13}$$

$$q = \frac{(a-c)}{bn} - \frac{(1+\gamma)[a+(n-1)c-nc_s]}{2(n+1)bn}. \tag{14}$$

Using (13) and (14), we derive the total quantity and price in equilibrium:

$$Q = \frac{2(n^2-1)(a-c)+(1+\gamma)[a+(n-1)c-nc_s]}{2n(n+1)b}, \tag{15}$$

$$p = \frac{(2n+1-\gamma)(a+(n-1)c)+(1+\gamma)nc_s}{2n(n+1)}. \tag{16}$$

Note from (13)-(16) that the equilibrium price and quantities are functions of γ (retailer R_1's buyer power).

In the case where $\gamma < \gamma_L$, on the other hand, the equilibrium is independent of R_1's buyer power because the wholesale price, $w^N = c$, is not influenced by γ. In this case, a small increase in the buyer power would have no effect as long as the increased value of γ remains below γ_L.

[9] It is easy to see from (12) that $\gamma_L < 1$. Moreover, $\gamma > \gamma_L$ is not a binding constraint if $\gamma_L \leq 0$, which occurs when $a - c \leq n(c - c_s)$.

IV. Buyer Power and Downstream Competition

In this section, we examine how buyer power and the intensity of downstream competition among retailers affect consumer welfare and social welfare. Recall that retailer R_1's buyer power is measured by γ. We suppose that an increase in the retailer's buyer power is brought about by its expansion into an additional geographic market either through *de novo* entry or through the acquisition of an existing retailer. In this partial equilibrium framework, consumer welfare and social welfare are represented by consumer surplus (CS) and total surplus (TS), respectively.

As noted earlier, a small increase in the buyer power of retailer R_1 would have no impact if its buyer power is below the threshold γ_L. Hence, for the rest of the analysis we assume that $\gamma > \gamma_L$. In essence, this assumption ensures that retailer R_1 has a meaningful amount of buyer power that would allow it to have a material influence on the wholesale price.

Proposition 1: An increase in the buyer power of retailer R_1 reduces both the wholesale price it pays and the equilibrium price in the retail market. Consumer welfare and social welfare are higher as a result.

Proof: Differentiating (11) and (15) with respect to γ yields:

$$\frac{\partial w^N}{\partial \gamma} = -\frac{a + (n-1)c - nc_s}{2n} < 0\,, \tag{17}$$

$$\frac{\partial Q}{\partial \gamma} = -\frac{1}{(n+1)b}\frac{\partial w^N}{\partial \gamma} = \frac{a + (n-1)c - nc_s}{2n(n+1)b} > 0\,. \tag{18}$$

Then $\partial p/\partial \gamma = (\partial p/\partial Q)(\partial Q/\partial \gamma) < 0$, and $\partial CS/\partial \gamma = -[(a-p)/b](\partial p/\partial \gamma) > 0$.

Total surplus in this market can be written as

$$TS = \int_0^{Q^*}(a - bQ)dQ - (n-1)cq - c_s q_1\,. \tag{19}$$

Using the equilibrium conditions we rewrite (19) as

$$TS = (a - c_s)q_1 - \frac{1}{2}bq_1^{\;2} + (n-1)(a-c)q - \frac{1}{2}(n-1)^2 bq^2 - (n-1)bqq_1 . \tag{20}$$

Noting, from (13) and (14), that

$$\frac{\partial q_1}{\partial \gamma} = \frac{a + (n-1)c - nc_s}{2(n+1)b} \tag{21}$$

and that

$$\frac{\partial q}{\partial \gamma} = -\frac{a + (n-1)c - nc_s}{2n(n+1)b} , \tag{22}$$

we differentiate (20) to obtain

$$\frac{\partial TS}{\partial \gamma} = \frac{a + (n-1)c - nc_s}{2n(n+1)b} \left[p - c + nc - nc_s \right], \tag{23}$$

which is positive because $p > c$ and $c > c_s$.   QED

A major departure of our model from von Ungern-Sternberg (1996) and Waterson and Dobson (1997) is that we have separate measures of retailer buyer power and retailer seller power. Accordingly, Proposition 1 shows that an increase in buyer power, in the absence of a simultaneous increase in seller power, benefits consumers and improves welfare. While this conclusion is similar to Chen (2003) on the surface, the underlying mechanism is different. Here an increase in the buyer power of the large retailer R_1 reduces its wholesale price, making itself a more aggressive competitor in the retail market. Retail price falls because of the intensified competition among retailers. Moreover, the increased quantity of sales by the large retailer does not cause any inefficiency in the provision of retail services. In Chen (2003), on the other hand, the fall in retail price is caused by the lower wholesale price paid by the competitors of the large retailer, and their expansion of sales may cause efficiency loss in the provision of retail services because they face rising costs of retailing.

Turning to the effects of downstream competition, recall that in Dobson and Waterson (1997), a reduction in the number of retailers can lead to lower consumer prices and higher social welfare if the competition at the retail level is sufficiently intense. By measuring buyer power separately from the concentration in the retail market, our analysis yields different conclusions regarding the impact of increased retail concentration.

Proposition 2: A more concentrated retail market (*i.e.* a smaller number of retailers) raises the mark-up and wholesale price of retailer R_1, leading to a higher retail price. Consumer welfare is lower as a result. Social welfare also falls if $c - c_s < (a-c)/(n+2)$.

Proof: Differentiating (11) with respect to *n*, we obtain:

$$\frac{\partial w^N}{\partial n} = -\frac{(1-\gamma)(a-c)}{2n^2} < 0. \tag{24}$$

Furthermore,

$$\frac{\partial\left(p - w^N\right)}{\partial n} = -\frac{(1+\gamma)\left(a + c_s - 2c\right)}{2(n+1)^2} < 0. \tag{25}$$

$$\frac{\partial Q}{\partial n} = \frac{1}{b(n+1)^2}\left(\left(a - 2c + w^N\right) - \frac{\partial w^N}{\partial n}(n+1) \right) > 0. \tag{26}$$

Using (26), we find that $\partial p / \partial n = -b \partial Q / \partial n < 0$. Then $\partial CS / \partial n = -[(a-p)/b](\partial p / \partial n) > 0$.

Differentiating (13) with respect to *n*, we obtain

$$\frac{\partial q_1}{\partial n} = -\frac{(1-\gamma)\left(a + c_s - 2c\right)}{2b(n+1)^2} < 0. \tag{27}$$

Then we have

$$\frac{\partial TS}{\partial n} = \frac{\partial Q}{\partial n}(p - c) + \frac{\partial q_1}{\partial n}(c - c_s) = \frac{(a - 2c + w^N)(p - 2c + c_s)}{b(n+1)^2} - \frac{(p - c + nc - nc_s)}{b(n+1)}\frac{\partial w^N}{\partial n}, \quad (28)$$

which is positive if $p - 2c + c_s > 0$. Using (16), we can show that the latter holds for all $\gamma \leq 1$ if $c - c_s < (a - c)/(n + 2)$. QED

Proposition 2 indicates that when buyer power is present, increased concentration in the retail market causes additional harm to consumers. In addition to higher retailer markups, reduced competition intensity in the retail market allows the large retailer to pay a higher wholesale price to its supplier, leading to a further increase in retail price. This confirms that the (sometimes) positive effect of increased retail concentration on consumers in Dobson and Waterson (1997) is indeed caused by the confluence of buyer power and seller power.

The impact of increased retail concentration on social welfare, however, is less clear-cut. The ambiguity arises because, under the assumption $c > c_s$, the increased concentration is associated with the elimination of a retailer whose supplier has a higher marginal cost than that of the large retailer. This produces an efficiency gain that can potentially dominate the loss due to the lessening of competition. Nevertheless, it can be shown that increased retail concentration reduces social welfare if the cost difference between suppliers is not too large in the sense that $c - c_s < (a - c)/(2 + n)$.

Propositions 1 and 2 have interesting policy implications. Merger reviews by competition authorities in North America and Europe have traditionally focused on market power on the seller side rather than on the buyer side.[10] In the case of a merger of two retailers, this approach typically involves the examination of individual geographic markets to ensure that

[10] This can be seen from the scant attention paid to buyer power in the merger enforcement guidelines in Canada, the EU and the US.

after the merger, there is sufficient competition among retailers in each local market. Propositions 1 and 2 combined suggest that this traditional approach to merger reviews can actually work reasonably well even in a situation where the merger also enhances the buyer power of the merged entity. By preventing the downstream market from becoming more concentrated, the competition authority would ensure that the post-merger retail price will not rise and may possibly fall.[11]

Finally, we examine the interaction of buyer power and the intensity of downstream competition. The question we want to address here is whether the impact of buyer power is larger or smaller when the retail market is more concentrated.

Proposition 3: The smaller is the number of retailers, the greater is the reduction in the wholesale and retail prices in response to an increase in the buyer power of retailer R_1.

Proof: Differentiating (17) with respect to n yields:

$$\frac{\partial^2 w^N}{\partial n \partial \gamma} = \frac{(a-c)}{2n^2} > 0 . \tag{29}$$

From $\partial p/\partial \gamma = (\partial p/\partial Q)(\partial Q/\partial \gamma) = -b\,\partial Q/\partial \gamma$, we obtain

$$\frac{\partial^2 p}{\partial n \partial \gamma} = -b\frac{\partial^2 Q}{\partial n \partial \gamma} = \frac{1}{(n+1)^2}\left((n+1)\frac{\partial^2 w}{\partial n \partial \gamma} - \frac{\partial w}{\partial \gamma}\right) > 0 . \tag{30}$$

QED

Proposition 3 suggests that when the downstream market is less competitive, an increase in the buyer power brings about a greater decrease in retail price and consequently a larger gain

[11] As will be discussed in section V, the retail price may be independent of buyer power if the large retailer and its supplier can use a non-linear contract to perfectly align their interests regarding the level of the wholesale price.

in consumer surplus. This result is surprising because intuitively the pressure for a retailer to pass on the cost savings from a lower wholesale price to consumers is stronger when there is more intense competition among retailers. This intuition might suggest that the reduction in retailer price resulted from the exercise of buyer power should be smaller when the retail market is less competitive. However, what this intuition misses is the fact that the profit margin between retail price and the marginal cost of production is also higher when the retail market is less competitive. Hence, there is more room for the retail price to fall in response to the increased buyer power, and Proposition 3 shows that this is indeed what happens in equilibrium.

The policy implication of Proposition 3 is also interesting. It suggests that a competition authority does not necessarily have to be more concerned about the effects of buyer power in a more concentrated retail market. A concentrated retail market is not desirable in terms of consumer and social welfare. But a merger that that enhances the buyer power of the merged entity without increasing the concentration in the retail market can be a good thing.

V. Sensitivity Analysis

In this section, we examine whether our analysis in the preceding section is sensitive to the assumptions in the model. Specifically, we will revise the model to consider a situation where: (a) the downstream market is served by a monopoly retailer, (b) retailers offer differentiated services, or (c) the large retailer and its supplier use a non-linear contract.

V.1 Downstream Monopoly

As discussed in Introduction, a common theme in the existing literature on buyer power is that the presence of competition in the retail market is necessary for buyer power to (possibly) benefit consumers and increase welfare. It is then worthwhile to investigate the effects of buyer power in the situation where competition is completely absent in the retail market. Will the effects of buyer power found in section IV still hold in the case of a monopoly retailer?

We modify our model such that the downstream market has no other retailers but R_1. All other aspects of the model remain the same as before. It is straightforward to derive the equilibrium wholesale price, retail price and quantity of the monopoly retailer:

$$w^m = \frac{a(1-\gamma) + c_s(1+\gamma)}{2}, \tag{31}$$

$$p^m = \frac{2a + a(1-\gamma) + c_s(1+\gamma)}{4}, \tag{32}$$

$$q_1^m = \frac{a-w}{2b} = \frac{(1+\gamma)(a-c_s)}{4b}. \tag{33}$$

Using (31)-(33), we can easily verify that an increase in the buyer power of the monopoly retailer reduces equilibrium wholesale price and retail price, and improves both consumer and social welfare. In other words, the effects of buyer power in the case of a monopoly retailer are qualitatively the same as those in the oligopolistic retail market. This conclusion is in sharp contrast to von Ungern-Sternberg (1996) and Dobson and Waterson (1997) in which increased buyer power in a highly concentrated retail market is detrimental to consumer and social welfare.

Of course, there are quantitative differences between a monopolistic retail market and an oligopolistic retail market. As one would expect, both retail price and retailer mark-up are higher under monopoly than under oligopoly. The magnitudes of the buyer power effects are also different, as the following proposition shows.

Proposition 4: An increase in the buyer power of retailer R_1 causes a greater reduction in wholesale and retail price in the monopolistic retail market than in the oligopolistic retailer market.

Proof: From (17) and (31), we derive

$$\frac{\partial w}{\partial \gamma} - \frac{\partial w^m}{\partial \gamma} = \frac{4(n^2-1)b^2(a-c) + bd_s\left[(n^2-n)(a-c_s) + (n^2-1)(a-c)\right]}{n(4b+d_s)(2(n+1)b+nd_s)} > 0 . \qquad (34)$$

Using (18), (33) and (34), we obtain

$$\frac{\partial Q}{\partial \gamma} - \frac{\partial q_1^m}{\partial \gamma} = -\frac{1}{(n+1)b}\frac{\partial w}{\partial \gamma} + \frac{1}{2b}\frac{\partial w^m}{\partial \gamma} < \frac{1}{b}\frac{\partial w}{\partial \gamma}\left(\frac{1}{2} - \frac{1}{(n+1)}\right) < 0 . \qquad (35)$$

Using the demand function and (35), we find

$$\frac{\partial p}{\partial \gamma} - \frac{\partial p^m}{\partial \gamma} = b\left(\frac{\partial q_1^m}{\partial \gamma} - \frac{\partial Q}{\partial \gamma}\right) > 0 . \qquad (36)$$

QED

Therefore, the benefit of increased buyer power to consumers is the largest when the competition in the retail market is the weakest. This and Proposition 3 suggest that buyer power and downstream competition can be viewed as substitutes in terms of their effects on consumers.

The idea that buyer power can be a substitute for competition was an important component of Galbraith's (1952) countervailing power hypothesis. So far, however, this idea has received very little theoretical support in the literature on buyer power. Our analysis instills more rigor to the meaning of this idea and identifies a setting where it holds true.

V.2 Product Differentiation

Now we return to the setting where the downstream market is oligopolistic and suppose, instead, the retail services are differentiated products. Specifically, suppose that retailer *i* (= 1, 2,…, *n*) faces the following inverse demand function:

$$p_i = a - bq_i - \theta b\sum_{j\neq i} q_j \, , \tag{37}$$

where parameter $\theta \in (0,1]$ measures the degree of substitutability between two retailers. The larger is the value of θ, the higher is the degree of substitutability. In the limit where θ = 1, this model converges to the one in section III where the retailers are homogeneous.

To distinguish from the case of homogenous retailers, we use superscript *D* to denote the equilibrium in the case of differentiated retailers. Solving the Cournot equilibrium in the downstream market using the demand function (37), we obtain the counterparts to (6) and (7):

$$q_1^D = \frac{(2+\theta n - 2\theta)(a-w) - \theta(n-1)(a-c)}{b(2-\theta)[2+\theta(n-1)]}; \quad q^D = \frac{(2-\theta)(a-c)-\theta(c-w)}{b(2-\theta)[2+\theta(n-1)]} \tag{38}$$

Since $w \geq c_s$, we assume $a - c > \theta(c - c_s)/(2-\theta)$ to ensure that q^D is positive.

It can be shown that the Nash bargaining solution in this case is

$$w^D = \frac{1}{2}\left[(1-\gamma)a + (1+\gamma)c_s - \frac{(1-\gamma)\theta(n-1)(a-c)}{2+\theta(n-2)}\right]. \tag{39}$$

As in the case of homogeneous retailers, retailer R_1's outside option is not binding only if its buyer power exceeds a certain threshold. Indeed, from (39) we find that $w^D < c$ as long as $\gamma > \hat{\gamma}_L$ where

$$\hat{\gamma}_L = \frac{(2-\theta)(a-c) - (2+\theta n - 2\theta)(c-c_s)}{(2-\theta)(a-c) + (2+\theta n - 2\theta)(c-c_s)}. \tag{40}$$

Consistent with our basic model, we assume $\gamma > \hat{\gamma}_L$ to focus on the situation where R_1 has a meaningful amount of buyer power to be able to influence its wholesale price.[12] Given this assumption, we have the following results.

Proposition 5: In the case where each retailer's demand function is represented by (37):

(i) An increase in the buyer power of retailer R_1 reduces its own wholesale price and the retail prices of all retailers. Consumer welfare and social welfare are higher as a result.

(ii) A more concentrated retail market (*i.e.* a smaller number of retailers) raises wholesale price of retailer R_1 and the retail prices of all retailers. Consumer welfare is lower as a result. Social welfare also falls if $c - c_s \le K(a-c)$, where[13]

$$K = \frac{(2-\theta)[2(2-\theta)+(1-\theta)(2+n\theta-\theta)]}{\theta[4(2-\theta)+2n\theta+(5-3\theta)(2+n\theta-\theta)]}. \qquad (41)$$

(iii) The smaller is the number of retailers, the greater is the reduction in the wholesale and retail prices in response to an increase in the buyer power of retailer R_1.

The proof of Proposition 5 is long and tedious. For this reason, it is relegated to the appendix.

A comparison of Proposition 5 with Propositions 1 – 3 indicates that the effects of buyer power and downstream competition in the presence of retailer differentiation are qualitatively the same as in the case of homogeneous retailers. In particular, retailer buyer power reduces the wholesale and retail prices, and this effect is larger when the retail market is more concentrated.

[12] It is clear from (40) that $\hat{\gamma}_L < 1$. Moreover, $\gamma > \hat{\gamma}_L$ is binding only if the numerator of (40) is positive, *i.e.*, only if $(2-\theta)(a-c) > (2+\theta n - 2\theta)(c-c_s)$.

[13] It can be shown that $K < (2-\theta)/\theta$. Accordingly, a positive q^D in (38) does not rule out the possibility that $c - c_s \le K(a-c)$.

Therefore, our conclusions are robust to the incorporation of retailer product differentiation into our model.[14]

V.3. Non-linear Contracts

An important assumption in the basic model is that a single per unit price is used in the contract between the large retailer R_1 and its supplier. If we change this assumption and suppose, instead, that the contract takes the form of a two-part tariff, the equilibrium will be qualitatively different. Specifically, the retailer and the supplier will set the wholesale price w to maximize their joint-profits and use the fixed fee to divide the joint profits. In this case, an increase in the retailer's buyer power will simply raise its share of the joint profits, but it will have no impact on retail price or welfare.

A two-part tariff and a single per unit price represent two extremes in terms of the ability of the retailer and the supplier to resolve their conflicting interests over the wholesale price. With a two-part tariff, they are able to align their interests perfectly and choose the wholesale price that maximizes their joint profits. With a single per unit price, on the other hand, their interests are diametrically opposed, with the supplier preferring a higher and the retailer preferring a lower wholesale price.

Our results in section IV would continue to hold qualitatively as long as the contract between the supplier and the retailer does not lead to a perfect alignment of their interests regarding the wholesale price. In such a situation, an increase in the retailer's buyer power will

[14] Here we use market concentration as our measure of competition intensity because this is a variable that a competition authority can influence through enforcement actions. Competition intensity in the retail market can also be affected by the degree of production differentiation, which is driven by consumer tastes and retailers' marketing strategies. In our model, we can show that the marginal effect of buyer power on prices is larger if θ is smaller (*i.e.*, if the degree of product differentiation among retailers is higher). In other words, buyer power and downstream competition are substitutes even if we measure the latter by the degree of retailer differentiation.

manifest itself, at least in part, through a lower wholesale price, and the lower wholesale price will have the effects examined in section IV.

In reality, the contract between a retailer and its supplier often contains more terms of trade than a single per unit price. It is plausible that these additional terms are put in place to address various information and incentive issues that may exist in the real world. Hence, while a two-part tariff can lead to a perfect alignment of the interests of the supplier and retailer in our simple setting, it may not achieve this in reality. In any case, it is an empirical question whether a retailer and its supplier always have the same view regarding what the wholesale price should be. Our results are relevant to situations where they do not.

VI. Conclusions

Using a model that isolates the effects of buyer power from those of the downstream competition, we have demonstrated that enhanced buyer power of a large retailer reduces retail price and improves consumer welfare, and this is true even in the case where the retail market is served by a monopolist. More interestingly, the beneficial effect of the increased buyer power on consumer welfare is larger when the intensity of downstream competition is lower, with the effect being the largest in the case of downstream monopoly. On the other hand, increased competition in the downstream market is beneficial to consumers as it forces the large retailer to bargain more vigorously with its supplier and pass on a greater share of cost savings to consumers. Therefore, our analysis suggests that the traditional approach to merger reviews, under which the focus of a competition authority is on maintaining competition in the local retail markets, can actually work reasonably well even in a situation where the merger enhances the buyer power of the merged entity. By preventing the downstream market from becoming more concentrated, the competition authority would ensure that the post-merger retail price will not rise and may possibly fall.

References

Battigalli, Pierpaolo, Chiara Fumagalli, and Michele Polo (2007) "Buyer Power and Quality Improvement," *Research in Economics*, 61, 45-61.

Binmore, Ken, Ariel Rubinstein, and Asher Wolinksky (1986) "The Nash Bargaining Solution in Economic Modelling," *RAND Journal of Economics*, 17, 176-188.

Chen, Zhiqi (2003) "Dominant Retailers and the Countervailing Power Hypothesis," *RAND Journal of Economics*, 34, 612-625.

Chen, Zhiqi (2007) "Buyer Power: Economic Theory and Antitrust Policy," *Research in Law and Economics, 22*, 17-40.

Chen, Zhiqi (2013) "Supplier Innovation in the Presence of Buyer Power: A General Theory with Applications," manuscript, Carleton University.

Competition Bureau (1999a) "Backgrounder: Loblaw Companies Limited – Acquisition of Provigo Inc. in Quebec and Ontario," published on August 12, 1999, viewed at http://www.competitionbureau.gc.ca/eic/site/cb-bc.nsf/eng/00812.html

Competition Bureau (1999b) "Backgrounder: Sobeys Inc. Acquisition of Certain Assets of the Oshawa Group Limited," published on December 22, 1999, viewed at http://www.competitionbureau.gc.ca/eic/site/cb-bc.nsf/eng/00820.html.

Competition Commission (2000) "Supermarkets: A Report on the Supply of Groceries from Multiple Stores in the United Kingdom," viewed at http://www.competition-commission.org.uk/rep_pub/reports/2000/446super.htm#full.

Competition Commission (2003) "Safeway plc and Asda Group Limited (Owned by Wal-Mart Stores Inc); Wm Morrison Supermarkets PLC; J Sainsbury plc; and Tesco plc: A Report on the Mergers in Contemplation," viewed at http://webarchive.nationalarchives.gov.uk/+/http://www.competition-commission.org.uk/rep_pub/reports/2003/481safeway.htm

Competition Commission (2008) "Supply of Groceries in the UK Market Investigation," viewed at http://www.competition-commission.org.uk/rep_pub/reports/2008/fulltext/538.pdf.

Dobson, Paul W. (2005) "Exploiting Buyer Power: Lessons from the British Grocery Trade," *Antitrust Law Journal*, 72, 529-535.

Dobson, Paul W. and Michael Waterson (1997) "Countervailing Power and Consumer Prices," *Economic Journal*, 107, 418-430.

Erutku, Can (2005) "Buying power and strategic interactions," *Canadian Journal of Economics*, 38, 1160-1172.

Federal Trade Commission (2008) "Round Table on Monopsony and Buyer Power," viewed at http://www.ftc.gov/bc/international/docs/monopsony.pdf.

Galbraith, J.K. (1952) *American Capitalism: The Concept of Countervailing Power*, Boston: Houghton Mifflin.

Harsanyi, J.C. and R. Selton (1972), "A Generalized Nash Solution for Two-Person Bargaining Games with Incomplete Information," *Management Science*, 18, 80 – 106

Horn, Henrick and Asher Wolinsky (1988) "Bilateral Monopolies and Incentives for Merger," *RAND Journal of Economics*, 1988, 408 – 419.

Inderst, Roman and Greg Shaffer (2007) "Retail Mergers, Buyer Power and Product Variety," *Economic Journal*, 117, 45-67.

Inderst, Roman and Tommaso M. Valletti (2011) "Buyer Power and the 'Waterbed Effect'," *Journal of Industrial Economics*, 59, 1 – 20.

Inderst, Roman and Christian Wey (2007) "Buyer Power and Supplier Incentives," *European Economic Review*, 51, 647 – 667.

Inderst, Roman and Christian Wey (2011) "Countervailing Power and Dynamic Efficiency," *Journal of the European Economic Association*, 9, 702-720.

Mills, David E. (2010) "Buyer Power and Industry Structure," *Review of Industrial Organization*, 36, 213 – 225.

Muthoo, Abhinay (1999) *Bargaining Theory with Applications*, Cambridge: Cambridge University Press.

OECD (1998) "Roundtable on Buying Power of Multiproduct Retailers," viewed at http://www.oecd.org/dataoecd/1/18/2379299.pdf.

OECD (2004) "Roundtable on Competition and Regulation in Agriculture: Monopsony Buying and Joint Selling," viewed at http://www.oecd.org/dataoecd/7/56/35910977.pdf.

OECD (2008) "Policy Roundtables: Monopsony and Buyer Power," viewed at http://www.oecd.org/dataoecd/38/63/44445750.pdf.

Office of Fair Trading (2007) "Groceries Market Investigation: Emerging Thinking," viewed at http://www.competition-commission.org.uk/inquiries/ref2006/grocery/index.htm.

Smith, Howard and John Thanassoulis (2009) "Upstream Competition and Downstream Buyer Power," University of Oxford Economics Series Working Papers 420.

Vieira-Montez, J. (2007) "Downstream Mergers and Producer's Capacity Choice: Why Bake a Larger Pie When Getting a Smaller Slice?" *RAND Journal of Economics*, 38, 948-966.

von Ungern-Sternberg, Thomas (1996) "Countervailing Power Revisited," *International Journal of Industrial Organization*, 14, 507-520.

Appendix

Proof of Proposition 5

To simplify presentation, define $Z \equiv (2-\theta)[2+(n-1)\theta]$. Regarding part (i) of Proposition 5, we use (37) – (39) to show that

$$\frac{\partial w}{\partial \gamma} = -\frac{1}{2(2+\theta n-2\theta)}\left[(2-\theta)\left(a-c_s\right)+\theta(n-1)\left(c-c_s\right)\right] < 0\,; \tag{A1}$$

$$\frac{\partial p_1}{\partial \gamma} = \frac{2-\theta+\theta(n-1)(1-\theta)}{Z}\frac{\partial w}{\partial \gamma} < 0\,; \tag{A2}$$

$$\frac{\partial p}{\partial \gamma} = \frac{\theta}{Z}\frac{\partial w}{\partial \gamma} < 0\,. \tag{A3}$$

The consumer welfare associated with demand function (37) can be expressed as

$$CS = a\sum q_i - \frac{b}{2}\left(\sum q_i^{\,2} + 2\theta\sum_{i\neq j} q_i q_j\right) - p_1 q_1 - (n-1)pq\,. \tag{A4}$$

Differentiating (A4) and using (38) – (39), we find that

$$\frac{\partial CS}{\partial \gamma} = -\frac{1}{Z}\left\{(n-1)\theta q + \left[2-\theta+\theta(n-1)(1-\theta)\right]q_1\right\}\frac{\partial w}{\partial \gamma} > 0\,. \tag{A5}$$

Using (A4) and the firms' profit functions, we write the social welfare as

$$TS = a\sum q_i - \frac{b}{2}\left(\sum q_i^{\,2} + 2\theta\sum_{i\neq j} q_i q_j\right) - c_s q_1 - (n-1)cq\,. \tag{A6}$$

Differentiate (A6) to obtain

$$\begin{aligned}\frac{\partial TS}{\partial \gamma} = \frac{1}{bZ^2}\frac{\partial w}{\partial \gamma}\Big[&-\left\{4(1-\theta)+(n-1)\theta+(2n-1)\theta(1-\theta)+(n-2)\theta(1-\theta^2)\right\}(w-c_s) \\ &-\left\{(2+\theta n-2\theta)^2+\theta^2(n-1)\right\}(a-c_s)+\theta(n-1)\left(4+\theta n-2\theta\right)(a-c)\Big] > 0.\end{aligned} \tag{A7}$$

In determining the sign of (A7), note that $\partial w/\partial\gamma < 0$, $w \geq c_s$, $a-c_s > a-c$, and

$(2+\theta n-2\theta)^2 + \theta^2(n-1) > \theta(n-1)(4+\theta n-2\theta)$.

.

Regarding part (ii) of Proposition 5, we use (37) – (39) to find

$$\frac{\partial w}{\partial n} = -\frac{(1-\gamma)\theta(2-\theta)(a-c)}{2(2+\theta n-2\theta)^2} < 0 ; \tag{A8}$$

$$\frac{\partial p_1}{\partial n} = \frac{1}{Z^2}\left(-(2-\theta)\theta bZq + \frac{\partial w}{\partial n} Z[2-\theta+\theta(n-1)(1-\theta)] \right) < 0 ; \tag{A9}$$

$$\frac{\partial p}{\partial n} = \frac{1}{Z^2}\left(-(2-\theta)\theta bZq + \frac{\partial w}{\partial n}\theta Z \right) < 0 . \tag{A10}$$

To find the effect of *n* on consumer welfare, differentiate (A4) to obtain:

$$\begin{aligned} \frac{\partial CS}{\partial n} &= \frac{q_1}{Z}\left(-\frac{\partial w}{\partial n}[2-\theta+\theta(n-1)(1-\theta)] + \theta(2-\theta)bq \right) \\ &+ \frac{q}{Z}\left(-\frac{\partial w}{\partial n}\theta(n-1) + \frac{1}{2}bq\left[\theta^2(n-1)(1+\theta) + 2(1-\theta)[3\theta(n-1)+2-\theta]\right] \right) > 0. \end{aligned} \tag{A11}$$

Differentiate (A6) to determine the effect of *n* on social welfare:

$$\begin{aligned} \frac{\partial TS}{\partial n} &= \frac{q}{Z}\left[\left(2(2-\theta) + \frac{1}{2}(1-\theta)Z \right)(p-c) - \theta(2-\theta)(p_1-c_s) \right] \\ &+ \frac{1}{Z}\frac{\partial w}{\partial n}\left[q\theta(n-1) - q_1(2+\theta n-2\theta) - \frac{(2+\theta n-2\theta)(w-c_s)}{b} \right]. \end{aligned} \tag{A12}$$

The sign of the second term in (A12) is positive because $\partial w / \partial n < 0$ and $q\theta(n-1) < q_1(2+\theta n-2\theta)$. The latter can be verified by using (38) and $w < c$. Then the sign of (A12) is positive if

$$\left(2(2-\theta) + \frac{1}{2}(1-\theta)Z \right)(p-c) - \theta(2-\theta)(p_1-c_s) \geq 0 . \tag{A13}$$

Using the first-order conditions of the retailers' profit maximization problems, we rewrite (A13) as:

$$\left(2(2-\theta) + \frac{1}{2}(1-\theta)Z \right)bq - \theta(2-\theta)bq_1 - \theta(2-\theta)(w-c_s) \geq 0 . \tag{A14}$$

Note from (38) that q is increasing in w while q_1 is decreasing in w. Since $w \geq c_s$, we substitute (38) for q and q_1, with $w = c_s$, into (A14) to obtain the following sufficient condition for the sign of (A12) to be positive:

$$\left(2(2-\theta)+\frac{1}{2}(1-\theta)Z\right)\frac{(2-\theta)a-2c+\theta c_s}{Z}-\theta(2-\theta)\frac{(2-\theta)a+\theta(n-1)c-(2+\theta n-2\theta)c_s}{Z} \qquad \text{(A15)}$$
$$-\theta(2-\theta)(w-c_s)\geq 0.$$

Noting that $w < c$, we substitute c for w into (A15) to derive a slightly different sufficient condition for the sign of (A12) to be positive:

$$\left(2(2-\theta)+\frac{1}{2}(1-\theta)Z\right)\frac{(2-\theta)a-2c+\theta c_s}{Z}-\theta(2-\theta)\frac{(2-\theta)a+\theta(n-1)c-(2+\theta n-2\theta)c_s}{Z} \qquad \text{(A16)}$$
$$-\theta(2-\theta)(c-c_s)\geq 0.$$

Re-arrange the terms in (A16), we obtain $c-c_s \leq K(a-c)$, where K is defined in (41).

To prove part (iii) of Proposition 5, we differentiate (A1) – (A3) to obtain:

$$\frac{\partial^2 w}{\partial n \partial \gamma}=\frac{\theta(2-\theta)(a-c)}{2(2+\theta n-2\theta)^2}>0; \qquad \text{(A17)}$$

$$\frac{\partial^2 p_1}{\partial n \partial \gamma}=\frac{1}{Z^2}\left(-(2-\theta)\theta^2\frac{\partial w}{\partial \gamma}+\frac{\partial^2 w}{\partial n \partial \gamma}Z\left[2-\theta+\theta(n-1)(1-\theta)\right]\right)>0; \qquad \text{(A18)}$$

$$\frac{\partial^2 p}{\partial n \partial \gamma}=\frac{1}{Z^2}\left(-(2-\theta)\theta^2\frac{\partial w}{\partial \gamma}+\frac{\partial^2 w}{\partial n \partial \gamma}\theta Z\right)>0. \qquad \text{(A19)}$$

QED