Deregulation of Letter Markets and its Impact on Process and Product Innovation

Helmut Dietl, Andreas Grütter, and Martin Lutzenberger University of Zurich

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Abstract

Anticipating the upcoming deregulation of letter markets, incumbents must decide on how much to invest in process and product innovations in order to be competitive once markets are deregulated. We analyze this decision process with a two stage model with price competition and product differentiation. We distinguish between the regulatory scenarios of end-to-end competition and work sharing, and compare these scenarios with regards to the incumbent's innovation incentives. We find that the incumbent's incentives for process innovations in the upstream segment are stronger under end-to-end competition. Assuming that the entrant's demand under work sharing is higher than the decline in the incumbent's incentives for downstream process innovations are stronger under work sharing. If the access price is higher than the firms' average downstream costs, incentives for product innovations are stronger under work sharing.

1 Introduction

The European Union plans to liberalize the letter markets of its member countries in 2009. In particular, the reserved area that secures the incumbent postal service providers (incumbent) monopoly positions for letters up to a certain weight limit will be eliminated. Incumbents must anticipate deregulation and prepare accordingly. In particular, the incumbent must decide on how much to invest into R&D in order to be competitive once letter markets are deregulated. In recent years, incumbents have made major efforts to improve efficiency, e.g. USPS' large scale upgrade project, Deutsche Post's STAR project, and Swiss Post's REMA Project. Additionally, incumbents have introduced a variety of new products.

The regulatory authorities must take into account how regulatory policy impacts the incumbents' incentives to invest into improving process efficiency (process innovation) and into the development of new products (product innovation). In particular, there is the question whether competition over the whole value chain (end-to-end competition) is more conducive to innovation, or whether the incumbent's innovation incentives are higher if entrants are only allowed to compete in the upstream segment of the postal value chain, and then have the incumbent process their mail (work sharing).

There is a sizeable amount of non-sector specific literature on the effect of competition on innovation. Baily and Gersbach (1995), Blundell et al. (1995), and Nickell (1996) provide empirical evidence for a positive effect of competition on innovation. However, the theoretical literature is less clear on this issue. In contrast to Arrow (1962), Demsetz (1969) shows a negative effect of competition on innovation incentives. Kamien and Schwartz (1970) find that the incentives depend on the market structure and on the price-elasticity of demand. Martin (1993) develops a principal agent model of Cournot Competition and finds that firm efficiency is inversely related to the number of firms. Boone (2000) finds that the effect of competition on a firm's innovation strategy depends on the firm's efficiency level relative to that of its competitors.

Postal economists have compared the regulatory scenarios of end-to-end competition and work sharing from different points of view; see e.g. Crew and Kleindorfer (1998), Cremer et al. (2001), Panzar (2002), De Donder et al. (2005), and Dietl et al. (2005). However, to this date innovation incentives have not been explicitly taken into account by postal sector specific models.

In order to fill this gap, we develop a two stage model with price competition and product differentiation. Our model is based on the duopoly model with quantity competition and product differentiation by Rosenkranz (2003). In the first stage, before deregulation, the incumbent decides on how much to invest into improving efficiency, and on how much to invest into the development of new products. In the second stage, after deregulation has taken place, firms compete in prices.

This paper is organized as follows. In section 2, we give a brief overview over recent innovations in letter markets. In section 3, we introduce our model and apply it to the scenario of end-to-end competition and work sharing. In section 4, we compare the scenarios of end-to-end competition and work sharing with respect to the incumbent's innovation incentives. In Section 5, we show the effect of acess pricing on innovation incentives under work sharing. Section 6 concludes.

2 Recent Innovations in Letter Markets

For the purposes of this discussion, process innovations are new, improved ways to produce existing services, and product innovations are new services. Process innovations increase the quality of a process, and/or reduce a process costs. Process innovations are targeted at one or more of the activities of the traditional postal value chain, consisting of collection, sorting, transportation, and delivery. Product innovations increase a customer's willingness to pay for a product either by actually improving a product, or by product differentiation, taking advantage of the fact that customers value product variety.

2.1 Process Innovations

The most promising way to reduce the costs of collection without a decline in quality is to eliminate this stage altogether. This elimination can be achieved by hybrid mail services. To reduce the costs of collection per unit of physical mail, service providers can optimize the density and placement of letter boxes and local post offices.

Sorting technology has the largest potential for cost savings in the postal value chain (Arthur D. Little, 2004). To reduce the costs of sorting, postal operators must first and foremost reduce the fraction of mail that is sorted manually. In particular, the introduction of optical character reading (OCR) technology allows postal operators to sort the large majority of mail automatically. At the present time, OCR technology can accurately sort about 80% of all handwritten addresses. During the stage of outward sorting, barcodes are attached to mail. Barcodes can be read at a much higher accuracy and at lower costs than normal addresses. Therefore, the use of barcodes allows reducing the costs of sorting during the second stage of sorting, i.e., during the stage of inward sorting. For some services, radio frequency identification (RFID) tags are used instead of barcodes. RFID tags can store more information than barcodes. This added information can be used to increase the information content available through track and trace services.

Pieces of mail that cannot be recognized by OCR are digitally scanned and forwarded to a remote encoding centre (REC), where addresses are read manually. Compared to the manual sorting at multiple sorting centres, a single REC is more cost efficient since the aggregate fluctuations in workload are lower than the sum of the individual fluctuations. From lower aggregate fluctuations follows an increase in the average utilization and a decrease in the required staff size. Voice recognition technology has the potential to further increase REC efficiency. However, technical limitations still prevent voice recognition technology from effectively replacing input through keyboards at the present time.

In order to reduce the costs of transportation, postal service providers are constantly monitoring the flow of mail in order to optimize their networks. Furthermore, most postal operators maintain contracts with external logistics enterprises, allowing them to outsource transportation to some extent during high load times. There is some conflict between the costs of sorting and transportation, as a lower amount of sorting centres decreases the costs of sorting, but increases the costs of transportation, and vice versa. In recent years, there has been a trend for postal operators to reduce the number of sorting centres, which suggests that the decreased costs of sorting outweigh the increased costs of transportation.

Although delivery is the single most expensive process of the postal value chain, the scope for a reduction of the costs of delivery is limited without altering the USO. Efforts of established service providers have concentrated on introducing more efficient transport vehicles, as well as on optimizing delivery routes.

2.2 Product Innovations

A first group of product innovations is designed to improve physical mail. These innovations either assist customers in the creation and handling of letters and parcels, or offer value-added services. For business customers, postal service providers offer services preliminary to the actual postal value chain, e.g. address management and printing. Furthermore, some service providers offer to assist with customers' response management, which concerns the handling and analysis of response letters. In effect, postal service providers expand their traditional value chain with these services.

A second group of product innovations makes use of the service providers' networks, although the actual services are not related to the sending of mail. In particular, these new services include services from the areas of insurance and financial services, but also pickup/recycling services. Furthermore, post offices are used as retail stores for various commodities that may or may not be related to the traditional core competencies of postal operators.

A third group of product innovations is based on electronic services. Web portals offer one-way services such as information about products and track and trace services, as well as interactive services. These interactive services allow customers to order products, access and change their own personal data, and conduct financial transactions. There are also some new hybrid products, i.e., products using both physical and electronic media. These products transform messages submitted in electronic form via electronic data interchange, E-mail, SMS, or MMS into letters.

3 The Model

On the demand side we assume that a customer's (or sender's) utility depends on the quantity of letters sent, and that consumers have a preference for product variety. The utility function of a representative sender is given by

$$U(x_i, x_e, y) = a(x_i + x_e) - \frac{(x_i^2 + x_e^2 + 2\delta x_i x_e)}{2(1 - \delta^2)} + y,$$
(1)

where $a > \max[c_i, c_e]$, $\delta \equiv \delta_i + \delta_e$, and $0 \le \delta < 1$. Parameter *a* influences market size, parameter *y* is the amount of money spent on other goods, and parameter δ measures the degree of product substitutability. If parameter δ tends to zero, then both firms effectively become monopolists. If parameter δ tends to one, then the goods of firm *i* and firm *e* are perfect substitutes. In contrast to Rosenkranz (2003), we assume that $\partial^2 U/\partial \delta^2 < 0$, which indicates decreasing marginal utility of product differentiation. The representative sender must satisfy the budget constraint $y + p_i x_i + p_e x_e \le m$, where parameter *m* denotes the initial wealth endowment. Utility maximization leads to the demand function

$$x_j = (1 - \delta)a - p_j + \delta p_{-j}, \tag{2}$$

where j = i, e.

On the supply side, we consider a duopolistic industry with an incumbent i and entrant e. The entrant represents a set of entrants behaving like a competitive fringe. The incumbent and the entrant produce quantities x_i and x_e , respectively. We distinguish between an upstream segment and a downstream segment, denoted by s = u, d, respectively. The upstream segment contains the activities of collection, transportation, and sorting, and the downstream segment contains delivery.

We assume that the entrant enters the market with costs of production c_e and a degree of product substitutability δ_e . For the incumbent, we assume a two stage decision process. In the first stage, before deregulation takes place, the incumbent chooses its marginal costs $c_i \equiv c_i^u + c_i^d$ and its degree of product substitutability δ_i . The incumbent determines its marginal costs of a segment by investing in a research project leading to a process innovation, and its degree of product substitutability δ_i by investing in another research project leading to a product innovation. In the second stage, after deregulation has taken place, the incumbent sets the profit maximizing price p_i^* , given the entrant's equilibrium price p_e^* .

3.1 End-to-End Competition

Applying backward induction, we first analyze the price decisions in the second stage. Due to the assumption that the entrant e represents a set of entrants behaving like competitive fringe, entrant's price is equal to marginal cost:

$$p_e^* = c_e \tag{3}$$

The incumbent's profit function is

$$\pi_i(p_i, p_e) = x_i(p_i, p_e, \delta)p_i - x_i(p_i, p_e, \delta)c_i.$$

$$\tag{4}$$

Given this profit function, and given the entrant's price, we obtain the incumbent's profit maximizing price:

$$p_i^* = \frac{1}{2} \left((1 - \delta)a + \delta c_e + c_i \right).$$
 (5)

The incumbent's corresponding demand is

$$x_i^* = \frac{1}{2}(a - c_i - (a - c_e)(\delta_i + \delta_e)).$$
(6)

Using the incumbent's profit function and substituting 3 and the incumbent's profit maximizing price, we can write the incumbent's reduced form profit function for the first stage of its decision process:

$$\pi_i^*(c_i, c_e, \delta_i, \delta_e) = \frac{1}{4}(-a + c_i + (a - c_e)(\delta_i + \delta_e))^2 = (x_i^*)^2.$$
(7)

Anticipating the market outcome after market liberalization, the incumbent chooses its profit maximizing R&D projects. The incumbent's strategy set for

the first stage is given by $(c_i^u, c_i^d, \delta_i) \in \mathbb{R}^3$, with $c_i^u \in [0, c_0^u]$, $c_i^d \in [0, c_0^d]$, and $\delta_i \in [0, \delta_0]$.

Following D'Aspremont and Jacquemin (1988), we assume that there are increasing marginal costs of innovation. The incumbent's cost function for process innovations is

$$K(c_i^s) = \frac{1}{2}(c_0^s - c_i^s)^2,$$
(8)

and the incumbent's cost function for product innovations is

$$G(\delta_i) = \frac{1}{2}(\delta_0 - \delta_i)^2.$$
(9)

The higher the optimal marginal cost of a segment and the higher the incumbent's optimal degree of product substitutability, the lower is the needed research investment.

The incumbent's maximization problem in the first stage is

$$(c_i^{s^*}, \delta_i^*) \in \arg\max_{c_i^s, \delta_i} \{ \Pi_i = \pi_i^*(c_i^s, c_e, \delta_i, \delta_e) - K(c_i^s) - G(\delta_i) \}.$$
(10)

Differentiating the reduced form profit function with respect to the incumbent's marginal cost of a segment and solving for K' leads to the following first order condition:

$$K'_{s} = \frac{1}{2}(-a + c_{i} + (a - c_{e})(\delta_{i} + \delta_{e}))$$
(11)

Comparing equations (11) and (6), we can see that the right hand side of equation (11), i.e., the incumbent's marginal revenues from investing in process innovation in the upstream segment, equals the negative of the incumbent's profit maximizing demand, i.e.,

$$K'_s = -x_i^*. (12)$$

This result holds for process innovations in both segments. Differentiating the reduced form profit function with respect to the incumbent's degree of product substitutability and solving for G' leads to the first order condition

$$G' = \frac{1}{2}(a - c_e)(-a + c_i + (a - c_e)(\delta_i + \delta_e)).$$
(13)

Substituting the incumbent's demand in the equilibrium, we can rewrite this condition as

$$G' = -x_i^*(a - c_e).$$
(14)

The incumbent's marginal revenues of product innovation are influenced by the incumbent's demand and, in addition, by a factor including the entrant's marginal costs.

3.2 Work Sharing

In the case of work sharing, the entrant's marginal cost depends on the access price. The access price is the price that the entrant must pay to the incumbent in order to deliver one piece of the entrant's mail. The access price can be either the result of negotiations between the incumbent and the entrant, or be directly determined by the regulatory authority. For our analysis, we do not focus on the determination of the welfare maximizing access price. Instead, we are interested in the effect of the access price on the incumbent's innovation incentives. Therefore, we treat the access price as an exogenous variable. The incumbent's profit function for the second stage changes to

$$\pi_i(p_i, p_e) = x_i(p_i, p_e, \delta) p_i - x_i(p_i, p_e, \delta) c_i + (\alpha - c_i^d) x_e(p_i, p_e, \delta),$$
(15)

where parameter α is the access price.

Due to the assumption that there is a set of entrants behaving like a competitive fringe, the entrant's equilibrium price equals the entrant's marginal cost, which is equal to the sum of the entrant's marginal upstream costs and the access price:

$$p_e^* = c_e^u + \alpha. \tag{16}$$

The corresponding demand is

$$x_e^* = a - c_i^u - \alpha - \frac{1}{2} \left[(\delta_e + \delta_i)(a - c_i^d - c_i^u + (a + c_i^d - c_e^u - 2\alpha)(\delta_e + \delta_i)) \right].$$
(17)

Maximizing the incumbent's profit function while taking into account the entrant's equilibrium price, we obtain the incumbent's profit maximizing price:

$$p_i^* = \frac{1}{2} \left[(1 - \delta)a + \delta(c_e^u + 2\alpha - c_i^d) + c_i \right].$$
(18)

The incumbent's corresponding demand is

$$x_i^* = \frac{1}{2} \left[a - c_i - (a - c_i^d - c_e^u) \delta \right].$$
(19)

Using the incumbent's profit function and the profit maximizing prices, rearranging and substituting the incumbent's profit maximizing demand, we can write the incumbent's reduced form profit function for the first stage of the incumbent's decision process:

$$\pi_i^*(c_i, c_e, \delta_i, \delta_e, \alpha) = x_i^{*2} + (\alpha - c_i^d)(-a + c_e^u + \alpha)((\delta_i + \delta_e)^2 - 1).$$
(20)

Differentiating the reduced form profit function with respect to the incumbent's marginal upstream cost and solving for K'_u leads to the first oder condition:

$$K'_{u} = \frac{1}{2} \left[-a + c_{i} + (a - c_{i}^{d} - c_{e}^{u})(\delta_{i} + \delta_{e}) \right]$$
(21)

which we can rewrite as

$$K'_u = -x_i^*. \tag{22}$$

By differentiating the reduced form profit function with respect to the incumbent's marginal downstream cost, we find the following first order condition for downstream process innovations:

$$K'_{d} = \frac{(-1+\delta_{i}+\delta_{e})(3a-c_{i}-2(c_{e}^{u}+\alpha)+(a+c_{i}^{d}-c_{e}^{u}-2\alpha)(\delta_{i}+\delta_{e}))}{2}, \quad (23)$$

which we can rewrite as

$$K'_d = -x_i^* - x_e^*. (24)$$

The incumbent's marginal revenues of downstream process innovations depend on the incumbent's and on the entrant's demand, since the incumbent delivers the entrant's mail.

Differentiating the reduced form profit function with respect to the incumbent's degree of product substitutability and solving for G' leads to:

$$G' = \frac{1}{2} \left[(-a + c_i)(a - c_i^d - c_e^u) + (a + c_i^d - c_e^u - 2\alpha)^2 (\delta_i + \delta_e) \right].$$
(25)

In the case where the access price equals the incumbent's profit maximizing downstream cost, the incumbent's marginal revenues of product innovation under work sharing equal the incumbent's marginal revenues of product innovation under end-to-end competition:

$$G' = -x_i^* (a - c_i^d - c_e^u) \mid \alpha = c_i^d.$$
(26)

4 Comparing End-to-End Competition and Work Sharing

In order to analyze the effect of different regulatory regimes on innovation incentives, we compare the corresponding marginal revenues of process and product innovation.

4.1 Process Innovation

Figure 1 shows the incumbent's marginal cost function for process innovation and the incumbent's marginal revenue function for process innovation under end-to-end competition (in absolute values).

If the degree of product substitutability increases or the marginal cost of the entrant decreases, there is an inward shift of the marginal revenue graph, i.e., the incumbent's profit maximizing marginal cost increases. Since under end-to-end competition, the incumbent's incentives for process innovation are proportional to the incumbent's demand, the incumbent's incentives for process innovations increase if the degree of product substitutability decreases or the marginal cost of the entrant increases.

In order to compare the innovation incentives for the upstream segment, we can compare the incumbent's demand under end-to-end competition (6) and



Figure 1: $|MC(c_i)|$ and $|MR(c_i)|$ for End-to-End Competition

under work sharing (19). If the incumbent's downstream cost under work sharing is the same as the cost of the entrant under end-to-end competition, the incumbent's demand is not affected by the regulatory scenario. However, if the incumbent's downstream cost under work sharing is lower than the downstream cost of the entrant under end-to-end competition, the incumbent's demand is lower under work sharing. There is empirical evidence that delivery, i.e., the downstream activity, exhibits strong economies of scale; see Rogerson and Takis (1993) and Cazals et al. (1997). Therefore, we can conclude that the incumbent's demand under work sharing is lower than under end-to-end competition. Thus, the incumbent's incentives for process innovations in the upstream activities are stronger under end-to-end competition than under work sharing.

Under work sharing, the incentives for downstream innovations are proportional to market demand. The incumbent's lower demand under work sharing decreases innovation incentives compared to end-to-end competition. However, the incumbent's increasing demand due to the letters delivered for the entrant increases the incumbent's incentives for downstream process innovations. As long as the entrant's demand under work sharing is higher than the decline in the incumbent's demand, the incumbent's incentives for downstream process innovations are higher under work sharing.

4.2 Product Innovation

The incumbent's marginal revenues of product innovation are influenced by the incumbent's demand and, in addition, by a factor including the entrant's marginal costs. Figure 2 shows the incumbent's marginal cost function for product innovation and the incumbent's marginal revenue function for product innovation under end-to-end competition (in absolute values).



Figure 2: $|MC(\delta_i)|$ and $|MR(\delta_i)|$ for End-to-End Competition

The intercepts on the x- and y-axis, as well as the slope of the incumbent's marginal revenue function depend on the entrant's marginal cost. If the entrant has relatively high marginal costs, an increase in the incumbent's demand leads to higher incentives for product innovation. If the entrant has relatively low costs, an increase in the incumbent's demand lowers the incentives for product innovation. An intuitive explanation for this result is that an increase in the incumbent's demand is the result of higher marginal costs of the entrant. If the entrant operates at relatively low costs, the incumbent's competitive advantage arising from the entrant's increasing marginal cost increases with a higher degree of product substitutability. Therefore, the incumbent's incentives for product innovation decrease when the entrant's marginal cost increases. In contrast, if the entrant's cost are relatively high, a further increase in the entrant's marginal cost only leads to a small increase in the incumbent's demand, because consumers have a preference for product variety. Therefore, a lower degree of product substitutability increases the incumbent's marginal revenues of product innovation.

Comparing the incumbent's marginal cost function for product innovation under end-to-end competition (14) and under work sharing (26), we can see that incentives for product innovations are unaffected by entry regulation as long as $\alpha = c_{i,WS}^d$ and $c_{i,WS}^d = c_{e,E2E}^d$. In order to analyze the cases where $c_{i,WS}^d \neq c_{e,E2E}^d$ and $\alpha \neq c_{i,WS}^d$, we rewrite the incumbent's marginal revenue function of product innovation under end-to-end competition (13) as:

$$G' = \frac{1}{2} \left[(a - c_e)(-a + c_i) + (a - c_e)^2 (\delta_i + \delta_e) \right].$$
(27)

This form is similar to the form of the incumbent's marginal revenue function of product innovation under work sharing (25). As in the case of process innovations, we take economics of scale in the downstream activities for granted, and assume for the following analysis that $c_{i,WS}^d < c_{e,E2E}^d$. This assumption holds as long as no cream skimming behavior takes place. To avoid confusion, remember that in our setting marginal costs and marginal revenues are negative. For this reason, we find that lower marginal revenues lead to higher innovation incentives.

Comparing (27) and (25), we can see that the first term in the brackets is lower under work sharing than under end-to-end competition. If

$$\alpha = \frac{1}{2} \left(c_{i,WS}^d + c_{e,E2E}^d \right), \tag{28}$$

the second term in the brackets is equal under end-to-end competition and work sharing. Therefore, we conclude that the incentives for product innovation are higher under work sharing as long as (28) is satisfied. Furthermore, higher incentives for product innovations under work sharing take place for all cases where the access price is higher than the average of the incumbent's downstream cost under work sharing and the entrant's downstream cost under end-to-end competition. If

$$\alpha < \frac{1}{2} \left(c_{i,WS}^d + c_{e,E2E}^d \right), \tag{29}$$

the second term in the brackets is higher under work sharing. In this case, the total effect of entry regulation on the marginal revenues of product innovation is unclear. The value of the access price where innovation incentives are equal for both regulatory regimes depends on the incumbent's cost advantage and on the entrant's choice of its degree of product substitutability.

5 Effects of Access Pricing on Innovation

If the regulatory regieme of work sharing takes place, the effect of access pricing on innovation incentives becomes important. As shown in Chapter 3.2 the incumbent's innovation incentives for product innovation and process innovation in the downstream segment depend on the access price. Because the marginal revenues of process innovation in the upstream activities are proportionally related to the incumbent's demand, there is no direct effect of the access price on the incumbent's incentives for process innovation in the upstream segment. However, there is an indirect effect, since the incentives for process innovations in the upstream segment depend positively on the incentives for process innovations in the downstream segment. In addition, there is an indirect effect of the incumbent's incentives for product innovations on the incumbent's incentives for process innovations in the upstream segment.

To analyze the effect of the access price on the incumbent's innovation incentives for process innovation in the downstream segment, we differentiate the corresponding marginal revenues (23) with respect to the access price, and find the following relationship:

$$\frac{\partial MR(c_i^d)}{\partial \alpha} = (1 - \delta_i - \delta_e)(1 + \delta_i + \delta_e) > 0.$$
(30)

Downstream process innovations decrease when the access price increases (recall that the incumbent's cost function of process innovation is downward sloping). The magnitude of this effect depends on the degree of product differentiation in the market. If products are perfect substitutes, then $MR(c_i^d) = 0$, and therefore no process innovation takes place.

Differentiating the right hand side of equation (25) with respect to the access price, we obtain:

$$\frac{\partial MR(\delta)}{\partial \alpha} = -2\delta(a + c_i^d - c_e^u - 2\alpha) \begin{cases} > 0 & if \quad \alpha > (a + c_i^d - c_e^u)/2 \\ = 0 & if \quad \alpha = (a + c_i^d - c_e^u)/2 \\ < 0 & if \quad \alpha < (a + c_i^d - c_e^u)/2 \end{cases}$$
(31)

The direction of the effect of the access price on product innovation in the downstream segment depends on whether the access price is higher or lower than a certain value. If the access price is sufficiently low, then an increase in the access price leads to higher incentives for product innovations. If the access price is sufficiently high, then an increase in the access price leads to lower incentives for product innovations. Therefore we have an access price

$$\alpha = \frac{1}{2}(a + c_i^d - c_e^u), \tag{32}$$

which maximizes the incumbent's incentives for product innovations.

6 Conclusion

Anticipating the upcoming deregulation of letter markets, incumbents must decide on how much to invest in process and product innovations in order to be competitive once markets are deregulated. We analyze this decision process with a two stage model with price competition and product differentiation.

Under end-to-end competition, the incumbent's marginal revenues of process innovation are directly proportional to the incumbent's demand. The same holds true for process innovation in the upstream segment under work sharing. For process innovation in the downstream segment under work sharing, the incumbent's marginal revenues are directly proportional to the sum of the incumbent's and the entrant's demand. The incumbent's marginal revenues for product innovation also depend on demand. In addition, there is a factor including the entrant's marginal costs that influences the incumbent's marginal revenues of product innovation.

Because economies of scale occur mostly in the downstream segment of the value chain, but not in the upstream segment, the incumbent's incentives for process innovations in the upstream segment are stronger under end-to-end competition. Assuming that the entrant's demand under work sharing is higher than the decline in the incumbent's demand, the incumbent's incentives for downstream process innovations are stronger under work sharing.

Whether the incumbent's incentives for product innovation are stronger under end-to-end competition or under work sharing depends on the access price. If the access price is higher than the firms' average downstream costs, incentives for product innovations are stronger under work sharing.

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