CEP 14-03

Supplier Innovation in the Presence of Buyer Power

Zhiqi Chen

May 2014

CARLETON ECONOMIC PAPERS

Carleton UNIVERSITY

Department of Economics

1125 Colonel By Drive
Ottawa, Ontario, Canada
K1S 5B6

Supplier Innovation in the Presence of Buyer Power

by

Zhiqi Chen*
Department of Economics
Carleton University
Ottawa, Canada K1S 5B6
Telephone: (+1) 613-520-2600 ext. 7456
Fax: (+1) 613-520-3906
Email: Zhiqi.Chen@carleton.ca

May 2014

Abstract

A theoretical framework is constructed to derive general conditions under which increased buyer power weakens or strengthens a supplier's incentive to innovate. These conditions are then applied to two sets of specific models: one on product innovation and the other on process innovation. The analysis shows that the effects of buyer power depend on the type of innovation, the source of buyer power, and the channel through which buyer power manifests itself. It identifies circumstances under which an increase in buyer power has a negative, positive or zero impact on innovation. The welfare consequences of buyer power are also investigated.

Key words: Buyer power, innovation, product variety

JEL Classification: L1, L4

---

* For comments, I would like to thank Yongmin Chen, David Mills, Pascal Courty, Paul Schure, David Scoones, Tommaso Valletti, and seminar participants at Shanghai University of Finance and Economics, University of Victoria and Queen's University. Financial assistance from the Social Sciences and Humanities Research Council of Canada is gratefully acknowledged.

1. Introduction

The rise of large, powerful retail organizations such as Wal-Mart, Home Depot and Staples has enhanced the interest among academics and practitioners of competition policy in the effects of buyer power, as the success of these retailers has been partially attributed to their ability to exercise buyer power against their suppliers (see, for example, Vance and Scott 1994). While some commentators have argued that retailer buyer power benefits consumers, others have expressed concerns over the longer term impact of such power on the suppliers' incentives to innovate. In particular, a frequently raised concern is the possibility that the squeeze on suppliers' profit margins by large retailers may lead to reduced product choices for consumers or weakened incentives to reduce costs (see, for example, Dobson and Waterson 1999, European Commission 1999, OECD 1999, FTC 2001, OECD 2008). Given the critical role of innovation in modern-day economies, it is then important to understand how innovation would be affected by the rise of powerful buyers.

The objective of this paper is to analyze a supplier's incentive to innovate by examining a general model as well as a series of specific models of buyer power in the context of product and process innovation. Using the general model, I derive a set of conditions under which increased buyer power strengthens or weakens the supplier's incentive to innovate. These general conditions are then elaborated upon through the analysis of the specific models. In addition to the impact on innovation, the analysis also sheds light on the effects of buyer power on consumer welfare and social welfare. In so doing, I strive to construct a general theory that encompasses different types of innovations, different sources of buyer power and different channels through which buyer power manifests itself.

To be more specific, I consider a situation where a manufacturer produces and supplies a set of products to retailers in a number of geographic markets, with each market being served by one large retailer and possibly a number of fringe retailers. The terms of trade between the supplier and each large retailer are negotiated, but the supplier's investment in innovation is not contractible. Using the generalized Nash bargaining solution, I study retailer buyer power that manifests itself through three channels: the retailer's bargaining power, the retailer's bargaining position, and the supplier's bargaining position. After examining of these three manifestations of buyer power in the general model, I study each of them in more detail in specific models where buyer power comes from each of the following two sources: a reduction in the number of fringe retailers in a geographic market and an increase in the size of a chain store that serves multiple geographic markets. The former confers more buyer power to the large retailer in that geographic market as it weakens the supplier's bargaining position. The latter enhances the chain store's profitability of producing its own brand of differentiated products (backward integration) in the event of a disagreement with the supplier, and thus improves the retailer's bargaining position. Moreover, I develop a theory to demonstrate that a reduction in the number of fringe retailers or an increase in the size of the chain store can strengthen the retailer's relative bargaining power because it induces the retailer to boost its spending on the quality of its negotiation team.[1] Therefore, this analysis covers a wide range of scenarios where buyer power comes from two different sources and manifests itself through three different channels.

As alluded to earlier, I examine two sets of specific models, one for product innovation and the other for process innovation. In the former, the supplier's incentive to invest is measured by

[1] Depending on the source of the increased buyer power, the supplier's spending on the quality of its negotiation team either falls or rises. But even in the latter case, the increase in spending by the retailer is larger than that by the supplier, thus enhancing the retailer's relative bargaining power.

the number of differentiated products it produces. In the latter, it is measured by the level of investment in R&D that reduces the marginal cost of production. Both types of innovations are modelled in the context of the Dixit-Stiglitz (1977) framework of production differentiation, which enables an examination of the welfare consequences of increased buyer power.

The analysis of the general model highlights a simple but useful principle, that is, the impact of increased buyer power on the incentive to innovate depends on its marginal effect on the supplier's *marginal* – as opposed to the *total* – gains from the investment. While intuitively one might expect that the change in the marginal gains should normally go in the same direction as the change in the total gains, the analysis of the specific models identifies circumstances under which this intuition does or does not hold. As summarized in Table 1, the impact of buyer power on the supplier's incentive to innovate depends on the type of innovation and the channel through which the buyer power manifests itself. For example, an increase in a retailer's buyer power through the retailer's improved bargaining position has a negative impact on the supplier's incentive to engage in product innovation, but it has no impact on process innovation. On the other hand, an increase in buyer power that manifests itself through a weakened bargaining position of the supplier can strengthen the supplier's incentive to engage in product innovation under a certain demand condition. The analysis of these specific models reveals a number of different mechanisms through which buyer power affects supplier innovation.

The preceding discussion implies that the impact of increased buyer power on consumer and social welfare will also depend on the type of innovation, the source of buyer power, and the channel through which the buyer power manifests itself. Indeed, the increased buyer power reduces consumer welfare and social welfare in situations where it weakens the incentives to

innovate. On the other hand, increased buyer power that strengthens the incentives to innovate benefits the consumers but may have an ambiguous impact on social welfare.

In the literature, numerous authors have studied the short-run effects of buyer power on prices. For example, von Ungern-Sternberg (1996) and Dobson and Waterson (1997) demonstrate that increased concentration in a retailer market does not necessarily lead to lower prices for consumers; under certain conditions it in fact results in higher prices. Chen (2003), on the other hand, shows that increased buyer power in the hands of a dominant retailer reduces prices for consumers, but it does not necessarily improve welfare.

By examining the long-term effect of buyer power on suppliers' incentives to innovate, the present paper follows Inderst and Wey (2007 and 2011).[2] In particular, Inderst and Wey (2011) demonstrate that buyer power may induce a supplier to increase its investment in process innovation. In their model, the source of buyer power is its size; an increase in the size of a retailer improves the attractiveness of backward integration by the retailer. While the main contribution of the other article by Inderst and Wey (2007) is the identification of two sources of buyer power in situations where a supplier faces strictly convex costs or capacity constraints, it also examines the supplier's choice between two alternative production technologies and, respectively, two alternative products.

Relative to the works by Inderst and Wey, I present a more general theory that encompasses different sources of buyer power and different types of innovations. In addition to backward integration, I also study the buyer power arising from a reduction in the number of competing retailers in a market and from a retailer's endogenous spending on the quality of its negotiation

[2] Also of relevance are Battigalli *et al.* (2007) and Montez (2007) that study the impact of downstream market power on upstream incentives to invest in, respectively, quality improvement and production capacity.

team. To the best of my knowledge, the link between spending on the quality of its negotiation team and the retailer's bargaining power has never been articulated and examined in the literature. Furthermore, I conduct a detailed analysis of product innovation based on the Dixit-Stiglitz framework. The rich structure of these models enables a comprehensive analysis of buyer power.

The paper is organized as follows. In section 2, I present a general framework of supplier innovation in the presence of buyer power and use it to derive a number of general conditions under which an increase in buyer power weakens or strengthens the supplier's incentive to innovate. In sections 3 and 4, I examine specific models of product innovation and process innovation, respectively. In section 5, I extend the models in section 3 to incorporate endogenous bargaining power and demonstrate that an increase in the size of a large retailer induces the retailer to increase its spending on the quality of its negotiation team, thus enhancing the retailer's relative bargaining power. Conclusions are in section 6.

2. A General Theory

Consider a situation where a manufacturer produces and supplies n products to retailers in m geographic markets. The demand functions for these products are identical across the m markets. Each market is served by one large retailer and possibly a number of fringe retailers. The fringe retailers are price-takers both in the retail markets and in their dealing with the manufacturer. Accordingly, the retail prices in a geographic market are set by the large retailer serving that market. A large retailer may operate a chain that serves multiple markets. Taking into account this possibility, let l ($\leq m$) be the number of large retailers and j the index of a large retailer.

The manufacturer/supplier and each large retailer play the following two-stage game. In

stage 1 the supplier chooses the level of investment in innovation, which influences either its revenue (product innovation) or its costs of production (process innovation) in some way. In stage 2 the supplier negotiates with each large retailer over the terms under which the products are sold to the latter. In the case where fringe retailers are present, the supplier makes a take-it-or-leave-it offer to these retailers. The game ends with each large retailer and (if applicable) the fringe retailers resell the products to final consumers. The supplier's investment in innovations is a sunk cost and hence is not recoverable in stage 2.[3]

The production technology of the supplier exhibits constant returns to scale. This implies that the negotiation between the supplier and the large retailer in a market is independent of what happens in the other markets. The negotiation game itself is modelled as the generalized Nash bargaining solution (Harsanyi and Selton 1972). Consistent with this, we assume that the terms of contract between the supplier and the large retailer are non-linear so that it maximizes the joint surplus that the two parties earn from the sales in the retailer's market(s).[4] Moreover, the use of non-linear contracts also enables the supplier to extract all the profits from the fringe retailers (if there are any).

Let Π^j denote the maximum joint surplus of the supplier and large retailer *j*, and π_M^j the surplus earned by the supplier from the sales through retailer *j* (*j* = 1, 2, ..., or, *l*) and (if

[3] Therefore, at the core of this model is the familiar investment holdup problem. While the literature on this topic has focused mostly on ways to deal with the under-investment caused by the holdup problem (Che and Sákovics 2004), the present paper examines how the investment level is affected by the market power of the buyer and shows that buyer power may stimulate investment under some circumstances.

[4] In practice, contracts between manufacturers and retailers are complex and highly non-linear (Inderst and Wey 2004 p6). Theoretically, it is easy to design a two-part tariff that enables the supplier and the retailer to achieve joint-surplus maximization. In Chen (2004), for example, the contract between the supplier and the retailer consists of a wholesale price and a lump sum fee while the retailer is free to choose the retail price. It is shown that joint-surplus maximization is achieved by setting the wholesale price equal to the marginal cost of production.

applicable) the fringe retailers in the same market(s). Then the surplus earned by retailer *j* is $\Pi^j - \pi_M^j$. The disagreement payoffs are denoted by π_M^{jd} for the supplier and π_R^{jd} for the retailer. To make the bargaining problem meaningful, assume that $\Pi^j > \pi_R^{jd} + \pi_M^{jd}$, which ensures that there are gains from reaching an agreement. Since the supplier's investment cost is sunk, Π^j, π_M^j and π_M^{jd} are quasi-rents without deducting the investment cost.

The generalized Nash bargaining problem between the supplier and retailer *j* can be written as:

$$\max_{\pi_M^j} \left(\Pi^j - \pi_M^j - \pi_R^{jd}\right)^{\gamma^j} (\pi_M^j - \pi_M^{jd})^{1-\gamma^j}, \qquad (1)$$

where parameter $\gamma^j \in (0,1)$ determines retailer *j*'s share of the net gains from the agreement. Following the terminology of Dukes *et al.* (2006), I will refer to γ^j as retailer *j*'s (relative) *bargaining power*, π_R^{jd} *retailer j's bargaining position*, and π_M^{jd} the *supplier's bargaining position*.

It is straightforward to solve (1) to obtain the supplier's payoff from the sales in the market(s) of retailer *j*:

$$\pi_M^j = \left(1 - \gamma^j\right)\Pi^j + \gamma^j \pi_M^{jd} - \left(1 - \gamma^j\right)\pi_R^{jd}, \quad (2)$$

and retailer *j*'s payoff:

$$\pi_R^j = \gamma^j \Pi^j + \left(1 - \gamma^j\right)\pi_R^{jd} - \gamma^j \pi_M^{jd}. \qquad (3)$$

From (2) and (3) we can see that an improvement in the supplier's bargaining position (*i.e.*, a larger π_M^{jd}) raises its own payoff and lowers the retailer's payoff, while an improvement in the retailer's bargaining position (*i.e.*, a larger π_R^{jd}) does the opposite. Furthermore, it can be shown

that an increase in the retailer's relative bargaining power (*i.e.*, a larger γ^j) benefits the retailer but hurts the supplier.

Let β^j denote retailer *j*'s buyer power.[5] It can manifest itself through three channels. First, it can manifest itself through the retailer's relative bargaining power, in which case we expect $\partial\gamma^j/\partial\beta^j > 0$. Second, it can have an impact on the retailer's bargaining position. Third, it can weaken the supplier's bargaining position. In the latter two cases, β^j influences the value of π_R^{jd} or π_M^{jd}. Specifically, we expect that $\partial\pi_R^{jd}/\partial\beta^j > 0$ and $\partial\pi_M^{jd}/\partial\beta^j < 0$. In other words, to the extent that buyer power affects the disagreement payoffs, it strengthens the retailer's bargaining position and/or weakens that of the supplier.

Let k denote the amount of investment on innovation made by the supplier and f the cost per unit of investment. The joint surplus Π^j is a function of k because of the latter's impact on the revenues or costs. For the supplier to undertake any investment at all, the marginal benefit of the investment has to be positive. Accordingly, I assume that $\partial\Pi^j/\partial k > 0$. On the other hand, the disagreement payoffs, π_R^{jd} and π_M^{jd} , may or may not be dependent on k. In the case of process innovation, for example, it is reasonable to expect that a cost reduction brought about by investment *k* will have an impact on π_M^{jd} but not on π_R^{jd}. Thus, I do not make any assumption regarding the signs of $\partial\pi_M^{jd}/\partial k$ and $\partial\pi_R^{jd}/\partial k$ in the general model.[6]

The objective here is to examine the impact of an increase in β^j on the equilibrium value of *k*. The supplier chooses the value of k in stage 1 by maximizing its profits from all *l* retailers and

[5] To maintain the generality of this analysis, the source of buyer power is not specified here. In sections 3-5, I will study the buyer power that stems from specific sources.
[6] In the specific models studied in sections 3 and 4, the signs of these derivatives are determined endogenously.

(if applicable) all fringe retailers:

$$\max_k \pi_M = \sum_{j=1}^{l} \pi_M^j - kf = \sum_{j=1}^{l}\left[\left(1-\gamma^j\right)\Pi^j + \gamma^j \pi_M^{jd} - \left(1-\gamma^j\right)\pi_R^{jd}\right] - kf, \quad (4)$$

with the resulting first-order condition:

$$\frac{\partial \pi_M}{\partial k} = \sum_{j=1}^{l}\left[\left(1-\gamma^j\right)\frac{\partial \Pi^j}{\partial k} + \gamma^j \frac{\partial \pi_M^{jd}}{\partial k} - \left(1-\gamma^j\right)\frac{\partial \pi_R^{jd}}{\partial k}\right] - f = 0. \qquad (5)$$

Assume that the second-order condition for a maximum, $\partial^2 \pi_M / \partial k^2 < 0$, is satisfied.

Intuitively, one might expect that the impact of buyer power on the supplier's investment in innovation should depend on how the latter's profits are affected, *i.e.*, on the sign of $\partial \pi_M / \partial \beta^j$. If the buyer power improves (respectively, reduces) the supplier's profits, it should strengthen (respectively, weaken) its incentive to innovate. Indeed, the common concerns over the impact of buyer power on supplier innovation appear to be motivated by the expectation that buyer power would lead to decreased profitability of suppliers (see, for example, OECD 1999 and Dobson and Chakraborty 2008).

Using this general theoretical framework, I am able to add more rigor to the above intuition. Totally differentiating (5), I obtain:

$$\frac{\partial k}{\partial \beta^j} = -\frac{\partial^2 \pi_M / \partial \beta^j \, \partial k}{\partial^2 \pi_M / \partial k^2}. \qquad (6)$$

Since $\partial^2 \pi_M / \partial k^2 < 0$, the sign of (6) depends on that of $\partial^2 \pi_M / \partial \beta^j \, \partial k$. Thus, (6) suggests a simple but useful principle. That is, the impact of buyer power on the investment in innovation depends on how buyer power (β^j) affects the supplier's *marginal* gains from the investment ($\partial \pi_M / \partial k$). To be more specific, buyer power weakens the supplier's incentives to innovate if and only if it reduces the marginal gains from the innovation. This suggests that even though

buyer power may lower the supplier's profits in many situations, this by itself does not mean that the supplier has a smaller incentive to invest in innovation. While this point is elementary to an economist, it is not always recognized or made clear in the policy discussions of buyer power.

More can be said about condition (6) for each of the three manifestations of buyer power. In the case where buyer power manifests itself through retailer *j*'s bargaining power (*i.e.*, $\partial\gamma^j/\partial\beta^j > 0$):

$$\frac{\partial k}{\partial \beta^j} = -\left[\frac{\partial^2 \pi_M/\partial\gamma^j\,\partial k}{\partial^2 \pi_M/\partial k^2}\right]\frac{\partial \gamma^j}{\partial \beta^j} = \frac{\partial\gamma^j/\partial\beta^j}{\partial^2\pi_M/\partial k^2}\left[\frac{\partial \Pi^j}{\partial k} - \frac{\partial \pi_M^{jd}}{\partial k} - \frac{\partial \pi_R^{jd}}{\partial k}\right]. \qquad (7)$$

Equation (7) implies that an increase in retailer *j*'s relative bargaining power reduces the supplier's investment in innovation if and only if the marginal increase in joint surplus from the investment is sufficiently large that $\partial\Pi^j/\partial k > \partial\pi_M^{jd}/\partial k + \partial\pi_R^{jd}/\partial k$. For example, if their bargaining positions are independent of the investment (*i.e.*, if $\partial\pi_M^{jd}/\partial k = \partial\pi_R^{jd}/\partial k = 0$), increased retailer bargaining power unambiguously reduces the investment in innovation. On the other hand, if the investment affects the disagreement payoffs in such a way that $\partial\pi_M^{jd}/\partial k + \partial\pi_R^{jd}/\partial k > \partial\Pi^j/\partial k$, the increase in retailer bargaining power strengthens the supplier's incentives to innovate. This latter case is particularly worth noting because $1-\gamma^j$ determines the supplier's share of net gains from the negotiation with retailer *j*, and one might have thought that an increase in γ^j should reduce both the total and the marginal gains from the investment in innovation.

In the case where buyer power strengthens a retailer's bargaining position (*i.e.*, $\partial\pi_R^{jd}/\partial\beta^j > 0$),

$$\frac{\partial k}{\partial \beta^j} = -\frac{\partial^2 \pi_M / \partial \beta^j \, \partial k}{\partial^2 \pi_M / \partial k^2} = \frac{\left(1-\gamma^j\right) \partial^2 \pi_R^{jd} / \partial \beta^j \, \partial k}{\partial^2 \pi_M / \partial k^2}. \qquad (8)$$

Equation (8) suggests that an increase in retailer *j*'s buyer power reduces the investment in innovation if and only if $\partial^2 \pi_R^{jd} / \partial \beta^j \, \partial k > 0$, *i.e.*, if and only if the buyer power enhances the marginal impact of the investment on the retailer's bargaining position. Similarly, if the buyer power weakens the supplier's bargaining position (*i.e.*, $\partial \pi_M^{jd} / \partial \beta^j < 0$),

$$\frac{\partial k}{\partial \beta^j} = -\frac{\partial^2 \pi_M / \partial \beta^j \, \partial k}{\partial^2 \pi_M / \partial k^2} = -\frac{\gamma^j \, \partial^2 \pi_M^{jd} / \partial \beta^j \, \partial k}{\partial^2 \pi_M / \partial k^2}. \qquad (9)$$

Equation (9) implies that an increase in retailer *j*'s buyer power reduces the investment in innovation if and only if $\partial^2 \pi_M^{jd} / \partial \beta^j \, \partial k < 0$. Since $\partial \pi_M^{jd} / \partial \beta^j < 0$, a negative sign of $\partial^2 \pi_M^{jd} / \partial \beta^j \, \partial k$ means that the buyer power magnifies the marginal impact of investment on the supplier's bargaining position (by making $\partial \pi_M^{jd} / \partial \beta^j$ more negative).

The preceding analysis begs the question: Can buyer power actually have such effects on the supplier's marginal gains of investment as contemplated above? Intuitively it seems likely that if buyer power reduces the supplier's gains from the investment, it will reduce its marginal gains as well. Are there plausible circumstances under which buyer power reduces the supplier's total gains yet raises its marginal gains from the investment in innovation?

To answer these questions, I will examine, in the next two sections, the three manifestations of buyer power in specific models of product innovation and process innovation. To highlight the link between these specific models and the general framework in this section, I present, in Table 2, a summary of the results from the analysis of the specific models. From the table it can be seen that an increase in buyer power can have a positive, negative, no effect on the supplier's

marginal gains from innovation.

3. Product Innovation

In this section, I construct a set of more elaborate models of buyer power for the case of product innovation. To be more specific, I consider a situation where the supplier manufactures *n* differentiated products and treat *n* as a measure of product innovation. Intuitively, it seems reasonable to postulate that more investment in product innovation would enable the supplier to launch more products into the market, and hence, a stronger incentive to engage in product innovation would lead to a larger *n*. Relating to the general framework in section 2, I have $k = n$ in this section.

3.1 Consumer Preferences and Welfare Measures

The preferences of a representative consumer in each market are represented by the Dixit-Stiglitz (1977) utility function $u = U\left(x_0, \{\sum_{i=1}^{n} x_i^{\rho}\}^{1/\rho}\right)$, where x_0 is the quantity of a numeraire good, x_i (*i* = 1, 2. ... *n*) is the quantity of differentiated product *i*, and $\rho < 1$. Let *y* denote the second argument in *U*. The utility function *U* is homothetic and concave in x_0 and y. Let p_i be the price of differentiated product *i*, and *I* be the representative consumer's income. The price of the numeraire good is normalized to be 1. Then the consumer's budget constraint is: $x_0 + \sum_{i=1}^{n} p_i x_i = I$. The first-order condition of the consumer's utility maximization problem is:

$$p_i \frac{\partial U}{\partial x_0} = x_i^{\rho-1} \frac{\partial U}{\partial y} \left\{ \sum\nolimits_{j=1}^{n} x_j^{\rho} \right\}^{1/\rho-1}, \qquad (i = 1, 2 \ldots . n). \qquad (10)$$

It has been derived by Dixit and Stiglitz (1977 p299) that when all differentiated products are sold at the same price *p*, the demand for product *i* solved from (10) can be written in the form

$$x_i = x(p,n) = \frac{Is(q)}{pn}, \qquad (11)$$

where $s(q)$ is a function that depends on the form of U, and q is a price index defined by $q = \left\{\sum_{i=1}^{n} p_i^{-\rho/(1-\rho)}\right\}^{-(1-\rho)/\rho} = pn^{-(1-\rho)/\rho}$. Since all of the n products are symmetric in the utility function, in equilibrium the supplier and retailers will treat them symmetrically. I will thus drop the subscript i in x_i and p_i.

Substituting (11) and the consumer's budget constraint into the utility function, I obtain a measure of consumer welfare:

$$V(p,I,n) = U\left[I - npx(p,n), n^{1/\rho}x(p,n)\right]. \qquad (12)$$

Using the envelope theorem, I can easily show that $\partial V/\partial p < 0$ and $\partial V/\partial I > 0$. Moreover,

$$\frac{\partial V}{\partial n} = \frac{px(1-\rho)}{\rho}\left(\frac{\partial U}{\partial x_0}\right) > 0. \qquad (13)$$

That is, consumers benefit from the supplier's investment in product innovation, *ceteris paribus*.

Assuming that profits are distributed evenly to the representative consumers in the m markets, I rewrite (12) to obtain a social welfare function:

$$W(p,n) = V\left(p, I_0 + \frac{\Pi_T}{m}, n\right) = U\left[I_0 + \frac{\Pi_T}{m} - npx(p,n), n^{1/\rho}x(p,n)\right], \qquad (14)$$

where Π_T is the joint profits of all firms and I_0 is the consumer's income from other sources. In (14), Π_T is divided by m because U is the utility of the representative consumer in one of the m markets.

Let $\theta(q)$ be the elasticity of the function $s(q)$, *i.e.*, $-qs'(q)/s(q)$. It is straightforward to show that the price elasticity of demand implied by (11), where all differentiated products are sold at the same price p, is equal to $(1 + \theta)$. Following Dixit and Stiglitz (1977), I assume

$$\theta(q) < \frac{\rho}{1-\rho} \qquad (15)$$

to ensure that the Chamberlinian dd curve is more elastic than the DD curve.[7] Conditions (11) and (15) imply that

$$\frac{\partial x(p,n)}{\partial n} = -\frac{Is[\theta(1-\rho)/\rho - 1]}{n^2 p} < 0, \qquad (16)$$

i.e., the demand for each product is smaller when the number of products increases.

On the production side, each differentiated product is manufactured at constant marginal cost c_M. Since this section is not concerned with process innovation, c_M is normalized to zero. Consistent with the notations in the general framework in section 2, let f denote the R&D costs of developing a product. Then the total costs of developing and producing *n* products are nf. The retail cost of selling a unit of any product is *c*.

With the use of non-linear contracts, the supplier and the retailers are able to maximize their joint quasi-rents from the sales of the *n* products. This implies the maximization of the quasi-rents in each retail market because the demand (and cost) in different markets is independent of each other. Thus, the retail price in market *h* (=1, 2.., *m*), p^h, solves

$$\Pi^{h*} = \max_{p^h} (p^h - c)\left[\frac{Is(q^h)}{p^h n}\right] n. \qquad (17)$$

The first-order condition for an interior solution implies the following standard monopoly pricing rule (with $1+\theta$ being the elasticity of demand):

$$\frac{p^h - c}{p^h} = \frac{1}{1 - q^h s'(q^h)/s(q^h)} = \frac{1}{1+\theta(q^h)}. \qquad (18)$$

[7] The dd curve is the demand curve for a product holding the prices of other products constant, while the DD curve is the demand curve for the product when the prices of all products change simultaneously (Chamberlin 1933).

In order to ensure that the first-order condition (18) and the second-order condition for this optimization problem are satisfied, assume that $\theta(q) > 0$ and $\theta'(q) > 0$, or equivalently, $s' < 0$ and $s'' < 0$.

Let $p^h(n)$ be the solution to (18). Comparative statics reveals that

$$\frac{\partial p^h}{\partial n} = \frac{p^h c\theta'[(1-\rho)/\rho]q^h}{np^h\theta^2 + nc\theta' q^h} > 0, \qquad (19)$$

which means that the equilibrium retail price rises with the number of products. Since consumer preferences are the same across the *m* markets, $p^h(n)$ and $q^h = p(n)n^{-(1-\rho)/\rho}$ are the same in all markets. From now on, I drop the superscript *h* on *p* and *q*. Accordingly, I rewrite (17) as:

$$\Pi^* = [p(n) - c]\left[\frac{Is(q(n))}{p(n)}\right]. \qquad (20)$$

It is easy to verify that

$$\frac{\partial \Pi^*}{\partial n} = -\frac{(p-c)(1-\rho)Is'}{\rho n^{1/\rho}} > 0, \qquad (21)$$

which says that an increase in the number of products raises the joint quasi-rents in each market.

Using $p(n)$, I can write the consumer welfare in (12) in the form $V(p(n), I, n)$. Then using (12), (13), and (19), I find the effect of a change in *n* on consumer welfare:

$$\frac{dV(p(n), I, n)}{dn} = \frac{\partial V}{\partial p}p'(n) + \frac{\partial V}{\partial n} = \frac{x(1-\rho)\theta^2}{\rho[p\theta^2 + (c+w)q\theta']}\frac{\partial U}{\partial x_0} > 0. \qquad (22)$$

That is, after taking into consideration of the rise in retail prices, consumer welfare still increases with the number of products.

In the remainder of section 3, I will study three specific models based on the framework developed above. In these models, retailer buyer power manifests itself through three different

channels, namely, the supplier's bargaining position, the retailer's relative bargaining power, and the retailer's bargaining position.

3.2. Supplier's Bargaining Position and Product Innovation

In the first specific model, a retailer's buyer power manifests itself through the supplier's bargaining position. Specifically, consider a situation where the success of a large retailer reduces the number of competing retailers in a geographic market, thus decreasing the number of retail channels available to the supplier. This, in turn, weakens the supplier's bargaining position in this market.

Specifically, I assume that each geographic market j is served by $\mu^j + 1$ retailers: one large retailer and μ^j fringe retailers. The large retailer possesses market power, but the fringe retailers do not. In other words, a fringe retailer is a price-taker both in its dealing with the supplier and in its operation in the retail market. To simplify presentation, suppose that each retailer sells in one market only; thus, $l = m$.

The fringe retailers in each market are reliable retail channels for the supplier in the sense that products are sold through these retailers independent of whether the supplier reaches an agreement with the large retailer in this market. In particular, the supplier would sell exclusively through the fringe retailers if it cannot reach an agreement with the large retailer. Accordingly, I assume that the disagreement point of the bargaining game in stage two is such that the supplier sells all of its products through the fringe retailers in this market while the large retailer makes no sales. The latter implies that the large retailer's disagreement payoff is 0. Since this specific model is not about bargaining power, I assume for simplicity that the relative bargaining power of each large retailer, γ^j, is equal to $1/2$.

Assume that each fringe retailer has the same marginal cost of retailing, *c*, as a large retailer. But a fringe retailer differs from a large retailer in that it faces a capacity (*e.g.*, shelf space) constraint. To be more specific, suppose that a fringe retailer can sell no more than *X* units of all products combined. When *n* products are sold at the same retail price, the fringe retailer will divide its *X* units of capacity evenly among the *n* products, selling *X*/*n* units of each product.

Since each fringe retailer is a price-taker in both the upstream and downstream markets, the supplier can extract all profits from the fringe retailers in a market by charging them a wholesale price equal to the difference between the equilibrium retail price and retail cost *c*. This implies that the combined quasi-rents of the supplier and the large retailer in market *j* are equal to Π^* as given by (20).

Note that if there are a sufficiently large number of fringe retailers in a market, the supplier would stop dealing with the large retailer and sell exclusively through the fringe retailers. To eliminate this possibility and ensure that the large retailer in each geographic market *j* sells a positive quantity in equilibrium, assume that $\mu^j X$ is relatively small so that the retail price of a good at the disagreement point would be higher than the joint-surplus maximizing price determined by (18). In other words, $p^{jd} > p(n)$, where p^{jd} denotes the retail price in market *j* in the event of a disagreement between the supplier and the large retailer.

The value of p^{jd} is determined by the market clearing condition

$$\frac{\mu^j X}{n} = x\left(p^{jd}, n\right) = \frac{Is\left(q^{jd}\right)}{p^{jd} n}. \qquad (23)$$

Comparative statics on (23) reveals that $\partial p^{jd}/\partial n > 0$ and $\partial p^{jd}/\partial \mu^j < 0$; in other words, an increase in the number of products raises, and an increase in the number of fringe retailers

reduces, the retail price at the disagreement point. Let π_M^{jd} denote the supplier's disagreement payoff in market *j*. Since there are μ^j fringe retailers and each fringe retailer has a capacity to sell *X* units, the supplier's payoff at the disagreement point is:

$$\pi_M^{jd} = \left(p^{jd} - c\right)\mu^j X. \qquad (24)$$

Differentiating (24) and using (23), I obtain

$$\frac{\partial \pi_M^{jd}}{\partial \mu^j} = X p^{jd}\left[\frac{p^{jd} - c}{p^{jd}} - \frac{1}{1 + \theta(q^{jd})}\right] > 0. \qquad (25)$$

The sign of (25) is determined with the aid of $p^{jd} > p(n)$, $\theta'(q) > 0$ and (18). It suggests that the supplier's bargaining position in a market is weaker if there are fewer fringe retailers in the market. Thus, if the large retailer can reduce the number of fringe retailers (through either acquisition or aggressive competition), it will weaken the supplier's bargaining position in this market. Relating to the general framework in section 2, here I have $\beta^j = -\mu^j$.

However, a reduction in the supplier's disagreement payoff does not necessarily mean that the supplier's marginal gains from producing an additional product will fall. That depends on the sign of

$$\frac{\partial^2 \pi_M^{jd}}{\partial \mu^j \partial n} = -\frac{X(1-\rho)p^{jd}\theta^{jd}}{2\rho n(1+\theta^{jd})^3}\left[\frac{s'' q^{jd}}{s'} + 1 - (\theta^{jd})^2\right], \qquad (26)$$

which can be either positive or negative depending on the sign of $s'' q^{jd}/s' + 1 - (\theta^{jd})^2$. This implies that a reduction in the number of fringe retailers can either strengthen or weaken the supplier's incentives to engage in product innovation. To be more specific,

Proposition 1:[8] An increase in the buyer power of the large retailer in market *j*, brought about by

[8] The proofs of this and all subsequent propositions are relegated to the appendix.

a reduction in the number of fringe retailers that weakens the supplier's bargaining position, raises the equilibrium number of products and retail prices in all markets if and only if $[\theta(q)]^2 < 1 + s''(q)q/s'(q)$.

Proposition 1 indicates that the effects of buyer power in this model depend on the demand condition, as given by the relative magnitudes of $[\theta(q)]^2$ and $1 + s''(q)q/s'(q)$. Recall that the price elasticity associated with the demand function (11) is 1+ $\theta(q)$. Hence, Proposition 1 implies that increased buyer power strengthens the supplier's incentive to invest in product innovation and hence raises the equilibrium number of products if the demand elasticity is not too large.

The intuition behind this demand elasticity condition can be understood using (24). Holding μ^j (the number of fringe retailers in market *j*) constant, a larger n increases the supplier's disagreement payoff, *i.e.*, $\partial\pi_M^{jd}/\partial n > 0$, because it raises the retail price p^{jd}. A fall in μ^j reduces the total number of units that the supplier can sell in market *j* in the event of a disagreement. This has two opposing effects on $\partial\pi_M^{jd}/\partial n$. On the one hand, it reduces the marginal impact of a larger n on the supplier's disagreement payoff as fewer units are sold. On the other hand, it raises the marginal benefit of a larger n by causing the price p^{jd} to rise further. The latter effect dominates if the demand elasticity is not too large.

Note from Proposition 1 that the prices in all geographic markets rise or fall in tandem even though the change in buyer power occurs in only one market and the demands are independent across the markets. This is because the same set of products is sold in all markets, and consequently a reduction in product diversity affects all markets.

The rich structure of the specific model also enables the analysis of welfare consequences of increased buyer power.

Proposition 2: An increase in the buyer power of the large retailer in market *j*, brought about by a reduction in the number of fringe retailers that weakens the supplier's bargaining position, improves consumer welfare if and only if $[\theta(q)]^2 < 1 + s''(q)q/s'(q)$. But it reduces the combined profits of all firms in either case. Consequently, its effect on social welfare is negative if $[\theta(q)]^2 > 1 + s''(q)q/s'(q)$ and is ambiguous otherwise.

Proposition 2 suggests that an increase in buyer power in this specific model raises consumer welfare if the demand elasticity is not too large. A comparison with Proposition 1 indicates the change in consumer welfare is in tandem with the change in the equilibrium number of products, with higher consumer welfare associated with a larger number of products. The latter is true despite the higher equilibrium prices.

It is interesting to note that an increase in buyer power in this specific model reduces the combined profits of all firms whether the demand elasticity is small or large. This arises because, as shown in the proof of Proposition 2 in Appendix, the same demand elasticity condition also determines the impact of n (the number of products) on the combined profits. Specifically, the combined profits of all firms increase (respectively, decrease) with the number of products if the demand elasticity is relatively large (respectively, small). As a result, the combined profits fall because of fewer products in the case where the demand elasticity is relatively large. In the case where the demand elasticity is relatively small, the combined profits still fall, this time because of more products.

3.3 Retailer's Bargaining Power and Product Innovation

In the second specific model, I study a situation where a retailer's buyer power manifests itself through its relative bargaining power. To do so, I abandon the assumption $\gamma^j = 1/2$ and, instead, allow γ^j to take on any value in the interval (0, 1). All other aspects of the model are the same as that in section 3.2. Recall, in particular, that the retailer's disagreement payoff is 0, *i.e.* $\pi_R^{jd} = 0$.

In this specific model, an improvement in large retailer *j*'s buyer power is represented by an exogenous increase in γ^j.[9] Using (7) from the general model and noting that, in this specific case, $\beta^j = \gamma^j$, $k = n$, $\Pi^j = \Pi^*$ and $\partial\pi_R^{jd}/\partial n = 0$, I obtain:

$$\frac{\partial n}{\partial \gamma^j} = -\frac{\partial^2 \pi_M/\partial\gamma^j \partial n}{\partial^2 \pi_M/\partial n^2} = -\frac{1}{\partial^2 \pi_M/\partial n^2}\left[\frac{\partial \pi_M^{jd}}{\partial n} - \frac{\partial \Pi^*}{\partial n}\right]. \qquad (27)$$

Note that $\partial^2\pi_M/\partial n^2 < 0$ by the second-order condition of the supplier's optimization problem. Then the sign of (27) is determined by the relative magnitudes of $\partial\Pi^*/\partial n$ and $\partial\pi_M^{jd}/\partial n$. The former is given by (21), and the latter can be derived from (24) using (23):

$$\frac{\partial \pi_M^{jd}}{\partial n} = -\frac{(1-\rho)\mu^j X p^{jd} I s'\left(q^{jd}\right)}{\rho n^{1/\rho}[\mu^j X - I s'(q^{jd}) n^{-(1-\rho)/\rho}]} > 0. \qquad (28)$$

It turns out that the relative magnitudes of these two derivatives depend on the elasticity of demand, as indicated in the following proposition.

Proposition 3: An increase in the bargaining power of the large retailer in market *j* raises the equilibrium number of products, retail prices and consumer welfare in all markets if and only if $[\theta(q)]^2 < 1 + s''(q)q/s'(q)$. Its effect on social welfare is negative if $[\theta(q)]^2 >$

[9] In section 5, I develop a theory of endogenous bargaining power that establishes a link between γ^j and the size of retailer *j*.

$1 + s''(q)q/s'(q)$ and is ambiguous otherwise.

Proposition 3 is surprising because γ^j determines how the gains from trade is divided between the supplier and retailer j. One might have thought that a larger γ^j should reduce the supplier's share of both the total gain of and the marginal gain of selling n products, thus unambiguously reducing the equilibrium number of products. The reason this intuition fails is that, as can be seen in (2) (with $\pi_R^{jd} = 0$), a larger γ^j reduces the supplier's share of Π^* (the joint quasi-rents from the sales in market j) but increases the influence of π_M^{jd} (the supplier's disagreement payoff in market j) on the supplier's payoff. Thus, the net effect of a larger γ^j on the supplier's payoff in market j is $\partial\pi_M^j/\partial\gamma^j = -\left(\Pi^* - \pi_M^{jd}\right) < 0$. Accordingly, in (27) the marginal impact of γ^j on the supplier's marginal gain of an additional product depends on the difference between $\partial\pi_M^{jd}/\partial n$ and $\partial\Pi^*/\partial n$. While a larger number of products raises both π_M^{jd} and Π^*, the supplier would want to increase the number of products in response to a larger γ^j as long as the rise in the former is faster than the increase in the latter, *i.e.*, $\partial\pi_M^{jd}/\partial n > \partial\Pi^*/\partial n$. This is indeed true when the demand elasticity is not too large.[10]

A comparison of Proposition 3 with Propositions 1 and 2 reveals that qualitatively an increase in the retailer's bargaining power has the same effects as a reduction in the number of fringe retailers. But the mechanism through which the buyer power affects product innovation is different. To be specific, consider the case where the elasticity of demand is large. If increased buyer power weakens the supplier's bargaining position, the supplier offers fewer products as a way to counteract the erosion of its bargaining position (see (25) and (26)). If the buyer power

[10] The demand elasticity plays a role here because it influences how high the price will rise and by how much the quasi-rents (Π^* and π_M^{jd}) will increase when n becomes larger.

manifests itself through stronger bargaining power on the part of the retailer, on the other hand, reducing the number of products actually lowers the supplier's disagreement payoff π_M^{jd} and thus weakens its bargaining position (see (28)). But it lowers the joint quasi-rents Π^* even more because $\partial\Pi^*/\partial n > \partial\pi_M^{jd}/\partial n$ when the demand elasticity is relatively large. By narrowing the difference $\Pi^* - \pi_M^{jd}$, the reduction in the number of products mitigates the impact of a larger γ^j on the supplier's payoff.

3.4 Retailer's Bargaining Position and Product Innovation

In the third specific model, buyer power manifests itself through the retailer's bargaining position. The model is based on the idea that it is easier for a large retailer to find an alternative source of supply than for a small retailer. For example, it may be more attractive for a chain store to develop and produce its own version (the store brand) of the supplier's products because it is able to spread the fixed costs of developing each product over a large number of markets.[11] The larger is the chain, the lower are the average fixed costs of developing a product.

To simplify the presentation, I consider a situation where one and only one of the l large retailers is a chain store that sells in multiple geographic markets. To be more specific, suppose that the chain store operates an outlet in each of λ ($< m$) geographic markets, while each of the remaining $m - \lambda$ markets is served by a single-outlet retailer. This implies $l = m - \lambda + 1$.

To keep the focus of the analysis on the chain store's bargaining position, I assume that there

[11] Galbraith (1952 p126) is among the early authors who discussed such a possibility: "The retail buyers have a variety of weapons at their disposal to use against the market power of their suppliers. Their ultimate sanction is to develop their own source of supply as the food chains, Sears, Roebuck and Montgomery Ward have extensively done." This idea has been analyzed by, among others, Inderst and Wey (2011). Differences between the present model and Inderst and Wey (2011) are discussed below.

are no fringe retailers so that the disagreement payoff of the supplier is 0.[12] Since the interest here is not in retailers' bargaining power, I assume that $\gamma^j = 1/2$ for all large retailers.

Let f_R denote the fixed costs of developing a product by a retailer. Suppose that $f_R \geq f$; that is, the retailer is no more efficient than the supplier at developing a product. Moreover, because the store brand produced by the retailer is only an imitation of the supplier's products, I assume that at the same *p* and *n*, the demand for the imitation is lower than that for the supplier's original product. With reference to (11), I write the demand for the retailer's imitation product as

$$z_i = \frac{\alpha I s(q)}{pn}, \qquad (29)$$

where $0 < \alpha < 1$. Therefore, holding everything else constant, the retailer prefers purchasing from the supplier over producing its own store brand. The store brand, then, is only used as a threat point in the chain store's negotiation with the supplier.

Therefore, the disagreement point in the bargaining game between the chain store and the supplier is one where the retailer would produce and sell its store brand and the supplier would make no sales in these λ markets. The disagreement payoff of the chain store is

$$\pi_R^{Cd} = max_p \left[\lambda(p-c)\frac{\alpha I s(q)}{pn} - f_R\right] n, \qquad (30)$$

while that of the supplier is 0. It is easy to see that π_R^{Cd} is increasing in λ. I focus on the case where λ is large enough that $\pi_R^{Cd} > 0$.[13] On the other hand, suppose $\pi_R^{Cd} < 0$ at λ = 1, so that it is not profitable for a single-store retailer to launch its store brand.

Accordingly, an increase in the size of the chain store (as measured by λ) strengthens the

[12] The results would be the same if I assume that there are μ fringe retailers in each market.

[13] If $\pi_R^{Cd} < 0$, it is not in the interest of the chain store to develop the store brand. The disagreement point then becomes (0, 0), in which case a marginal increase in the size of the chain store would have no impact on the retailer's bargaining position.

retailer's bargaining position. Moreover,

$$\frac{\partial^2 \pi_R^{Cd}}{\partial n \partial \lambda} = -\frac{\alpha(1-\rho)(p-c)Is'}{\rho n^{1/\rho}} > 0. \qquad (31)$$

In other words, an increase in the number of differentiated products magnifies the strengthening of the chain store's bargaining position brought about by its larger size. The general theory in section 2 then suggests that an increase in the size of the retailer will reduce the supplier's incentive to engage in product innovation. Indeed,

Proposition 4: An improvement in the bargaining position of the chain store, brought about by its larger size, reduces the equilibrium number of products and retail prices in all markets. As a result, the combined profits of all firms, the consumer welfare and social welfare fall in all markets.

Intuitively, the underlying reason for the sign of (31) and Proposition 4 is that the consumers value product diversity. Accordingly, a larger number of products would enable the chain store to earn more quasi-rents from its store brand in each of the markets it serves in the event of a disagreement.[14] This, in turn, would magnify the increase in the chain store's disagreement payoff as it grows larger. Thus, to counteract the strengthening of the chain store's bargaining position arising from its larger size, the supplier has to offer fewer products.

The welfare result in Proposition 4 is somewhat surprising because one would normally have expected that a change that lowers the prices and reduces the combined profits of all firms should benefit consumers. In this model, however, the more significant factor is the reduction in the number of products. The effects of this reduced product diversity dominate those of lower

[14] Only the quasi-rents matter in (31) because the fixed costs of developing the store brand, nf_R, are independent of λ.

prices. Consequently, consumers lose. Social welfare is also lower because both consumer welfare and total profits are down.

This specific model builds on the same idea as Inderst and Wey (2011) that the large retailer has the option of developing its own source of supply. The main difference between these two models is that the present model is about product innovation rather than process innovation. Through product innovation, the supplier is able to influence the large retailer's revenues from the alternative source of supply in the event of disagreement. This channel of influence does not exist in the process innovation studied by Inderst and Wey (2011). Instead, the supplier in their model affects the large retailer's profits from the alternative source of supply through the retailer's rivals: A lower marginal cost achieved through the supplier's process innovation makes these rivals more competitive, thus reducing the large retailer's profits from the alternative supply option.

Another important difference from Inderst and Wey (2011) is that consumer preferences are explicitly modelled in the present analysis.[15] This enables the examination of the welfare consequences of increased buyer power.

4. Process Innovation

In this section, I investigate the supplier's incentives to engage in process innovation. To be more specific, let $C_M(t)$ denote the supplier's marginal cost of production, where t is the amount of investment in process innovation. The investment reduces the cost, *i.e.*, $C_M'(t) < 0$. I assume $C_M''(t)$ is positive and is sufficiently large that the second-order condition associated with the

[15] A technical difference between these two models is that in the present model, the option of an alternative source of supply affects the disagreement point. Thus, the alternative source of supply is effectively treated as an inside option (see, for example, Muthoo 1999). In Inderst and Wey (2011), on the other hand, it is modelled as an outside option.

choice of t is satisfied. This assumption implies that the investment in process innovation is subject to significant diminishing returns. Since the focus here is on process innovation, I take the number of differentiated goods manufactured by the supplier as exogenously fixed. All remaining aspects of the model are the same as in section 3.1.

Given that the number of differentiated goods is fixed, I can simplify the presentation greatly by expressing the differentiated goods in terms of the composite good $y \equiv \left\{\sum_{i=1}^{n} x_i^{\rho}\right\}^{1/\rho}$ and its price index $q \equiv \left\{\sum_{i=1}^{n} p_i^{-\rho/(1-\rho)}\right\}^{-(1-\rho)/\rho}$. Define $S(q) = s(q)/q$. Then using (11) and the definitions of y and q, I can write the demand for y as: $y = IS(q)$. The assumption $s'(q) < 0$ implies that $S'(q) < 0$. Suppose that the marginal cost of production $C_M(t)$ is expressed in units of y. Let C denote the retail cost of selling one unit of y.

Given that non-linear contracts are used, the supplier and each large retailer are able to maximize the joint quasi-rents in a geographic market:

$$\widetilde{\Pi}^* = max_q(q - C_M - C)IS(q). \qquad (32)$$

The first-order condition to (32) is:

$$(q - C_M - C)IS'(q) + IS(q) = 0\,. \qquad (33)$$

It is easy to verify that the value of q determined by (33) rises with C_M.

Using this framework of process innovation, I examine the impact of buyer power on the supplier's incentive to innovate in the same way as in section 3. Specifically, I study the same three channels of buyer power: the supplier's bargaining position, the retailer's relative bargaining power, and the retailer's bargaining position.

4.1 Supplier's Bargaining Position and Process Innovation

Reconsider the model in section 3.2, and let Y denote the capacity of a fringe retailer in units of y. In the event of failure to reach an agreement with retailer j, the supplier would sell its products through the fringe retailers in market j, at price q^{jd} as determined in $IS(q^{jd}) = \mu^j Y$. It is easy to verify that q^{jd} decreases with μ^j. Note that q^{jd} is independent of the supplier's marginal cost C_M. The supplier's bargaining position is represented by

$$\tilde{\pi}_M^{jd} = \mu^j Y\left(q^{jd} - C_M - C\right). \qquad (34)$$

It can be seen from (34) that a reduction in the supplier's marginal cost (C_M) improves its bargaining position. Furthermore, since

$$\frac{\partial^2 \tilde{\pi}_M^{jd}}{\partial \mu^j \partial t} = \frac{\partial^2 \tilde{\pi}_M^{jd}}{\partial \mu^j \partial C_M} C_M'(t) = -Y C_M'(t) > 0, \qquad (35)$$

a reduction in the number of fringe retailers decreases the marginal effect of investment in process innovation on the supplier's bargaining position.

Proposition 5: An increase in the buyer power of the large retailer in market j, brought about by a reduction in the number of fringe retailers that weakens the supplier's bargaining position, causes the supplier to decrease its investment in process innovation. Both consumer welfare and social welfare are lower as a result.

Given the fixed capacity of each fringe retailer, a fall in their number in a market reduces the number of units that the supplier is able to sell through the fringe retailers. This, in turn, decreases the amount of cost savings that the supplier can reap in the event that it fails to reach an agreement with the large retailer in this market. This, it reduces the supplier's marginal benefit from the investment in process innovation.

A comparison of Proposition 5 with Propositions 1 and 2 demonstrates that increased buyer power arising from the same source (here a weakening of the supplier's bargaining position) can have different effects for different types of innovation. In the case of product innovation, increased buyer power may increase or decrease the number of products depending on the demand elasticity. But it unambiguously reduces the investment in process innovation.

4.2 Retailer's Bargaining Power and Process Innovation

Now suppose retailer *j*'s bargaining power γ^j can take on any value in the interval (0, 1), and consider the effects of an increase in γ^j in the model of process innovation. Applying (7) in the general framework to the present model, I find that the effects of γ^j depends on the sign of

$$\frac{\partial \widetilde{\Pi}^*}{\partial t} - \frac{\partial \tilde{\pi}_M^{jd}}{\partial t} = -IS(q)C_M'(t) - \left[-\mu^j Y C_M'(t)\right] = \left[IS\left(q^{jd}\right) - IS(q)\right]C_M'(t). \quad (36)$$

It turns out that the sign of (36) is positive because $C_M'(t) < 0$ and $IS\left(q^{jd}\right) < IS(q)$ (the quantity sold through the fringe retailers in market *j* in the event of disagreement is less than that sold through both the fringe retailers and the large retailer *j* in equilibrium). This implies that the supplier's marginal gains from an additional unit of investment in process innovation are smaller when retailer *j* has stronger bargaining power. As a result,

Proposition 6: An increase in the bargaining power of a large retailer causes the supplier to decrease its investment in process innovation. Both consumer welfare and social welfare are lower as a result.

When buyer power manifests itself through the retailer's bargaining power, the supplier's incentive to invest in process innovation depends on the difference between $\partial \widetilde{\Pi}^* / \partial t$ and

$\partial\tilde{\pi}_M^{jd}/\partial t$. The former is larger than the latter because more units are sold and hence an additional unit of investment generates a larger cost saving at the equilibrium point than at the disagreement point.

4.3 Retailer's Bargaining Position and Process Innovation

Suppose that, as in section 3.4, a chain store has the option of offering its store brand, whose demand is given by (29). Let C_R be the chain store's marginal cost of production in units of y. Then the chain store's disagreement payoff can be written as:

$$\tilde{\pi}_R^{Cd} = max_q[\lambda(q - C_R - C)\alpha IS(q) - nf_R]. \qquad (37)$$

From (37), it is clear that $\partial\tilde{\pi}_R^{Cd}/\partial\lambda > 0$. Note, however, a reduction in the marginal cost of the supplier has no impact on the chain store's disagreement payoff. Thus, while an increase in the number of stores operated by the retailer improves its bargaining position and allows it to reap a larger profit in equilibrium, the supplier is not able to influence the retailer's bargaining position through its investment in process innovation. Therefore,

Proposition 7: An improvement in the bargaining position of the chain store, brought about by its larger size, has no impact on the supplier's incentives to engage in process innovation.

This result is obviously different from that in the case of product innovation. The difference arises from that the supplier is able to influence the chain store's bargaining position through product innovation, but not through process innovation.

One way to create a link between the chain store's bargaining position and the supplier's investment in process innovation is by introducing competition into the downstream market. A lower marginal cost would enable the supplier to sell its products to the chain store's competitors at lower prices. This may allow the supplier to reduce the chain store's disagreement payoff.

Indeed, that is the type of situations examined in Inderst and Wey (2011).

Interestingly, the incorporation of fringe retailers with fixed capacity into the present model would not change the result in Proposition 7. Given that these fringe retailers have fixed capacity, the chain store's bargaining position is still unaffected by the supplier's investment in process innovation because a lower cost of production does not change the total quantity supplied by the fringe retailers in a market. On the other hand, while the supplier's bargaining position is strengthened by more investment in process innovation, it is not affected by the size of the chain store. As a result, the supplier's investment in process innovation would still be independent of the retailer's size.

The preceding discussion suggests that the finding in Inderst and Wey (2011) that buyer power stimulates investment in process innovation depends on the assumption that the competitors of the strong retailer have elastic supply curves. If their supply is perfectly inelastic, an increase in buyer power would have no effect on the supplier's incentive to invest in process innovation.

5. Extension: Endogenous Bargaining Power

The analysis in the preceding two sections assumes that relative bargaining power of each large retailer (*i.e.*, γ^j) is exogenously given. It is natural to ask, where does the bargaining power of a large retailer come from? In the literature, however, there has been no formal argument for how the size of a retailer would affect its bargaining power (Inderst and Wey 2011 p708). Below I fill this gap by proposing a theory to show that the buyer power conferred by the retailer's size can manifest itself through its bargaining power.

The idea behind the theory is that a firm's bargaining power is a function of the quality of its

negotiators in terms of their negotiation skills, knowledge and experience. A firm can spend money to enhance the quality of its negotiation team. For example, it can hire better negotiators or provide more training to the employees assigned to the negotiation team.[16] If the marginal return from the enhanced bargaining power (relative to that of the supplier) is higher as a retailer becomes larger, it will want to spend more money on improving the quality of its negotiation team.

To develop this theory, I extend the model in section 3.3 by endogenizing the relative bargaining power of each large retailer *j*. Recall that in this model retailer *j* faces competition from μ^j fringe retailers and each fringe retailer has a fixed capacity. This implies that a fall in the number of fringe retailers μ^j expands the residual demand facing the large retailer and enables it to sell a larger quantity in equilibrium. Thus, the size of retailer *j*, measured by the quantity it sells, is inversely related to μ^j. To complete the theory, I need to establish a link between the number of fringe retailers in market *j* and retailer *j*'s bargaining power.

Specifically, suppose that retailer *j* and the supplier would have equal bargaining power, *i.e.*, $\gamma^j = 1/2$, if neither firm spend any additional resources on its negotiation team. Moreover, each firm can attempt to enhance its bargaining power by investing in the quality of its negotiators. Let b_R^j (respectively, b_M) denote the amount of money spent by retailer *j* (respectively, the supplier) on its negotiation team. The equilibrium value of γ^j is determined by the relative

[16] In his discussion of retailer power, Galbraith (1952 p127) pointed out that large retailers at the time (such as the A&P and Sears, Roebuck) attached great importance to their "buyers", those employees who were in charge of purchasing goods from the suppliers. "A measure of the importance which large retailing organizations attach to the deployment of their countervailing power is the prestige they accord to their buyers. These men (and women) are the key employees of the modern large retail organization; they are highly paid and they are among the most intelligent and resourceful people to be found anywhere in business."

qualities of the negotiation teams as follows:

$$\gamma^j = \frac{1}{2} + \delta\left(b_R^j\right) - \delta\left(b_M\right), \qquad (38)$$

where $\delta(b)$ represents the additional advantage a firm can gain in tipping the balance of bargaining power in its own favour via an investment of b. To simplify analysis, I assume that this function takes the form,

$$\delta(b) = \delta_0 b - \frac{1}{2}\delta_1 b^2 \quad (\delta_0 > 0, \delta_1 > 0). \qquad (39)$$

It implies that the investment in the quality of negotiators is subject to diminishing returns.

I now modify stage 2 of the general model by assuming that this stage begins with the supplier and the large retailers choosing, simultaneously, the quality of their negotiation teams. Then the negotiation team of the supplier conducts bargaining, sequentially, with the negotiation team of each retailer. The outcome of the bargaining process is determined by the generalized Nash bargaining solution, with the equilibrium value of γ^j determined by (38).

Next, I solve the equilibrium in this modified stage 2 to find the relationship between γ^j and μ^j. Using (2) and (38) and recalling $\pi_R^{jd} = 0$, I write the supplier's optimization problem with regard to b_M as:

$$max_{b_M}\, \pi_M = \sum_{i=1}^{m}\left[1 - \left(\frac{1}{2} + \delta\left(b_R^i\right) - \delta\left(b_M\right)\right)\right]\Pi^* + \sum_{i=1}^{m}\left(\frac{1}{2} + \delta\left(b_R^i\right) - \delta\left(b_M\right)\right)\pi_M^{id} - b_M - nf. \quad (40)$$

Using (39), I solve (40) to find:

$$b_M = \frac{\delta_0}{\delta_1} - \frac{1}{\delta_1\left(m\Pi^* - \sum_{i=1}^{m}\pi_M^{id}\right)}. \qquad (41)$$

Similarly, I use (3) and (38) to write retailer j's optimization problem regarding b_R^j as:

$$max_{b_R^j}\, \pi_R^j = \left(\frac{1}{2} + \delta\left(b_R^j\right) - \delta(b_M)\right)\Pi^* - \left(\frac{1}{2} + \delta\left(b_R^j\right) - \delta(b_M)\right)\pi_M^{jd} - b_R^j. \qquad (42)$$

The solution to (42) is:

$$b_R^j = \frac{\delta_0}{\delta_1} - \frac{1}{\delta_1\left(\Pi^* - \pi_M^{jd}\right)}. \qquad (43)$$

Keep in mind that in (41) and (43), the number of fringe retailers μ^j affects a firm's spending on its negotiation team through π_M^{jd}. Conducting comparative statics using (38), (39), (41) and (43), I find

$$\frac{\partial \gamma^j}{\partial \mu^j} = \frac{\partial \pi_M^{jd}/\partial \mu^j}{\delta_1}\left(\frac{1}{(m\Pi^* - \sum_{i=1}^m \pi_M^{id})^3} - \frac{1}{\left(\Pi^* - \pi_M^{jd}\right)^3}\right) < 0. \qquad (44)$$

The sign of (44) is determined by observing that $\partial \pi_M^{jd}/\partial \mu^j > 0$ and $\Pi^* > \pi_M^{id}$ in every market. It suggests that a reduction in the number of fringe retailers in market *j* indeed enhances retailer *j*'s bargaining power. Intuitively, (41) and (43) imply that the reduction in μ^j, which decreases π_M^{jd}, prompts both the supplier and retailer *j* to spend more money on its negotiation team. But this effect is stronger for retailer *j* than for the supplier, leading to the strengthening of the retailer's bargaining power. This demonstrates that the buyer power conferred by a retailer's size can indeed manifest itself through the retailer's relative bargaining power.

This extended model also illustrates how a particular source of buyer power can manifest itself through multiple channels. By now we have seen that a reduction in the number of fringe retailers strengthens the large retailer's buyer power through two channels: the supplier's bargaining position (π_M^{jd}) and the retailer's relative bargaining power (γ^j). Propositions 1 and 3 imply that the buyer power manifested through these two channels reinforce each other, both

strengthening the supplier's incentive to invest in product innovation if and only if $[\theta(q)]^2 < 1 + s''(q)q/s'(q)$.

A careful examination of the supplier's optimization problem regarding *n* reveals that there is a third channel. It works indirectly through the large retailer's spending on the quality of their negotiators. To see this, consider the supplier's choice of *n* in stage 1, where it maximizes the profits given in (40), taking into consideration (41) and (43). Using the envelope theorem and noting that Π^* is a function of *n*, I obtain the following first-order condition:

$$\frac{\partial \Pi^*}{\partial n} \sum_{i=1}^{m} \left[1 - \left(\frac{1}{2} + \delta\left(b_R^i\right) - \delta(b_M)\right)\right] + \sum_{i=1}^{m} \left(\frac{1}{2} + \delta\left(b_R^i\right) - \delta(b_M)\right) \frac{\partial \pi_M^{id}}{\partial n}$$

$$- \sum_{i=1}^{m} \left(\Pi^* - \pi_M^{id}\right)\left(\delta_0 - \delta_1 b_R^i\right) \frac{\partial b_R^i}{\partial n} \quad = f. \qquad (45)$$

Parameter μ^j affects each of the three terms on the left-hand side of (45). The effects of μ^j on $1/2 + \delta\left(b_R^j\right) - \delta(b_M)$ (*i.e.*, γ^j) in the first and the second term represent the channel through the retailer's bargaining power. Its effect on $\partial \pi_M^{jd}/\partial n$ in the second term reflects the channel through the supplier's bargaining position. The third term in (45) represents the indirect effect of *n* on the supplier's profit through each larger retailer's spending on its negotiation team, as captured by $\partial b_R^i/\partial n$. It can be shown that the effect of μ^j through this third channel would go in the same direction as the other two channels if the sign of $\partial^2 b_R^j/\partial \mu^j \partial n$ is the opposite to $\partial^2 \pi_M^{jd}/\partial \mu^j \partial n$.

Finally, it should be pointed out that the results from the analysis of this extended model are robust to extensions of other specific models presented in sections 3 and 4. In particular, I have

studied an extension to the chain store model in section 3.4, and I can show that an increase in the number of stores in the chain causes the chain store to boost its spending, and the supplier to *reduce* its spending, on their respective negotiation teams. Both factors strengthen the retailer's bargaining power.[17]

6. Conclusions

In this paper, I have constructed a theoretical framework to study the impact of buyer power on the supplier's incentives to innovate. Subsumed in the general framework are two sets of specific models: one on product innovation and the other on process innovation. Through the analysis of these models, I have found that the effects of buyer power on innovation depend on the type of innovation, the source of buyer power, and the channel through which the buyer power manifests itself. For example, while the buyer power resulted from a reduction in retail channels weakens the supplier's incentives to innovate and reduces welfare in the case of process innovation, its effects in the case of product innovation can go either way depending on the property of the demand function. In particular, it enhances the incentive to invest in product innovation and improves consumer welfare if the demand elasticity is not large. However, the supplier's incentive to engage in product innovation is weakened if the increased buyer power comes from the larger size of a chain store that improves the latter's bargaining position. The analysis of the specific models has revealed a number of mechanisms through buyer power affects supplier innovation and welfare.

[17] Details of this extension are not presented here because of space constraint. But they are available upon request.

References

Battigalli, P. C. Fumagalli, and M. Polo (2007) "Buyer Power and Quality Improvement," *Research in Economics*, 61, 45-61

Chamberlin, E.H. (1933) *The Theory of Monopolistic Competition*, Cambridge. MA: Harvard University Press

Che, Y. and J. Sákovics (2004) "A Dynamic Theory of Holdup," *Econometrica*, 72: 1063-1103

Chen, Z. (2003) "Dominant Retailers and the Countervailing Power Hypothesis," *RAND Journal of Economics*, vol. 34, No. 4, 612-625

Chen, Z. (2004) "Monopoly and Product Diversity: The Role of Retailer Countervailing Power," Carleton Economic Papers, 04-19

Dixit, A.K. and J.E. Stiglitz (1977) "Monopolistic Competition and Optimum Product Diversity," *American Economic Review*, 67: 297-308

Dobson, P.W. and R. Chakraborty (2008) "Buyer Power in the U.K. Groceries Market," *Antitrust Bulletin*, 53: 333-365

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

Dobson, P.W. and M. Waterson (1999) "Retailer Power: Recent Developments and Policy Implications," *Economic Policy*, 28: 133-164

Dukes, A.J., E. Gal-Or and K. Srinivasan (2006) "Channel Bargaining with Retailer Asymmetry," *Journal of Marketing Research*, 43: 84-97

European Commission (1999) "Buyer Power and Its Impact on Competition in the Food Retail Distribution Sector of the European Union," Study Contract No. IV/98/ETD/078, Brussels

FTC (2001) "Report on the Federal Trade Commission Workshop on Slotting Allowances and Other Marketing Practices in the Grocery Industry," A Report by Federal Trade Commission Staff (February 2001), Washington DC

Galbraith, J.K. (1952) *American Capitalism: The Concept of Countervailing Power*, New York: 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

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

Inderst, R. and T.M. Valletti (2011) "Buyer Power and the 'Waterbed Effect'," *Journal of Industrial Economics*, 59: 1-20

Inderst, R. and C. Wey (2007) "Buyer Power and Supplier Incentives," *European Economic Review*, 51: 647-667

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

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

OECD (1999) "Buying Power of Multiproduct Retailers," DAFFE/CLP(99)21, Paris

OECD (2008) "Monopsony and Buyer Power," DAF/COMP(2008)38, Paris

Montez, João V. (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

Vance, S.S. and R.V. Scott (1994) *Wal-Mart: A History of Sam Walton's Retail Phenomenon*, New York: Twayne Publishers

von Ungern-Sternberg, T. (1996) "Countervailing Power Revisited," *International Journal of Industrial Organization*, 14: 507-20

Appendix

Proof of Propositions

Proof of Proposition 1: Using (2), (20) and (24) and setting $\gamma^j = 1/2$, I write the supplier's optimization problem in stage 1 as,

$$max_n \pi_M = \sum_{j=1}^{m} \frac{\Pi^* + \pi_M^{jd}}{2} - nf = \sum_{j=1}^{m} \frac{1}{2}\left[[p(n) - c]\frac{Is\big(q(n)\big)}{p(n)} + \big[p^{jd}\big(n, \mu^j\big) - c\big]\mu^j X\right] - nf. \quad (A1)$$

The first-order condition of the supplier's optimization problem (A1) is:

$$-\frac{[p(n) - c]Is'\big(q(n)\big)(1-\rho)}{2\rho n^{1/\rho}} + \frac{X}{2}\sum\nolimits_{j=1}^{m} \mu^j \frac{\partial p^{jd}}{\partial n} = f. \qquad (A2)$$

Comparative statics on (A2) reveals:

$$\frac{\partial n}{\partial \mu^j} = \frac{X(1-\rho)p^{jd}\theta(q^{jd})}{2\rho n[1+\theta(q^{jd})]^3\left[\partial^2\pi_M/\partial n^2\right]}\left[1 + \frac{s''(q^{jd})q^{jd}}{s'(q^{jd})} - \left[\theta(q^{jd})\right]^2\right], \qquad (A3)$$

which is negative if and only if $[\theta(q)]^2 < 1 + s''(q)q/s'(q)$ at $q = q^{jd}$. The impact on retailer prices follows from (19). QED

Proof of Proposition 2: Consumer welfare changes in the same direction as *n* because $\partial V/\partial \mu^j = [dV(p(n), I, n))/dn]\ (\partial n/\partial \mu^j\ )$ has the same sign as $\partial n/\partial \mu^j$. (Keep in mind that an increase in retailer's *j* buyer power is measured by a reduction in μ^j).

The combined profits of all firms is $\Pi_T = m\Pi^* - nf$. Using (21) and (A2), I find:

$$\frac{\partial \Pi_T}{\partial n} = \frac{(1-\rho)I}{2\rho n}\sum\nolimits_{j=1}^{m}\left[\frac{\theta(q)s(q)}{1+\theta(q)} - \frac{\theta(q^{jd})s(q^{jd})}{1+\theta(q^{jd})}\right]. \qquad (A4)$$

The assumption of small $\mu^j X$ implies that $q < q^{jd}$. It can be verified that $\theta(q)\, s(q)/[1+\theta(q)]$ is increasing (respectively, decreasing) in q if $[\theta(q)]^2$ is less than (respectively, greater than)

$1 + s''(q)q/s'(q)$. Therefore, $\partial\Pi_T/\partial n < 0$ if and only if $[\theta(q)]^2 < 1 + s''(q)q/s'(q)$. Combining (A3) and (A4), I conclude that $\partial\Pi_T/\partial\mu^j = (\partial\Pi_T/\partial n)\left(\partial n/\partial\mu^j\right) > 0$ as long as $1 + s''(q)q/s'(q) - [\theta(q)]^2$ maintains the same sign for q in the relevant range. The change in total welfare is determined by

$$\frac{\partial W}{\partial\mu^j} = \frac{dW}{dn}\frac{\partial n}{\partial\mu^j} = \left(\frac{dV}{dn} + \frac{1}{m}\frac{\partial V}{\partial I}\frac{\partial\Pi_T}{\partial n}\right)\frac{\partial n}{\partial\mu^j}, \qquad (A5)$$

which has a positive sign if $[\theta(q)]^2 > 1 + s''(q)q/s'(q)$, but has an ambiguous sign otherwise. QED

Proof of Proposition 3: Using (18) to rewrite (21) and (23) to rewrite (28), I obtain:

$$\frac{\partial\Pi^*}{\partial n} - \frac{\partial\pi_M^{jd}}{\partial n} = \frac{(1-\rho)I}{\rho n}\left[\frac{\theta(q)s(q)}{1+\theta(q)} - \frac{\theta(q^{jd})s(q^{jd})}{1+\theta(q^{jd})}\right]. \qquad (A6)$$

The discussions after (A4) imply that the sign of (A6) is negative if and only if $[\theta(q)]^2 < 1 + s''(q)q/s'(q)$. Then (27) implies that $\partial n/\partial\gamma^j > 0$ under the same condition. The proof of the remaining results in this proposition is the same as that of Proposition 2. QED

Proof of Proposition 4: Using (2) and (20) and setting $\gamma^j = 1/2$, I obtain the Nash bargaining solution for the supplier:

$$\pi_M^C = \frac{1}{2}\left[\frac{\lambda(p-c)Is(q)}{p} - \pi_R^{Cd}\right]. \qquad (A7)$$

Since a single-store retailer does not find it profitable to offer a store brand, the Nash bargaining solution for such a retailer and the supplier is $\Pi^*/2$ for each. Using (20), (30) and (A7), I write the supplier's total profits from *m* markets as

$$max_n\pi_M = \pi_M^C + (m-\lambda)\left(\frac{\Pi^*}{2}\right) - nf = \frac{1}{2}\left[(m-\lambda\alpha)[p(n)-c]\frac{Is\left(q(n)\right)}{p(n)} + nf_R\right] - nf. \quad (A8)$$

The first-order condition of (A8) implies

$$-(m-\alpha\lambda)(p-c)\left(\frac{1-\rho}{\rho n^{1/\rho}}\right)Is' + f_R - 2f = 0. \quad (A9)$$

Conducting comparative statics on (A9), I find $\partial n/\partial\lambda < 0$. Using the same procedure as in the proof of Propositions 1 and 2, I conclude that $\partial p/\partial\lambda < 0$ and $\partial V(p(n), I, n)/\partial\lambda < 0$. Totally differentiating the combined profits, $\Pi_T = m\Pi^* - nf$, with respect to *n* and using (A9), I obtain:

$$\frac{\partial \Pi_T}{\partial\lambda} = -\alpha\lambda(p-c)\left(\frac{1-\rho}{\rho n^{1/\rho}}\right)Is'\frac{\partial n}{\partial\lambda} < 0. \quad (A10)$$

Then using (14), I can show $\partial W/\partial\lambda < 0$. QED

Proof of Proposition 5: Using (32) and (33), I express the supplier's optimization problem as:

$$max_t\ \tilde{\pi}_M = \frac{1}{2}\sum_{j=1}^{m}(\tilde{\Pi}^* + \tilde{\pi}_M^{jd}) - t = \frac{1}{2}\sum_{j=1}^{m}\left[(q - C_M - C)IS(q) + \mu^j Y\left(q^{jd} - C_M - C\right)\right] - t. \quad (A11)$$

With the aid of the envelope theory, the first-order condition of the supplier's optimization problem (A11) can be written as:

$$-\frac{1}{2}\sum_{j=1}^{m}(IS + \mu^j Y)C_M' = 1. \quad (A12)$$

Comparative statics on (A12) yields:

$$\frac{\partial t}{\partial \mu^j} = \frac{YC_M'}{2\partial^2\tilde{\pi}_M/\partial t^2} > 0. \quad (A13)$$

Consumer welfare in a market is measured by $V(q, I) = U(I - qIS(q), IS(q))$. Using the envelope theorem, I derive

$$\frac{\partial V}{\partial t} = \frac{\partial V}{\partial q}\frac{\partial q}{\partial C_M}C_M'(t) = -\frac{\partial U}{\partial x_0}\frac{ISS'C_M'(t)}{(q - C_M - C)S'' + 2S'} > 0. \quad (A14)$$

Total welfare in a market is obtained by setting $I = I_0 + (m\Pi^* - t)/m$ in $V(q, I)$. Using (A12)

and (A14), I obtain:

$$\frac{\partial W}{\partial t} = C_M'(t)\frac{\partial U}{\partial x_0}\left[\frac{ISS'}{(q - C_M - C)S'' + 2S'} + \frac{mIS - \sum_{i=1}^{m}\mu^i Y}{2m}\right] > 0. \quad (A15)$$

The second term in the square brackets of (A15) is positive because $IS(q) > \mu^i Y$ in every market. From (A13)–(A15), I conclude $\partial V/\partial\mu^j > 0$ and $\partial W/\partial\mu^j > 0$. QED

Proof of Proposition 6: From (7) and (36), I conclude that $\partial t/\partial\gamma^j < 0$. The results on consumer and social welfare are proved in the same way as in the proof of Proposition 5. QED

Proof of Proposition 7: From (37), I find $\partial^2\tilde{\pi}_R^{Cd}/\partial t\partial\lambda = 0$. Then (8) implies that λ has no impact of the supplier's choice of *t*. QED

Tables

Table 1: Impact of Increased Buyer Power on Incentives to Innovate

Channel of Buyer Power / Type of Innovation	Supplier's Bargaining Position	Retailer's Bargaining Power	Retailer's Bargaining Position
Product Innovation	Positive if demand elasticity is not too large	Positive if demand elasticity is not too large	Negative
Process Innovation	Negative	Negative	No Impact

Table 2. Impact of Increased Buyer Power on Supplier's Marginal Gains from Innovation

Channel of Buyer Power / Type of Innovation	Supplier's Bargaining Position	Retailer's Bargaining Power	Retailer's Bargaining Position
Product Innovation	$\partial^2 \pi_M^{jd} / \partial \beta^j \, \partial k > 0$ if demand elasticity is not too large	$\partial^2 \pi_M / \partial \beta^j \, \partial k > 0$ if demand elasticity is not too large	$\partial^2 \pi_R^{jd} / \partial \beta^j \, \partial k > 0$
Process Innovation	$\partial^2 \pi_M^{jd} / \partial \beta^j \, \partial k < 0$	$\partial^2 \pi_M / \partial \beta^j \, \partial k < 0$	$\partial^2 \pi_R^{jd} / \partial \beta^j \, \partial k = 0$