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Vertical Integration and Rent Extraction: Lessons from the Dairy Industry*

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Abstract:

Farm cooperatives are often vertically integrated with dominant downstream firms and face very limited competition. We study a recent case of the dairy industry in New Zealand and find that the cooperative Fonterra adopts a price squeeze strategy in order to exploit its smaller competitors. We show that a price squeeze is a necessary condition for exploitation, not a practice of exclusion, and that the cooperative earns more than the monopoly profit through rent extraction. A price squeeze hurts the competitor and forecloses part of its efficient production, however, such foreclosure is a by-product of exploitation rather than as a result of intentional exclusion. We find that the current regulations in the New Zealand dairy industry cannot prevent the cooperative from exploiting its rivals. We further study the optimal regulation and structural remedy and provide testable implications for competition policy.

Keywords: Vertical Integration, Rent Extraction, Price Squeeze

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1 Introduction

Farmer-owned cooperatives play an enormously important role in the agricultural industries.[1] Many farmer cooperatives are also vertically integrated with downstream processors that process their members' commodities into finished products. The market share of the cooperatives as well as the degree of vertical integration have been steadily growing over recent decades.[2]

Agricultural markets are quite competitive, since a large number of farms produce highly homogeneous commodities that are non-storable and perishable. In contrast, the industries that process agricultural goods are often highly concentrated and have the potential to exercise monopsony power over the farmers they deal with. Farm cooperatives are formed to create a countervailing power and also to displace a monopsonic purchaser by actually owning and operating a processing firm. It is commonly acknowledged that such vertically integrated farm cooperatives promise to be an unambiguous improvement of social welfare, making farmers better off without making consumers worse off, and this "common sense" becomes the critical reason for the government to encourage the formation of farm cooperatives.

A farm cooperative must be able to control the aggregate supply and hence the price of the farmers' products in order to exercise countervailing market power. Indeed, farm cooperatives in the United States have been permitted to exercise this power by means of the Capper-Volstead Act of 1922, which gives farm cooperatives a partial exemption from antitrust laws.[3] There are similar laws that exempt farm cooperatives from competition laws in most developed

[1] The brand names used by some of these cooperatives are quite familiar to American consumers, such as Land O'Lakes (mid-western dairy farmers), Ocean Spray (New England), Mideastern, and Gold Kist (southern poultry producers), among others. Many of these firms are impressively large. As at 1992, Land O'Lakes, Gold Kist and Ocean Spray were among the leading 50 firms in the processed food industry and were also on Fortune magazine's list of the 500 largest US industrial corporations. In the EU, by the early 1970s, cooperatives accounted for 45 percent of the agricultural market in France, 48 percent in Germany, 60 percent in Holland, over 70 percent in Denmark, and 80 percent in Sweden. Among these and other European countries, the area of concentration roughly paralleled that in the US, with cooperatives having especially large market shares in dairy products and grains. See Hansmann (1996) for a more detailed discussion.

[2] According to Hansmann (1996), in 1962, there were only five agricultural cooperatives in the US among the Fortune 500 largest industrial firms, however the number increased to 14 over the next 30 years. The regional grain cooperatives, for example, developed substantial grain export facilities that permitted them to increase their share of total grain exports from roughly five percent in 1965 to 15 percent in 1985.

[3] Farmers have generally been allowed to form the processing cooperatives freely, and to use these cooperatives as means to set common prices for their products, so long as the cooperatives do not use "predatory tactics" to compel either farmers or purchasers to deal with them.

countries.[4] The formation of cooperatives and mergers among existing cooperatives have been freely permitted. However, this long-standing antitrust exemption raises the prospect that the cooperatives may have been used to establish market power, not just to counter monopsony, and further, to extract monopoly profits for the farmers themselves from their ultimate consumers.

The dairy industry provides a perfect example of monopolization. In the US, the dairy cooperatives have enforced a legally mandated minimum price for Grade A fluid milk in most parts of the country, (which are well above the competitive price), and have succeeded in raising prices even further. In New Zealand, the world largest dairy supplier, the vertically integrated dairy cooperative Fonterra has established its quasi-monopoly position in the collection and processing of raw milk after a merger in 2001.[5] Ironically, the merger was initially turned down by the New Zealand Commerce Commission, but later approved by the New Zealand Government. Acknowledging the risk of monopolization in the dairy industry, Fonterra is regulated by the New Zealand's Ministry of Agriculture and Forestry (MAF) (which is now called the Ministry for Primary Industries) under the Dairy Industry Restructuring Act (DIRA) of 2001, which aims to "promote the efficient operation of dairy markets in New Zealand" (Section 70).

According to DIRA regulation, Fonterra is obliged to supply about 5% of its total collection of raw milk to independent milk processors who compete with its subsidiary, Fonterra Brands, in the downstream market. The raw milk price is set by Fonterra according to the so-called Milk Price Manual.[6] In 2008, Fonterra adopted a new pricing manual based on the so-called Hypothetical Efficient Competitor (HEC) approach. According to this approach, the raw milk price is set to be the difference between the output price and the production cost of a "notional" processor, which identifies a notional pure commodity product manufacturing business within Fonterra. The estimated average processing cost for the notional processor by Fonterra is actually much lower than Fonterra's actual cost. That is, this hypothetical efficient producer is a

[4] Farm cooperatives in the EU are exempted from competition laws under the Common Agricultural Policy (CAP). Their activities that restrict competition can be allowed under the CAP derogations.

[5] Fonterra was formed in 2001 from the merger of the two largest cooperatives, the New Zealand Dairy Group and Kiwi Cooperative Dairies, together with the New Zealand Dairy Board, which had been the marketing and export agent for all of the cooperatives. Fonterra is owned by 13,000 New Zealand farmers, and it is also vertically integrated with its subsidiary Fonterra Brands. According to the report of Commerce Commission (2011), during the year of 2009/2010, Fonterra collected about 95% of raw milk produced in New Zealand, with Fonterra Brands processing about 90% of raw milk in the country. Thus, it effectively has monopsony control of the New Zealand domestic and export dairy industries.

[6] The price manual is to be reviewed by the regulators each year.

"super competitor" with much lower average costs than Fonterra. Indeed, Fonterra assumes that efficient competition comes from would-be new entrants who construct milk processing plants at a cost equivalent to this notional producer, and thus any competitor with higher processing costs than this super competitor could be foreclosed.

Fonterra's HEC approach is a typical practice of "price squeeze" between the firm's retail and wholesale prices, which reduces the profit margin of the downstream competitors and may force them to exit. It was heavily criticized by independent processors, who raised concerns and complaints to the Commerce Commission and the MAF. However, the Commerce Commission (2011) responded that further investigation and intervention was not needed as the industry is regulated by MAF: "Given the Regulations, it is questionable whether Fonterra has scope to exercise substantial market power in relation to the supply of raw milk to other processors. The Regulations provide an access regime for raw milk and are designed to counter Fonterra's market power."[7] Moreover, MAF concluded that "Fonterra's current milk price setting methodology is conceptually consistent with a milk price that would emerge in a competitive market for farmers' milk."[8]

The Fonterra case reveals a dilemma facing antitrust authorities as to whether or not such a "price squeeze" strategy is a violation of antitrust laws. To date, the judgements have been quite controversial. In 2009 the US Supreme Court passed judgement on the *Linkline* case, in which none of the nine Supreme Court Justices found a violation of the US antitrust law.[9] In Europe, by contrast, the Court of First Instance (CFI) in 2008 upheld a decision by the European Commission that Deutsche Telekom had abused a dominant position by operating a price squeeze strategy against its rivals.[10] The practice of price squeeze is commonly viewed as a form of exclusionary conduct in which the vertically integrated firm intends to exclude the rival from the downstream market. However, in the Fonterra case, the independent processors are not driven out of the market and there is no evidence that these firms are under a real threat of shutdown.[11] A question arises naturally from this dilemma: why do vertically integrated firms adopt a price squeeze strategy if they do not aim to exclude downstream rivals? In other words,

[7] See Commerce Commission (2011), paragraph 155, page 33.

[8] See MAF (2012) "Regulatory Impact Statement-Fonterra's Milk Price Setting, Capital Restructure and Share Valuation", paragraph 29, page 9.

[9] See *Pacific Bell Telephone Co v linkline Communications Inc*, 555 US_(2009).

[10] See *Deutsche Telekom v Commission*, T-271/03 [2008].

[11] Carlton (2008) argues that the price squeeze theory leads to no competitive harm and thus, using the theory of price squeeze to create antitrust liability, is likely to chill competition and harm consumers.

what is the rationale of a price squeeze if it is not exclusionary?

To answer this question, we study the Fonterra case and develop a simple theoretical model that captures the key features of the dairy market in New Zealand. These key features include: (a) Fonterra is a (quasi) upstream monopoly cooperative and is vertically integrated with a downstream dominant milk processor, Fonterra Brands; (b) the dominant milk processor also competes with small independent processors in the downstream market; (c) small processors are competitive fringe firms and price takers; and (d) small processors have a limited capacity to collect and process raw milk and face a convex cost function of processing. The feature of the milk processing industry, together with the downstream market structure, suggest that small independent processors could have a lower marginal cost than the dominant processor for small quantities.

We find that the vertically integrated cooperative adopts a price squeeze strategy: it sets a downstream price margin below its marginal cost. This practice squeezes the independent processors' profit margin and forces them to produce at a lower marginal cost (with a smaller quantity) than the dominant processor. By raising the raw milk price, the integrated cooperative extracts part of the efficiency rents from the independent processors and, in this way, earns a total profit even higher than the monopoly level (i.e., in the absence of independent processors).

This theoretical finding then sheds light on an exploitative nature of the price squeeze. It reasonably explains the rationale of the HEC approach adopted by Fonterra, which restricts the independent processors' output and forces them to produce as the super efficient competitor at a reduced capacity. The purpose of Fonterra's pricing formula is to extract efficiency rents rather than exclude the more efficient competitor, yet such rent extraction results in market foreclosure, as the independent processors produce a smaller quantity than they would have produced without rent extraction. Such rent extraction may significantly contribute to the total profit. Applying our theory to the Fonterra case, we find that rent extraction contributes about six percent of Fonterra's annual profit before tax, which is an important gain given that the competitors process only five percent of Fonterra's raw milk.

The exploitative nature of a price squeeze shows that the vertically integrated firm can earn *more than* one monopoly profit by accommodating the entry of a more efficient downstream competitor. Thus, a more efficient rival is a source of gain rather than a cause of loss, provided that the dominant firm can manipulate the input price to exploit the rival, and vertical integration opens the door for such exploitation.[12] Moreover, a price squeeze strategy is the necessary

[12] Vickers (2010) also discusses the potential exploitative effect of a price squeeze strategy in a different context,

condition for rent extraction.

Our finding enriches the theory of harm on vertical integration. Vertical integration increases the profit of the merged parties at a cost to competitors and a price squeeze strategy results in market foreclosure. However, this outcome of market foreclosure arises as a by-product of exploitation, rather than as a result of intentional exclusion. This result differs from the famous "raising rivals' costs" theory of market foreclosure,[13] which finds that vertical integration alters the pricing incentives of upstream firms and enables the integrated firm to foreclose the competitor by raising its cost (i.e., increasing the input price).[14] We find, however, that the integrated firm *raises the input price* but also *decreases the rivals' costs of production* (the rival is forced to produce as a super competitor), and it adopts such pricing for rent extraction.

We then examine the regulations in the dairy industries. The existing regulations cannot prevent Fonterra from exploitation. We find that the so-called "Efficient Component Pricing Rule" (ECPR) that requires Fonterra to treat the "notional" competitor as efficient as Fonterra itself could prevent the cooperative from rent extraction, but it does not contribute to reducing the final milk price: the cooperative is still able to charge the monopoly price in the downstream market. The optimal regulation must require the cooperative to set the raw milk price equal to its marginal cost of production. We also examine the structural remedy that encourages small processors to merge and form a strategic player. Such a merger could create "countervailing power" and curb the cooperative's capacity in rent extraction. Taking the merged independent processors as a Stackelberg follower in the downstream market, we find such a merger benefits independent processors. However, the merger would affect the final milk price and result in a higher price post merger if the demand function is concave. Therefore, such a structural remedy

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which focuses on the relationship between competition policy and regulation.

[13]Salop and Scheffman (1987) forms the basis for this argument, while Ordover, Saloner and Salop (1990) is perhaps the best-known article that pioneered the equilibrium analysis of vertical mergers. Other important contributions include Salinger (1988) and Hart and Tirole (1990).

[14]The theory of "raising rivals' costs" is revisited by Riordan (1998), who takes into account the upstream barriers to entry and expansion. He finds that such barriers create a rising supply curve for a fixed input and vertical integration makes it credible for the dominant firm to raise the cost of that input to rivals. In contrast, Chen (2001) argues that vertical integration may also change the pricing incentive of a downstream firm and the incentive of a competitor in choosing input suppliers. He finds that vertical integration could result in both efficiency gains and a collusive effect, and shows that a vertical merger can be procompetitive if the efficiency effect dominates.

should be carefully evaluated.

The vertically integrated cooperatives' market power can be mitigated if the entry barrier in the upstream market is removed. However, in many countries, including New Zealand, the acquisition of farm land by foreign investors is subject to strict scrutiny, and the size of acquired farm land is restricted. Nevertheless, it is still worthwhile to study the case with limited upstream competition. Facing limited competition in both markets from small but more efficient rivals, the vertically integrated firm's capacity for exploitation is restrained, and it faces a trade-off of exploitation between the upstream and the downstream markets. It can exploit either the upstream or the downstream competitor, but cannot do both. The cooperative can exploit the downstream competitor if the capacity of the upstream entrant is sufficiently small; in contrast, it will exploit the more efficient upstream entrant if its capacity is sufficiently large.

2 Rent Extraction and Market Foreclosure

2.1 Basic Model

A large number of small dairy farms form a cooperative to monopolize the supply of raw milk. Producing raw milk incurs a constant marginal cost γ.[15] The cooperative as a cartel can fully control the supply of raw milk from farmers.[16] The farm cooperative is also vertically integrated with a dominant processor in the downstream milk processing market (call it firm d). The dominant processor has already established its capacity, and processing raw milk involves a constant marginal cost c_d.[17]

There is also a competitive fringe of small independent processors in the downstream market. For the ease of exposition, we will take a representative fringe independent processor (call it firm f) which faces the aggregate cost function $C_f(q)$ of producing q units. The processors must

[15] Assuming the constant marginal cost simplifies the exposition. The main results are not affected with more general cost functions, assuming the aggregate cost of producing q units of raw milk is convex.

[16] This assumption is validated by the fact that the share holder farmers must purchase a quota of supply volume from the cooperative and have to pay higher costs for any extra supply above the quota. For instance, Fonterra requires farmers to purchase the rights to raw milk supply, with the price per share per kilogram of milk solids (kgMS) around $7 in 2014. Farmers who want to increase their output must purchase extra shares from Fonterra at a higher price. Moreover, farms are subject to capacity and finance constraints, and expanding the supply involves a higher marginal cost of production.

[17] We consider more general cost functions for the dominant firm in subsection 2.4, and show that the main insights and key results carry through.

collect the raw milk from farm gates, and the cost of collecting the raw milk consistutes a significant part of the total production cost. Small independent processors may build their processing plants close to some farms in order to save the collection cost. When the output expands, they need to collect raw milk from other farms further away, which could significantly increase their average cost. This suggests that the small independent processors can have a lower marginal cost than c_d at the small production scale; that is, there exists a threshold $\bar{q}_f$ such that $MC_f(q)$ is less than c_d for $q \leq \bar{q}_f$. The market for processed milk faces a downward sloping demand curve $D(p)$, where p is the per-unit price of processed milk.

The cooperative is owned by farmers, and the profit must be paid back to farmers. The transfer of the profit to farmers can be implemented through the payment scheme (w, t), where w is the per-unit raw milk price and t is the lump-sum payment representing the dividend of the ownership. We assume away the agency problem within the vertically integrated firm. The raw milk price w is set by the cooperative. According to the regulation, the independent processors can purchase raw milk from the cooperative at the same per-unit price, up to a quantity limit set by the regulation authority.

Remark 1: Sophisticated Vertical Contracts. Our analysis is focused on linear pricing, which is consistent with the evidence from the above-mentioned cases, particularly in the dairy industry. There is a vast amount of literature on vertical contracting, which shows that the upstream monopoly can use more sophisticated vertical contracts to maximize the joint profits of the industry, and can, moreover, extract all efficiency rents when it has full bargaining power. However, implementing these sophisticated vertical contracts can be quite costly. For instance, lump-sum payments incur significant financial costs as firms often face liquidity constraints. Imposing retail price maintenance and quantity restrictions may cause antitrust concerns of facilitating collusion, and in some situations, it is difficult to monitor the retail price and sales. Thus, linear pricing is still the most commonly observed pricing strategy in vertical relations.

2.2 Solving for Equilibrium

As a benchmark for comparison, we first consider the case where downstream firm d is a monopoly in the milk processing market. The vertically integrated monopoly earns a total profit:

$$\pi(p) = (p - c_d - \gamma) D(p).$$

Assume the demand function is not too convex such that the profit function $\pi(p)$ is concave.[18] Maximizing the above profit then leads to the monopoly price p^m, which is the unique solution to the following equation:

$$p - c_d - \gamma = -\frac{D(p)}{D'(p)}. \tag{1}$$

Let q^m denote the monopoly output and π^m denote the related monopoly profit. Since there is no downstream production externality with the monopoly downstream processor, any transfer scheme (w, t) satisfying $t + wq^m = \pi^m$ can implement the monopoly outcome. This suggests that the issue of optimal raw milk price is irrelevant here: the optimal raw milk price is indeterminate.

Suppose now the (representative) independent processor is able to purchase the raw milk from the cooperative at a per-unit price w for any quantity. The independent processor as a competitive fringe firm is the price taker, and thus takes the raw milk price w and the processed milk price p as exogenously given; its profit is then given by:

$$\pi_f(q) = (p - w) q - C_f(q).$$

The independent processor will optimally produce q_f such that its marginal cost, $MC_f(q_f)$, is equal to the marginal revenue:

$$MC_f(q_f) = \rho \equiv p - w, \tag{2}$$

where $\rho \equiv p - w$ is the markup between the final and raw milk price. The above equation defines the supply function of the fringe processor. To ensure that this supply function is well-defined, we need to impose the following technical assumption on the cost function:

Assumption A: The production cost facing the representative independent processor $C_f(q_f)$ is convex.

Thanks to Assumption A, equation (2) determines a unique supply function of the fringe firm as denoted by $q_f(\rho)$, which is increasing in ρ. Deducting the supply from the independent processor, the dominant processor then faces a residual demand $D_d(p, \rho) = D(p) - q_f(\rho)$, and its profit from milk processing is equal to $(p - c_d) D_d(p, \rho)$. In addition, the cooperative also earns a profit from selling the raw milk to the fringe processor, which is equal to $(w - \gamma) q_f(\rho)$.

[18] This requires $2D'(p) + (p - c_d - \gamma) D''(p) < 0$.

Thus, the vertically integrated cooperative earns a total profit equal to:

$$\begin{aligned} \Pi &= (p - c_d) D_d(p) + w q_f(\rho) - \gamma D(p) \\ &= (p - c_d - \gamma) D(p) - (\rho - c_d) q_f(\rho) \\ &= \pi(p) - K(\rho), \end{aligned} \tag{3}$$

where the second line is derived by using the relation $D_d(p, \rho) = D(p) - q_f(\rho)$. Note that the first term, $\pi(p) = (p - c_d - \gamma) D(p)$, is the profit that a monopoly cooperative would have earned, whereas the second term, $K(\rho) \equiv (\rho - c_d) q_f(\rho)$, is the foregone benefit due to the production of the independent processor, which is positive when $\rho = p - w > c_d$ but becomes negative when $\rho = p - w < c_d$.

It is straightforward to see that $\Pi(p, \rho)$ is separable in the variables p and ρ, and thus the maximum is achieved by choosing p to maximize $\pi(p)$ and choosing ρ to minimize $K(\rho) = (\rho - c_d) q_f(\rho)$. Minimizing $K(\rho)$ necessarily leads to $\rho < c_d$, thus the cooperative sets a retail markup below its marginal cost; that is, it adopts a "price squeeze" strategy:

Lemma 1 *The vertically integrated cooperative sets the downstream price margin below its marginal cost, in order to extract efficiency rents from the independent processor.*

This price squeeze strategy forces the independent processor to produce at a smaller scale, associated with a lower marginal cost than the cooperative: $MC_f(q_f) = \rho < c_d$, and the efficiency gain, as denoted by $R(\rho) \equiv -K(\rho)$, is actually extracted by the cooperative. The optimal downstream margin ρ^* is determined by solving $\max R(\rho)$, which is given by:

$$(c_d - \rho) q_f'(\rho) = q_f(\rho). \tag{4}$$

The above condition is equivalent to:

$$\frac{c_d - \rho}{\rho} = \frac{1}{\varepsilon_s},$$

where:

$$\varepsilon_s \equiv \frac{dq_f}{d\rho} \times \frac{\rho}{q_f}$$

is the elasticity of the supply from the fringe processor. Thus, the degree of price squeeze is inversely related to the elasticity of supply facing the fringe processor.

In addition, maximizing $\pi(p)$ leads to the monopoly price p^m and the associated monopoly profit $\pi(p^m)$. Thus, the cooperative's total profit comes from two sources: the monopoly profit

$\pi(p^m)$ as if it were a monopoly processor, and the efficiency rents $R(\rho^*)$ that are extracted from the independent processor; that is, $\Pi^* = \pi^m + R^*$, where:

$$R^* = (c_d - \rho^*)\, q_f(\rho^*) = \left(c_d - MC_f\left(q_f^*\right)\right) q_f^*,$$

and the cooperative actually makes a profit higher than the monopoly level.

Obviously the vertically integrated cooperative has no incentives to exclude the independent processor. The use of price squeeze appears to be the practice of exploitation rather than the conduct of exclusion. Yet, such rent extraction results in a partial foreclosure and a distortion in production since the independent processor's output is squeezed. As illustrated in Figure 1, the fringe processor produces q_f^* at a lower marginal cost, whereas it would have produced at least $\bar{q}_f$ without rent extraction. The amount of $\bar{q}_f - q_f^*$ is now processed by the dominant processor at a higher marginal cost c_d, resulting in a loss of efficiency. The fringe firm's profit is given by:

$$\pi_f\left(q_f^*\right) = MC_f\left(q_f^*\right) q_f^* - C_f\left(q_f^*\right) = \left(MC_f\left(q_f^*\right) - AC_f\left(q_f^*\right)\right) q_f^*. \tag{5}$$

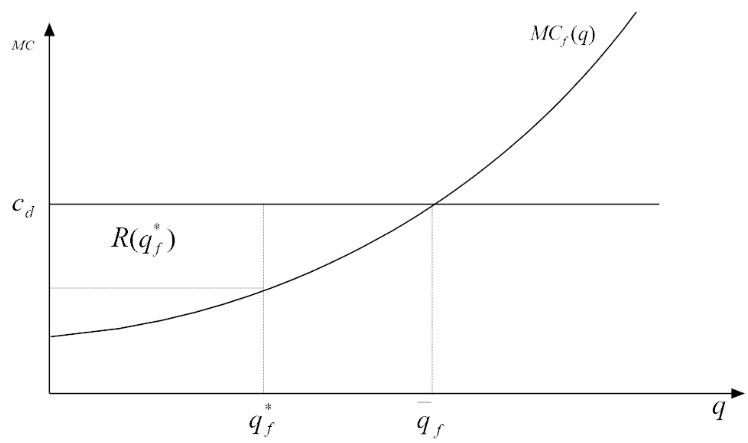

Figure 1 Rent Extraction

The optimal raw milk price is given by:

$$w^* = p^m - \rho^* = p^m - MC_f\left(q_f^*\right). \tag{6}$$

After paying farmers at the per-unit price w^*, the cooperative transfers its residual profit as the dividend of ownership to the farmers, which is equal to:

$$\begin{aligned} t^* &= \pi^m - w^* q^m + R^* \qquad (7) \\ &= (\rho^* - c_d)\, q^m + (c_d - \rho^*)\, q_f(\rho) - \gamma q^m \\ &= (c_d - \rho^*)\left(q_f(\rho^*) - q^m\right) - \gamma q^m, \end{aligned}$$

which is negative as $c_d > \rho^*$ and $q_f(\rho^*) < q^m$. Thus, the cooperative actually pays a negative dividend to farmers.

The above theoretical predication of equilibrium pricing is consistent with the observation that Fonterra pays the share-holder farmers a relatively high raw-milk price and relatively low dividend. In the 2014 financial year, Fonterra had a final cash payout to its supplier-shareholders of NZ$8.50, comprising the farm gate milk price of NZ$8.40 per kgMS and a dividend of 10 cents per share of kgMS.[19] Fonterra's total cash payout for the 2017/18 season was NZ$6.79 per kgMS, comprising a farm gate milk price of NZ$6.69 per kgMS and a dividend of 10 cents per share.[20] Note that the dividend accounts for less than 2% of total payment. Fonterra farmers had to purchase shares in order to be a supplier of raw milk to Fonterra, and the share price was around NZ$7 per share of kgMS in 2014. Taking into account the opportunity cost of capital, this dividend is actually negative.

Summarizing the above analysis leads to:

Proposition 1 *When the vertically integrated cooperative competes with a competitive fringe of independent processors, it charges the monopoly price for the processed milk and sets a high raw milk price, as given by* (6)*, and pays a negative dividend to farmers. The cooperative extracts the efficient rents from the independent processors and in this way earns a total profit above the monopoly level. Rent extraction results in the partial foreclosure of efficient production.*

This proposition establishes four important results: First, the vertically integrated cooperative still charges the monopoly price in the final product market, even in the presence of more efficient competitors. That is, the integrated cooperative is shielded from competition and its market power is not eroded. Consumers do not benefit from competition under vertical integration. Second, the integrated cooperative earns *more than* one monopoly profit when facing more efficient downstream competitors.

Third, the integrated firm sets a high input price and pays a negative dividend. It involves below-cost pricing downstream and cross-subsidizes the loss by the profit from upstream. Such a price squeeze practice is not predatory; instead, it is a necessary condition for rent extraction. Thus, it would be misleading to treat the price squeeze as predatory pricing: it is unlikely to show the feasibility that the predator could recoup the losses incurred during the predation

[19] See Fonterra Annual Report 2014, available at: https://www2.fonterra.com/files/2015-07/fsf-2014-annual-report.pdf.

[20] See https://www.nzx.com/announcements/323781.

phase by raising the prices after driving the rival out of the market.[21] Fourth, market foreclosure does arise in equilibrium as the competitors produce less than they would have produced in the absence of rent extraction. However, this foreclosure effect is a by-product of rent extraction rather than a result of intentional exclusion.

2.3 Review of Fonterra's Pricing Manual

In 2008, Fonterra adopted a new pricing manual based on the so-called Hypothetical Efficient Competitor (HEC) model, which sets the raw milk price as the difference between the output price and the production cost of a "notional" producer. According to Deloitte's report, this notional producer appears to be a "super competitor" that combines the best features of an independent processor's ability. It is estimated by Deloitte that Fonterra sets the processing costs for the notional producer at around \$0.40 to \$0.50 per kilogram of milk solids less than Fonterra could achieve, which is approximately half the operating profit margin of an efficient independent processor.[22]

The independent processors suffered considerably from the inflated raw milk price and raised their concerns to the Commerce Commission and MAF. In its regulatory impact statement (2012), MAF was also concerned that the raw milk price was inflated by Fonterra above the efficient milk price level. However, MAF argued that this result could be interpreted as Fonterra paying out a higher than efficient farm gate milk price—at the expense of its own profit, and concluded that Fonterra's current milk price manual was conceptually consistent with a milk price that would emerge in a competitive market for farmers' milk.

Our analysis effectively explains the motivation of Fonterra's raw milk pricing manual. Equation (6) reflects Fonterra's raw milk pricing manual. Here $MC_f\left(q_f^*\right)$ is the marginal cost of a "notional" producer which is supposed to be more efficient than Fonterra. The equilibrium raw milk price is set to be equal to the independent processor's profit margin $w^* = p^m - MC_f\left(q_f^*\right)$, which is higher than the dominant processor's profit margin $p^m - c_d$. In this way, the cooperative

[21] The feasibility of recoupment is often a necessary condition for a case of predation; in the US, for example, this approach was adopted by the Supreme Court in the *Brooke Group Ltd. v. Brown & Williamson Tobacco Corp*, which involved allegations of predatory pricing by Brown & Williamson against a smaller rival in an effort to discipline the pricing of generic cigarettes. The Court noted that predatory pricing was generally implausible without recoupment conditions, and further stated that intent ought not to play a role in assessing whether or not conduct is predatory.

[22] See the Summary of Deloitte's Analysis of Fonterra's Milk Price (2012). Available upon request.

actually extracts the efficiency rents from the more efficient fringe firm:

$$w^* = p^m - MC_f\left(q_f^*\right) = p^m - c_d + \delta,$$

where $\delta \equiv c_d - MC_f\left(q_f^*\right)$ is the efficiency gain of the fringe firm. Thus, Fonterra uses the HEC model to extract the efficiency rents from the competitor, and such rent extraction squeezes the profits of the independent processor and forecloses the efficient production.

According to Deloitte's estimation, the efficiency gain δ ranges from NZ\$0.40 to NZ\$0.50 per kgMS. In the 2011 financial year, the independent processors processed 75 million kgMS raw milk, which accounted for 5% of Fonterra's total supply of 1,500 million kgMS. A back of the envelope calculation then indicates that Fonterra has extracted about NZ\$30 million to NZ\$37.5 million from the independent processors, which contributes to about 5% to 6% of Fonterra's profit before tax.[23] Noting that the independent processors only possess 5% of Fonterra's total supply, its gain from rent extraction is significant.

Remark 2: International Market. Fonterra controls more than 95% of the raw milk supply in New Zealand and is almost a monopoly in the domestic market. However, a large proportion of New Zealand's milk products are supplied as milk powder to the international markets. The global dairy market is controlled by several large firms of which Fonterra has about a one-third market share. The oligopolistic firms face the capacity constraint in the short run and the interaction between these large firms can be characterized as Cournot competition. Moreover, Fonterra is the price leader in the global dairy market as it has created an auction mechanism to determine the market price for milk powder. The international and domestic markets are actually separated, as Fonterra exports milk powder while it mainly supplies liquid milk to the domestic market, for which the processing involves different technologies. Thus, Fonterra's monopoly power in the domestic market is not eroded by its supply to international markets. In the calculation of the raw milk price, Fonterra takes into account the revenues from both international and domestic markets. Yet, our analysis still applies when we interpret the final price p as the adjusted average price of the international and domestic markets. To see this, note that the rent that the cooperative exploits from the independent processors, $R(\rho) \equiv (c_d - \rho)\, q_f(\rho)$, depends on the profit margin ρ only, and that the optimal rent $R^*(\rho)$

[23] According to the Fonterra Annual Report (2012), Fonterra's profit before tax was \$622 million in 2011. The report is available at: https://www2.fonterra.com/files/financial-docs/presentations/2012-annual-results-presentation-26-september-2012-1-.pdf.

relies on the processors' marginal costs c_d and MC_f. Thus, the mechanism of rent extraction is not affected by the equilibrium final price p.

2.4 General Conditions for Exploitation

We have assumed that the dominant firm incurs a constant marginal cost c_d while the fringe competitors face an increasing marginal cost. We now show that the analysis and main insights carry through under general cost functions. Let $C_d(q)$ and $C_f(q)$ denote the cost functions for the dominant processor and for the representative competitive fringe processor, respectively. We do not impose any restrictive assumptions on these cost functions except for some regular conditions of continuity, as follows:

Assumption B: The cost functions $C_d(q)$ and $C_f(q)$ are differentiable and their marginal costs, $MC_d(q)$ and $MC_f(q)$, are continuous.

The vertically integrated firm sets p and w. The fringe firm's best response is to produce $q_f(p,w)$, which is determined implicitly by $MC_f(q_f) = \rho$. To ensure that this best response $q_f(p,w)$ is well-defined, we assume that the fringe firm's marginal cost is increasing at the beginning (with a small quantity) and the inverse demand function is not too convex:

Assumption C: $MC_f(q)$ is increasing at the beginning. In addition, the inverse demand function $P(Q)$ satisfies $P'(Q) + P''(Q)Q < 0$.

The integrated firm's total profit is given by:

$$\Pi(p,w) = pD_d(p) - C_d(D_d(p)) + wq_f(p,w) - \gamma D(p).$$

Using the relation $D(p) = D_d(p) + q_f$, the above profit can be further written as:

$$\begin{aligned}
\Pi(p,w) &= (p-\gamma)D(p) - C_d(D(p)) + C_d(D(p)) - C_d(D_d(p)) - (p-w)q_f(p,w) \\
&= \pi(p) + \Delta(p,w),
\end{aligned}$$

where $\pi(p) = (p-\gamma)D(p) - C_d(D(p))$ is the profit that the vertically integrated firm would have earned in the absence of the competitor, and the second term:

$$\begin{aligned}
\Delta(p,w) &\equiv C_d(D(p)) - C_d(D_d(p)) - (p-w)q_f(p,w) \qquad (8) \\
&= C_d(Q) - C_d(q_d) - (p-w)q_f,
\end{aligned}$$

is the extra benefit (or cost if negative) that the integrated firm can extract from production reallocation.

The production reallocation between the dominant firm and the competitor is indeed equivalent to the scenario of outsourcing, in which the dominant firm pays the competitor to produce q_f units at a per-unit price of $\rho = p - w$, saving the total production cost of $C_d(Q) - C_d(q_d)$. Thus, the vertically integrated firm can extract efficiency rents from production reshuffling if and only if the benefit from cost-saving in production is greater than the extra cost of outsourcing. Formally, $\Delta(p, w) > 0$ implies:

$$AC_d(q_f) \equiv \frac{C_d(Q) - C_d(q_d)}{q_f} > \rho = p - w. \tag{9}$$

Thus, a necessary condition for rent extraction is that the integrated firm sets the downstream margin below its average cost of producing extra q_f units; that is, the vertically integrated firm adopts a price squeeze strategy according to the following definition:

Definition 1 *Price Squeeze. A vertically integrated firm is engaged in a price squeeze if it sets the downstream price margin below its average cost of producing the residual output that it would have produced without competitors.*

Intuitively, a sufficient condition for such production reshuffling to be profitable is $MC_d(Q^m) > MC_f(0)$. That is, the dominant firm's marginal cost for the last unit is higher than the competitor's marginal cost at initial production. Note that the vertically integrated firm can exclude the downstream competitor by setting $w = p^m$ (thus $q_f = 0$) and earns a monopoly profit π^m. The dominant firm's marginal cost of producing the last unit is equal to $MC_d(Q^m)$. When $MC_d(Q^m) > MC_f(0)$, by continuity, there exists a value $\hat{q}_f > 0$, such that $MC_d(Q^m - q_f) > MC_f(q_f)$ for all $q_f < \hat{q}_f$. This suggests that it is profitable to reallocate part of the production to the competitor.

Summarizing the above analysis then leads to:

Proposition 2 *Suppose an upstream monopoly is vertically integrated with a downstream dominant firm and competes with a competitive fringe of small firms. When Assumptions B and C hold, then:*

- *the integrated firm can extract efficiency rents from the competitor if and only if it adopts a price squeeze;*
- *rent extraction arises if the dominant firm's marginal cost of producing the last unit of the monopoly output is higher than the competitor's marginal cost of producing the first unit.*

Proof. See Appendix A. ■

The above proposition provides a testable implication for exploitation. A necessary condition for exploitation is price squeeze. To examine whether a vertically integrated firm's pricing strategy is exploitative, it suffices to check if the condition in definition 1 is satisfied. The sufficient condition for rent extraction also indicates that exploitation arises under quite general conditions. It does not require the rival to be more efficient than the dominant firm: it only requires that the competitor's marginal cost of producing the first unit is less than the dominant firm's marginal cost of producing the last unit of the monopoly output. This holds even if the competitor's marginal cost is uniformly higher than the dominant firm's marginal cost for any output level, that is, if $MC_f(q) > MC_d(q)$ for any q, but $MC_f(0) < MC_d(Q^m)$ (see Figure 2).

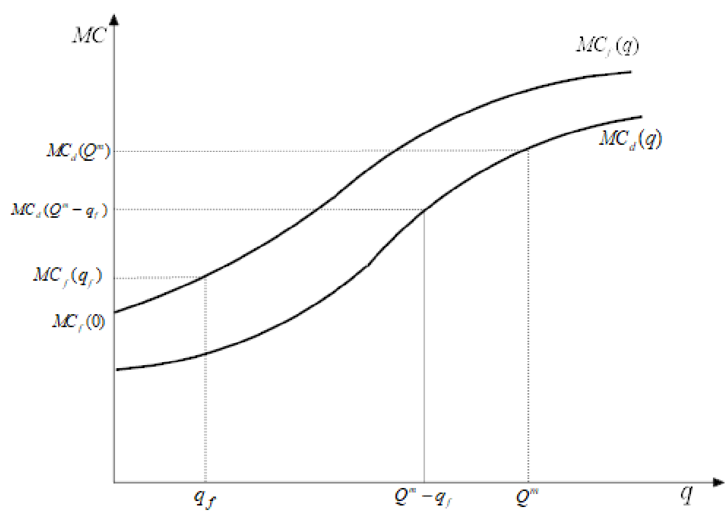

Figure 2 General Cost Functions

Competition authorities are more concerned with exclusion than exploitation; however, the exclusion rationale of a price squeeze has been heavily challenged by legal scholars and economists. This paper proposes an exploitation rationale for a price squeeze and shows that a price squeeze strategy used as exploitative abuse can arise in very general conditions. When a vertically integrated dominant firm competes with small rivals, it can exploit the rival as long as the latter is not socially inefficient in production. Such exploitation of efficiency gain can be achieved through production reshuffling. When the dominant downstream firm is vertically integrated with an upstream monopoly, it is able to exclude the downstream rival and become a monopoly in the downstream market. However, when the dominant firm's marginal cost of producing the last unit is higher than the rival's marginal cost of producing the first unit, it is more efficient to reallocate the production of the last unit to the rival. The vertically integrated firm can extract part of the cost saving by adopting a price squeeze strategy.

Yet, this production reallocation process under vertical integration is different from that under horizontal merger, in which the merged firm can fully control the process to minimize the total cost. Here, the dominant firm cannot fully control this production reshuffling under vertical integration. This process is essentially the same as outsourcing: the dominant firm pays the fringe firm to produce q_f units at a per-unit price, ρ, saving its production cost for these units. On the other hand, the vertically integrated firm is unable to extract the total efficiency gain from production reshuffling, because the competitor retains part of the benefit as its profit. This causes an efficiency loss, as the dominant firm and the competitor are unable to maximize their joint profits.

3 Regulations and Remedies for Competition

3.1 Regulations

Current Regulation

The New Zealand dairy industry is regulated by the Ministry of Agriculture and Forestry (it is now called the Ministry of Primary Industries) according to the Dairy Industry Restructuring Act (DIRA). Under current regulations, Fonterra is obliged to supply up to 600 million litres of raw milk per season (about 5% of its total collection) to independent processors at the same raw milk price that Fonterra pays to its farmers. The raw milk price is set by Fonterra according to the so-called Milk Price Manual. Both MAF and the Commerce Commission argue that this obligation of supply could prevent Fonterra from exercising market power against independent processors. Our analysis does not support their arguments.

Suppose the cooperative is obliged to supply $\bar{q}$ units to the competitive fringe firms, where $\bar{q}$ is the maximum requirement imposed by the regulator. If $\bar{q} > q_f^*$, this constraint of capacity is not binding as the fringe firms will produce q_f^* such that $MC_f\left(q_f^*\right) = p - w$ and Fonterra cannot force the fringe firms to buy more. If, instead $\bar{q} < q_f^*$, the independent processors want to purchase q_f^* and Fonterra is willing to supply more because q_f^* maximizes the efficiency rents. Intuitively, when the cooperative can set the raw milk price, it can induce the independent processors to produce q_f^* optimally. Therefore, such a maximum-quantity requirement cannot prevent Fonterra from rent extraction.

The DIRA "generally allows Fonterra to exercise wide discretion in making what are very technical and necessarily subjective input decisions". Fonterra's pricing manual is reviewed by the Commerce Commission each year, however, the regulator's recommendations are not mandatory for Fonterra:[24]

"To avoid the risk of regulatory error arising from asymmetric information, the Commerce Commission's findings are not binding on Fonterra's benchmark price calculation. Instead, they are designed to provide an informed public commentary by a credible and independent expert, with access to commercially sensitive information, to promote transparency of Fonterra's necessarily subjective assumptions that underpin the benchmark price calculation." It appears that the current regulation does not constrain Fonterra's market power.

ECPR Rule

If the government's objective is to protect competition and consumer welfare, it should regulate the raw milk price. Suppose the regulator sets the raw milk price w and the independent processors are free to access the raw milk supply at that price. The independent processor will optimally produce $q_f(p; w)$ according to equation (2). The cooperative's profit is then given by:

$$\begin{aligned}\Pi(p) &= \pi(p) - K(p, w) \\ &= \pi(p) - (MC_f(q_f) - c_d)\, q_f(p; w).\end{aligned}$$

The dominant firm chooses p to maximize its profit, and it now faces a trade-off as it could not extract the independent firm's profit by adjusting w.

First, we note that the Efficient Component Pricing Rule (known as the ECPR) can prevent Fonterra from exploitation. Some experts also argue that using ECPR pricing could improve downstream competition and thus reduce the final price, however, this is not true in Fonterra's case. Using the ECPR pricing rule requires the dominant firm to charge $w = p - c_d$. Given this price, the independent processor will produce q_f such that $MC_f(q_f) = p - w = c_d$, and the cooperative earns a profit exactly equal to the monopoly profit:

$$\Pi(p) = \pi(p).$$

It thus follows that consumers still face monopoly price p^m. It is true that under the ECPR rule the cooperative is unable to extract efficiency rents from the fringe firm, and the latter becomes better off. However, this rent redistribution does not benefit consumers.

[24] See "Modifying Fonterra's obligations under the Dairy Industry Restructuring Act 2001 (DIRA) regulatory regime", page 35; https://www.mpi.govt.nz/law-and-policy/legal-overviews/primary-production/dairy-industry-restructuring-act/dairy-industry-restructuring-act-2001-review/.

In May 2019, the DIRA was reviewed by the Ministry of Primary Industry of New Zealand (which has been transformed from the Ministry of Agriculture and Forestry). One of the main focuses of the review was to reform Fonterra's raw milk pricing approach. The Ministry acknowledges that there is an opportunity to improve Fonterra's benchmark milk pricing calculation. Indeed, in its yearly review 2017/2018, the Commerce Commission identified that Fonterra's estimation of the cost for a notional processor was too low and the resulting raw milk price was too high, which could reduce the profitability of the independent processors. The Ministry recommends amending the DIRA to reduce Fonterra's discretion in setting a key assumption (asset beta) underpinning the benchmark price calculation; in particular, it requires Fonterra's estimation of cost to be based on the milk processing operations of a "real" processor rather than a "notional" competitor:[25]

"Under this option, the DIRA would be amended to require Fonterra to adopt the Commerce Commission's approach to setting the asset beta assumption in its benchmark price calculation. The DIRA would require Fonterra to rely on the estimate of risk (measured by asset beta) consistent with dairy and other commodity processors when estimating the cost of financing milk processing operations."

The recommendation is consistent with the ECPR pricing rule. Provided that the Commerce Commission can estimate and calculate the average cost of milk processing adequately, this reform could prevent rent extraction by Fonterra and achieve an efficient output level.

Optimal Regulation

To reduce the final milk price, the regulator must set the raw milk price such that $w < p^m - c_d$. It is straightforward to see that the equilibrium price p decreases in w, thus the optimal regulation must set the raw milk price to the marginal cost of production; that is, $w = \gamma$. Given this pricing rule, the fringe processor will produce $q_f(p)$, such that $MC_f(q_f) = p - \gamma$. The dominant processor then faces a residual demand equal to $D_d(p) = D(p) - q_f(p)$, and earns a profit equal to:

$$\begin{aligned} \Pi(p) &= \pi(p) - (p - \gamma - c_d)\, q_f(p) \\ &= \pi(p) - \hat{K}(p), \end{aligned} \tag{10}$$

[25] See "Modifying Fonterra's obligations under the Dairy Industry Restructuring Act 2001 (DIRA) regulatory regime", page 37; https://www.mpi.govt.nz/law-and-policy/legal-overviews/primary-production/dairy-industry-restructuring-act/dairy-industry-restructuring-act-2001-review/.

where $\hat{K}(p) \equiv (p - \gamma - c_d)\, q_f(p)$ is the foregone profit due to the supply from the independent processors. As $p > \gamma + c_d$, the cooperative receives a lower profit than the monopoly level. As a result, the cooperative charges a final price lower than the monopoly price. To see this, the optimal final price must satisfy:

$$\frac{\partial \Pi(p)}{\partial p} = \frac{\partial \pi(p)}{\partial p} - \frac{\partial \hat{K}(p)}{\partial p} = 0, \tag{11}$$

which implies:

$$\begin{aligned} \frac{\partial \pi(p)}{\partial p} &= \frac{\partial \hat{K}(p)}{\partial p} \\ &= q_f(p) + (p - \gamma - c_d)\, q_f'(p) > 0, \end{aligned}$$

since $q_f'(p) > 0$. Therefore, the optimal price, which solves equation (11) is lower than p^m (recall that p^m maximizes $\pi(p)$).

When the fringe processor is free to access the raw milk at a per-unit price equal to the marginal cost of the production of raw milk, the cooperative is unable to extract the rents from the fringe firm. The cooperative then faces a trade-off in the determination of the final price. A higher price p will attract the independent processor to produce more and thus squeeze the residual demand facing the dominant processor. Moreover, as the cooperative sets a positive markup $p - \gamma - c_d > 0$, it attracts the independent processor to produce more than the efficient level: $MC_f(q_f) = p - \gamma > c_d$. Thus, the optimal regulation reduces the final price but causes inefficiency in milk processing.

To conclude the above analysis, we obtain:

Proposition 3 *Suppose the regulator imposes a maximum-quantity requirement for the supply of raw milk but allows the cooperative to set the raw milk price. Such regulation does not prevent rent extraction and market foreclosure. ECPR pricing prevents Fonterra from exploitation but does not contribute to reducing the final price. The optimal regulation must set the raw milk price equal to the marginal cost, which results in a lower final price than the monopoly level but involves inefficiency in milk processing.*

3.2 Remedy: Downstream Mergers

So far we have focused on the scenario in which the independent processors are competitive fringe firms. The vertically integrated cooperative could exploit these fringe processors by setting a high raw milk price. To prevent such rent extraction, the independent processors may want to merge and form a strategic rival against the dominant processor. For the competition authorities, whether or not such mergers could improve consumer surplus needs to be carefully evaluated.

Suppose all fringe processors merge to become one firm. The merged independent processor, as denoted by firm e, becomes a strategic player and competes with the dominant processor. For the purpose of comparison, we assume away the synergy effect of the merger and thus the merged firm faces the same aggregate cost equal to $C_f(q)$. The cooperative has the first-mover advantage by setting the raw milk price w and choosing the quantity q_d first, and thus operates as the Stackelberg leader in the downstream market, whereas the merged processor becomes the Stackelberg follower. Observing w and q_d, the independent processor chooses its output q_e to maximize its profit:

$$\pi_e(q_e) = (P(Q) - w)\, q_e - C_f(q_e),$$

where $Q = q_d + q_e$ represents the total supply and $p = P(Q)$ is the inverse demand function. Solving for firm e's best response (as the function of Q and w) leads to:

$$MC_f(q_e) - P'(Q)\, q_e = P(Q) - w. \tag{12}$$

Recall that the fringe firm's optimal output is determined such that its marginal cost $MC_f(q_f)$ is equal to the profit margin $\rho = p - w$, whereas here the strategic firm's optimal output reflects the fact that its marginal cost is lower than the profit margin. That is, firm e will produce less than the fringe firm given the same margin ρ. This is because the Stackelberg follower is not a price taker and will take into account its impact on the final price.

Assume that the demand function is not too convex such that $P'(Q) + P''(Q)\, Q < 0$. Then, equation (12) uniquely determines firm e's best response as denoted by $q_e \equiv q_e(q_d, w)$, which decreases in w and q_d. Taking into account the follower firm's best response, the cooperative chooses w and q_d to maximize its total profit:

$$\begin{aligned} \hat{\Pi}(q_d, w) &= (P(Q) - c_d)\, q_d + w q_e - \gamma Q \qquad (13) \\ &= (P(Q) - c_d - \gamma)\, Q - (P(Q) - w - c_d)\, q_e \\ &= \pi(Q) - (P(Q) - w - c_d)\, q_e(q_d, w), \end{aligned}$$

where $\pi(Q) = (P(Q) - c_d - \gamma)\, Q$ represents the aggregate profit of the vertically integrated cooperative in the absence of competition, and the second term is the foregone benefit due to competition from firm e. Obviously it is optimal for the vertically integrated cooperative to set a high raw milk price w such that $P(Q) - w < c_d$, in order to extract the efficiency rents from firm e. This implies:

$$MC_f(q_e) = P(Q) - w + P'(Q)\,q_e < c_d + P'(Q)\,q_e < c_d.$$

That is, firm e will produce at a lower marginal cost than the dominant firm.

When the competitive fringe of independent processors merge to form a strategic player and competes as a Stackelberg follower with the dominant processor, the cooperative's market power is mitigated and it can exploit less efficiency rents than before the merger. Substituting firm e's best response (12) into the cooperative's profit function (13), we obtain:

$$\hat{\Pi}(q_d) = \pi(Q) - \big(MC_f(q_e) - P'(Q)\,q_e - c_d\big)\,q_e = \pi(Q) + \hat{R}(q_e),$$

where $\hat{R}(q_e) \equiv (c_d - MC_f(q_e) + P'(Q)\,q_e)\,q_e$ denotes the efficiency rents. The cooperative induces q_e to maximize $\hat{R}(q_e)$. Since $\hat{R}(q) < R(q) = (c_d - MC_f(q))\,q$ for any given q, a simple revelation argument shows that $q_e^* = \arg\max \hat{R}(q) < q_f^* = \arg\max R(q)$. Thus, the cooperative extracts less rents than in the scenario with the competitive fringe: $\hat{R}(q_e^*) < R\left(q_f^*\right)$, and it earns less total profit after the merger:

$$\hat{\Pi}^* = \pi^*(Q^*) + \hat{R}(q_e^*) < \pi^m + R\left(q_f^*\right).$$

The merger of independent processors curbs the market power of the integrated firm and thus benefits the small competitors. However, such a merger does not necessarily benefit consumers. The final output of this Stackelberg equilibrium Q^* can be higher or lower than the monopoly level Q^m, depending on the shape of the demand function. Suppose the vertically integrated cooperative wants to induce the monopoly output Q^m (thus keeping the monopoly final milk price p^m) and sets the raw milk price at w^* as before. The Stackelberg follower would produce less than the competitive fringe and, as a result, the cooperative could extract less rents than the optimal level. The cooperative then has the incentive to increase the retail margin $\rho = P(Q) - w$ and induce the firm e to produce more, by either reducing output q_d or decreasing w. This results in a higher total output (lower final price) than before the merger when the demand function is convex, and the price changes have a large impact on quantity. Conversely, this leads to a lower total output (higher final price) when the demand function is concave.

To see this, using the entrant's best response equation (12), we can rewrite the cooperative's profit function as:

$$\hat{\Pi}(q_d) = \pi(Q) - \big(MC_f(q_e) - P'(Q)\,q_e - c_d\big)\,q_e.$$

Choosing q_d to maximize $\hat{\Pi}(q_d)$, the optimal output q_d^* (note that $q_d^* = Q^* - q_e^*$) satisfies:

$$\pi'(Q^*) = -P''(Q^*)\,(q_e^*)^2.$$

It follows that $\pi'(Q^*) > 0$ if and only if $P''(Q^*) \leq 0$. Recall that $\pi'(Q^m) = 0$, thus the final output Q^* is higher than the monopoly output Q^m (i.e., $p^* < p^m$) if the inverse demand function is convex, since convex demand means that price changes have a large impact on quantity. In contrast, the final output is lower than Q^m (i.e., $p^* > p^m$) if the demand is concave since concave demand means that the price changes have a small impact on quantity.

Summarizing the above analysis leads to:

Proposition 4 *Suppose fringe independent processors merge to form a strategic player and compete with the dominant processor as a Stackelberg follower. Then:*

- *the cooperative exploits less rents than before the merger;*
- *consumers face a higher final milk price than before the merger if the inverse demand function is concave and face a lower price if the demand is convex.*

Proof. See Appendix B. ■

4 Limited Upstream Competition

The dairy cooperative Fonterra is a quasi-monopoly in the supply of raw milk. However, it has been facing competition from new upstream entrants over recent years. The growth of the New Zealand dairy industry has attracted several foreign investors to acquire dairy farms. The Chinese investor Shanghai Pengxin Ltd. acquired the Crafar dairy farms in the central North Island: an acquisition that was approved by the New Zealand Government in 2011. Yet, such foreign investments are subject to the scrutiny of and are regulated by the government, and the size of the acquired farm land is restricted. These legal restrictions aim to protect Fonterra's dominant position in the upstream market.[26]

Nevertheless, when small entrants come into the upstream market, the vertically integrated firm faces competition in both downstream and upstream, and its market power of exploitation will be mitigated. Can the vertically integrated firm still exploit competitors when it faces competition in both upstream and downstream markets?

To answer this question, we extend our baseline model to examine the capacity of exploitation in the presence of an upstream entrant. Suppose there is another source of supplying the

[26] Shanghai Pengxi's second application for aquiring the Lochinver farm was rejected by the Overseas Investment Office of New Zealand in September 2015. See https://www.stuff.co.nz/business/farming/agribusiness/72135607/.

homogenous raw milk in the upstream market from a representative entrant. Due to legal restrictions, the entrant's capacity (or the size of farm land) is limited and its market share is quite small relative to Fonterra. It is thus reasonable to assume that the entrant is a competitive fringe firm and price taker. We are interested in the case with more efficient upstream entrants and, thus, assume that the entrant incurs a lower constant marginal cost $\gamma - \theta$ than the incumbent supplier, where $\theta \geq 0$ is the cost advantage. Denoting by s the size of the entrant, it will produce s units for any price $w \geq \gamma - \theta$ and zero for $w < \gamma - \theta$. As in the baseline setting, we assume that the downstream dominant firm incurs the constant marginal cost c_d, whereas the competitive fringe firm faces the increasing marginal cost $MC_f(\cdot)$.

The vertically integrated firm is the price leader in both markets and meets the residual demand in both markets. The upstream entrant can sell to either the dominant firm or to the downstream fringe firm at a per-unit price $w \geq \gamma - \theta$. Likewise, the downstream fringe firm can purchase from either the incumbent firm or the entrant at the same price. The equilibrium price of the intermediate good is determined when the total supply meets the aggregate demand. We restrict attention to non-discriminatory pricing in the upstream market, which is consistent with the evidence from most intermediate good markets, including the raw milk market. Discriminatory pricing in wholesale markets is not allowed in some industries due to regulation and could violate antitrust laws in some jurisdictions, including the US.

Conditions for Exploitation

The integrated firm sets the raw milk price $w > \gamma - \theta$, and the upstream competitor produces at its full capacity s.[27] The demand from the downstream competitor, $q_f(\rho)$, increases with the downstream price margin $\rho = p - w$. When ρ is sufficiently high such that $q_f(\rho) > s$, the downstream competitor will purchase the excessive demand $q_f - s$ from the integrated firm, and the latter can make an extra profit by setting $w > \gamma$. Whenever ρ is set sufficiently low such that $q_f(\rho) < s$, there is an excessive supply from the entrant and the integrated firm will purchase $s - q_f$ from the entrant, in which case it can exploit the entrant by setting $w < \gamma$.

Our first observation is that the vertically integrated firm cannot exploit more efficient competitors in both the upstream and downstream markets. A necessary condition for exploitation in one market is that the vertically integrated firm must set the price margin below its cost in that market. If the vertically integrated firm wants to exploit the downstream competitor, it must set its downstream margin $\rho = p - w$ below its cost c_d. Likewise, the integrated firm must set its upstream margin w below cost γ in order to exploit the upstream competitor. It is then

[27] We do not consider predation in this static setting.

straightforward to see that the integrated firm cannot exploit from both sides at the same time, as otherwise its total price margin, $w + \rho = p$, would be lower than the total average cost $c_d + \gamma$ and the integrated firm incurs a loss.

Facing competition in both markets, the vertically integrated firm's exploitation capacity is restrained, and it faces a trade-off of exploitation between the upstream and downstream markets. It can exploit either the upstream or the downstream competitor, but it cannot do both. If we observe downstream exploitation, then the integrated firm must accommodate the entrant in the upstream market, and vice versa.

The integrated firm's profit comes from two sources: the profit from selling the final product, $(p - \gamma - c_d) D_d(p)$, and the profit from selling (or buying) the intermediate good $(w - \gamma)(q_f - s)$. Its total profit is given by:

$$\begin{aligned} \Pi(p, w) &= (p - \gamma - c_d) D_d(p) + (w - \gamma) q_f(\rho) - (w - \gamma) s \\ &= \pi(p) + R(\rho) - L(w), \end{aligned} \tag{14}$$

where, as in the baseline model, $\pi(p) = (p - \gamma - c_d) D(p)$ is the profit that the integrated firm could have earned as the monopoly of the industry and $R(\rho) = (c_d - \rho) q_f(\rho)$ is the efficiency rents from the downstream competitor. The last term, $L(w) \equiv (w - \gamma) s$, which is new here, represents the foregone benefit due to the supply from the upstream competitor. However, $L(w)$ can be another source of profit when the integrated entity sets $w < \gamma$ and exploits the upstream entrant.

The first term $\pi(p)$ depends on p only and increases in p for any $p \leq p^m$, the third term $L(w)$ depends on w only and increases in w, whereas the second term $R(\rho)$ depends on both p and w. Changing p and w have different effects on $R(\rho)$, and these effects are cancelled out when p and w are modified with the same amount. Increasing the final price p has a positive impact on the profit $\pi(p)$ but a negative impact on the rent $R(\rho)$. In equilibrium, the marginal benefit and marginal cost of increasing p must be cancelled out, and the equilibrium price is determined by the following first-order condition:

$$\pi'(p) = -R'(\rho). \tag{15}$$

Likewise, increasing w has a positive impact on the rent $R'(\rho)$ but a negative impact on the foregone benefit $L(w)$, and the equilibrium price w must balance the marginal benefit and marginal cost, as given by:

$$-R'(\rho) = L'(w) = s. \tag{16}$$

It is straightforward to see that the integrated firm can exploit the downstream competitor *only if* the rival has excessive demand that needs to be fulfilled from the integrated firm. To see this, solving for equation (16) leads to:

$$q_f(\rho) - s = (c_d - \rho)\, q_f'(\rho),$$

thus, the integrated entity adopts a price squeeze downstream (i.e., $\rho < c_d$) if and only if:

$$s < q_f(\rho).$$

The above condition also indicates that, as long as the downstream competitor has excessive demand, the integrated firm extracts efficiency rents using a price squeeze strategy. This sufficient condition provides a testable implication for downstream exploitation: rent extraction arises when and only when the downstream competitor purchases from the integrated firm. Using the fact that $q_f(\cdot)$ is increasing, we can rewrite the condition for exploitation as:

$$s < q_f(\rho) < q_f(c_d) = \bar{q}_f, \tag{17}$$

where $\bar{q}_f$ is the competitor's efficient output as given by $MC_f(\bar{q}_f) = c_d$. Hence, rent extraction in the downstream market arises if and only if the upstream entrant cannot meet the demand of the efficient output from the downstream competitor.

Intuitively, when $s < \bar{q}_f$, the downstream competitor's marginal cost of producing s units is less than c_d: $MC_f(s) < MC_f(\bar{q}_f) = c_d$, thus, it is still profitable for the integrated firm to reallocate part of the production to the downstream rival, and it can extract part of the efficiency rents by production reshuffling. On the contrary, when $s \geq \bar{q}_f$, the downstream competitor's marginal cost exceeds c_d and there is no efficiency gain from production reallocation, in which case rent extraction in the downstream market will not arise.

In contrast, when the entrant's capacity is sufficiently large, the integrated firm may instead exploit the upstream entrant by setting $w < \gamma$. This transforms the loss of foregone benefit $L(w)$ into a source of profit. But, at the same time, it raises the downstream margin ρ, resulting in a loss in the downstream market. Thus, the integrated firm faces a new trade-off. Rent extraction in the upstream market arises when the marginal benefit exceeds the marginal cost; that is, when $L'(w) > -R'(\rho)$, and this condition is equivalent to:

$$s > \bar{s} \equiv q_f(\hat{p} - \gamma) + (\hat{p} - \gamma - c_d)\, q_f'(\hat{p} - \gamma), \tag{18}$$

where $\hat{p}$ is the optimal final good price that solves the first-order condition (15). Note that $\bar{s} > q_f(\hat{p} - \gamma) > q_f(c_d) = \bar{q}_f$, then, rent extraction does not arise when s lies between $\bar{q}_f$ and $\bar{s}$.

Summarizing the above analysis leads to:

Proposition 5 *Suppose the vertically integrated firm faces competitive fringe firms in both upstream and downstream markets, then:*

- *the integrated firm cannot exploit the upstream and downstream rivals at the same time;*
- *the integrated firm exploits the downstream competitor if and only if $s < \bar{q}_f$, and it exploits the upstream competitor if and only if $s > \bar{s}$;*
- *the integrated firm does not extract efficiency rents from either the upstream or downstream competitor when $\bar{q}_f \leq s \leq \bar{s}$.*

Proposition 5 establishes conditions for rent extraction upstream or downstream, taking the size of the upstream entrant as given. When the upstream entrant is too small to meet the demand of the efficient output from the downstream competitor, the integrated firm is still able to exploit the downstream competitor. When the upstream entrant is sufficiently large, the integrated firm will instead exploit the upstream entrant. However, rent extraction does not arise when the entrant is a medium size firm.

Equilibrium Prices

We now solve for the equilibrium prices and, moreover, examine the impact of increasing the size s on equilibrium prices. First, in the presence of upstream competition, the integrated firm can no longer charge the monopoly price. The final good price $\hat{p}$ is lower than the monopoly price p^m and is decreasing in s. To see this, combining conditions (15) and (16), we obtain:

$$\pi'(\hat{p}) = s,$$

which leads to $\hat{p} = \phi(s)$, where $\phi(\cdot)$ is the inverse function of $\pi'(\cdot)$. Since $\pi'(\hat{p}) > 0 = \pi'(p^m)$, it follows that $\hat{p} < p^m$. Moreover, the final good price $\hat{p} = \phi(s)$ decreases with s since its inverse function $\pi'(p)$ is decreasing in p.

Second, the equilibrium downstream margin $\hat{\rho}$ that solves the first-order condition $-R'(\hat{\rho}) = s$, is increasing in s. Denote by $\varphi(\cdot)$ the inverse function of $-R'(\cdot)$, then $\hat{\rho} = \varphi(s)$ increases in s since $-R(\rho)$ is convex. Thus, the downstream margin, as well as the downstream competitor's profit, increases with the upstream entrant's capacity. Finally, since $\hat{\rho}$ increases in s while $\hat{p}$ decreases in s, the intermediate good price $\hat{w}$ must decrease in s and more than offsets the reduction of $\hat{p}$ such that $\hat{\rho}$ increases in s.

Interestingly, the integrated firm's profit decreases with s for $s \leq \bar{s}$, then increases with s for $s > \bar{s}$. To see this, applying the envelope theorem to the equilibrium profit $\Pi(\hat{p}, \hat{w})$, we obtain

$d\Pi(\hat{p}, \hat{w})/ds = -(\hat{w} - \gamma)$. Thus, the integrated firm's profit decreases with s for $w > \gamma$ due to the competition effect, and increases in s for $w < \gamma$ due to the exploitation effect.

The following proposition summarizes the analysis:

Proposition 6 *Suppose the vertically integrated firm competes with the competitive fringe firms in both upstream and downstream markets, then:*

- *both the final and intermediate good prices decrease with the size of the upstream entrant s;*
- *the downstream price margin and the competitor's profit increase in s;*
- *the integrated firm's profit decreases in s for $s \leq \bar{s}$ and increases in s for $s > \bar{s}$.*

The following simple example further illustrates the equilibrium.

Example 1: Consider the linear demand $D(p) = a - p$ with $a > 2c_d + \gamma$, and assume further $MC_f(q) = q$. Then:

$$\pi'(p) = D(p) + (p - c_d - \gamma) D'(p) = a + c_d + \gamma - 2p,$$

and the optimal final good price $\hat{p}$, which solves $\pi'(p) = s$, is given by:

$$\hat{p} = \frac{a + c_d + \gamma - s}{2}.$$

In particular, $\hat{p} = p^m$ when $s = 0$. Moreover, solving for (16) gives the downstream margin:

$$\hat{\rho} = \hat{p} - \hat{w} = \frac{c_d + s}{2}.$$

Thus, the equilibrium intermediate price is equal to:

$$\hat{w} = \hat{p} - \hat{\rho} = \frac{a + \gamma}{2} - s.$$

Finally, downstream exploitation happens when $s < \bar{q}_f = c_d$ (i.e., $\hat{\rho} < c_d$), upstream exploitation arises when $s > \bar{s} = \frac{a-\gamma}{2}$, and no rent extraction arises for $c_d \leq s \leq \bar{s}$.

Vertically integrated farm cooperatives possesses substantial market power within the dairy industry. The entry of small but more efficient competitors in the upstream market could mitigate the integrated firm's market power, but does not prevent it from rent extraction. When the entrant's size is sufficiently small, the integrated firm will exploit the downstream competitor. In contrast, when the entrant's size is sufficiently large, exploiting the upstream competitor becomes more profitable, and the integrated firm's profit increases with the size of the entrant, as long as the entrant remains a price taker.

5 Conclusions

Farm cooperatives have been treated as an organization of countervailing power to mitigate the monopsony power in the agricultural processing market. However, the formation of vertically integrated cooperatives and mergers between existing cooperatives has led to substantial market power. As a result, in many countries farm cooperatives have become dominant in the industry and compete only with a competitive fringe of small independent processors. We find that the vertically integrated cooperative can exploit efficiency rents from competitors through the price squeeze strategy and, in this way, earn a profit even higher than the monopoly level. While such rent extraction results in partial foreclosure of the competitor's production, the foreclosure effect is a by-product of rent extraction, because the cooperative has no incentive to exclude the more efficient small competitors. Our theoretical analysis reveals the exploitative nature of Fonterra's milk pricing manual. We then examine the regulations of the dairy industry and the structure remedy for mitigating the cooperative's market power. The analysis is also extended to investigate the effect of limited competition in the upstream market, and we find that competition in both the upstream and downstream markets curbs the cooperative's capacity for rent extraction, and as a result, it can exploit efficiency rents from only one side. Our paper provides a theoretical foundation for the competition policy to restrict the market power of farm cooperatives.

The economic literature on farm cooperatives has mostly focused on ownership structures and the governance of the cooperative,[28] while, the research on the pricing behaviors of farm cooperatives is limited. In a pioneering paper, Helmberger and Hoos (1963) analyzed the impact of cartelization by a group of farmers supplying a perfect competitive processing market. They found that the group can raise the market price by restricting supply of members, and that farms outside the group can also benefit; a result that is now well-known in Cournot competition. Sexton (1990) finds that a cooperative will set farm gate prices on the basis of average revenue production rather than marginal revenue production. This can lead to more aggressive pricing and benefits all farmers. This paper studies the pricing behaviors of vertically integrated cooperatives and examines the anticompetitive nature of such pricing strategies. The existing literature views the formation of farm cooperatives as a countervailing market power

[28] For instance, Banerjee et al. (2001) study rent-seeking within agricultural cooperatives and find that inequality of asset ownership affects relative control rights of different groups of members. See Cook et al. (2004) for a detailed survey of the literature.

against the monopsonic power in the processing industry. Indeed, it has been largely ignored that many farm cooperatives become dominant in the industry and can actually exercise their market power in order to exploit small competitors and monopolize the market. Our research thus sheds new light on the harm caused by farm cooperatives to competition and appeals for increased regulation in the highly concentrated agricultural industries.

We have assumed away the agency problem within the farm cooperative in order to focus on the analysis of the cooperative's pricing behavior. Like other kind of organizations, the agency problem could affect the efficiency of the cooperative and may further affect the cooperative's pricing behavior. The study of such interaction is certainly important, and we leave this to the future research agenda.

Appendix A: Proof of Proposition

The first statement is shown in the main context. We show now that rent extraction arises if $MC_d(Q^m) > MC_f(0)$. Suppose $MC_d(Q^m) > MC_f(0)$. By assumption $MC_f(q)$ is increasing for small q, and by continuity, there exists a value $\hat{q}_f > 0$ such that $MC_d(Q^m - q_f) > MC_f(q_f) > MC_f(0)$ for all $q_f < \hat{q}_f$. Note that the integrated firm can always exclude the downstream competition and earn the monopoly profit π^m. Suppose now that the integrated firm reallocates q_f units ($q_f < \hat{q}_f$) to the competitor such that $MC_d(Q^m - q_f) > MC_f(q_f)$, while keeping the total output at Q^m (and thus the price $p = p^m$). Then, for all $q_f < \hat{q}_f$, we have:

$$C_d(Q^m) - C_d(Q^m - q_f) = \int_{Q^m - q_f}^{Q^m} MC_d(q)\, dq > \int_{Q^m - q_f}^{Q^m} MC_f(q_f)\, dq = MC_f(q_f)\, q_f.$$

The competitor is a competitive fringe firm and its best response is given by $MC_f(q_f) = \rho$. By construction, $MC_f(q_f)$ is increasing in q_f, for all $q_f < \hat{q}_f$, thus, the vertically integrated firm can set ρ to induce a given $q_f < \hat{q}_f$. It follows that condition $MC_d(Q^m) > MC_f(0)$ implies:

$$\Delta(p^m, w) = C_d(Q^m) - C_d(Q^m - q_f) - \rho q_f > 0.$$

Q.E.D.

Appendix B: Proof of Proposition 4

We show first that the competitor's best response function is well-defined and monotonic under the assumption $P'(Q) + P''(Q)\, Q < 0$. Note that the best response, $q_e(q_d, w)$, is determined by the following equation:

$$MC_f(q_e) - P'(Q)\, q_e = P(Q) - w.$$

Totally differentiating both sides with respect to w and q_d and rearranging the following equations, we obtain:

$$\begin{aligned} \frac{\partial q_e}{\partial w} &= \frac{-1}{MC_f'(q_e) - 2P'(Q) - P''(Q)\, q_e}, \\ \frac{\partial q_e}{\partial q_d} &= \frac{P'(Q) + P''(Q)\, q_e}{MC_f'(q_e) - 2P'(Q) - P''(Q)\, q_e}, \end{aligned} \tag{19}$$

which implies

$$\frac{\partial q_e}{\partial q_d} = -\left(P'(Q) + P''(Q)\, q_e\right) \frac{\partial q_e}{\partial w}. \tag{20}$$

Since $MC_f'(q_e) > 0$ and $2P'(Q) + P''(Q)\,q_e < P'(Q) + P''(Q)\,Q < 0$, the denominator is positive. Moreover, the numerator is negative: $P'(Q) + P''(Q)\,q_e < P'(Q) + P''(Q)\,Q < 0$. Thus, the best response function $q_e(q_d, w)$ is decreasing in w and q_d and is uniquely defined, given any values of w and q_d.

We have shown in the main context that the vertically integrated firm can earn more than monopoly profits through rent extraction, and that it exploits less rents and less profits than facing the fringe firm. It remains to prove the last statement regarding the final price and verify the below-cost pricing in equilibrium.

Recall that the integrated firm's profit is given by:

$$\hat{\Pi}(q_d, w) = \pi(Q) - (P(Q) - w - c_d)\,q_e(q_d, w).$$

Differentiating $\hat{\Pi}(q_d, w)$ with respect to w and q_d, we obtain:

$$\begin{aligned}
\frac{\partial \hat{\Pi}(q_d, w)}{\partial w} &= \left[\left(\pi'(Q) - P'(Q)\,q_e\right) - (P(Q) - w - c_d)\right]\frac{\partial q_e(q_d, w)}{\partial w} + q_e, \\
\frac{\partial \hat{\Pi}(q_d, w)}{\partial q_d} &= \left(\pi'(Q) - P'(Q)\,q_e\right)\left(1 + \frac{\partial q_e}{\partial q_d}\right) - (P(Q) - w - c_d)\,\frac{\partial q_e}{\partial q_d}.
\end{aligned}$$

Solving for the first order conditions yields:

$$q_e = -\left[\left(\pi'(Q) - P'(Q)\,q_e\right) - (P(Q) - w - c_d)\right]\frac{\partial q_e(q_d, w)}{\partial w}, \tag{21}$$

$$\pi'(Q) - P'(Q)\,q_e = -\left[\left(\pi'(Q) - P'(Q)\,q_e\right) - (P(Q) - w - c_d)\right]\frac{\partial q_e(q_d, w)}{\partial q_d}. \tag{22}$$

Using the relation (20), we obtain:

$$\begin{aligned}
\pi'(Q) - P'(Q)\,q_e &= -\left[\left(\pi'(Q) - P'(Q)\,q_e\right) - (P(Q) - w - c_d)\right]\frac{\partial q_e(q_d, w)}{\partial q_d} \qquad (23) \\
&= \left[\left(\pi'(Q) - P'(Q)\,q_e\right) - (P(Q) - w - c_d)\right]\frac{\partial q_e}{\partial w}\left(P'(Q) + P''(Q)\,q_e\right) \\
&= -\left(P'(Q) + P''(Q)\,q_e\right)q_e,
\end{aligned}$$

which amounts to:

$$\pi'(Q) = -P''(Q)\,q_e^2.$$

It follows that $\pi'(Q) \geq 0$ if and only if $P''(Q) \leq 0$, and thus, $Q < Q^m$ if the demand function is concave, and $Q > Q^m$ if the demand function is convex.

Finally, we verify that $P(Q) - w < c_d$ at the optimum. To see this, rearranging the FOC

(21) and using conditions (23) and (19), we obtain:

$$\begin{aligned}
P(Q) - w - c_d &= \pi'(Q) - P'(Q)\, q_e + \frac{q_e}{\frac{\partial q_e(q_d, w)}{\partial w}} \\
&= \pi'(Q) - P'(Q)\, q_e - \left(MC_f'(q_e) - 2P'(Q) - P''(Q)\, q_e\right) q_e \\
&= -\left[P'(Q) + P''(Q)\, q_e + MC_f'(q_e) - 2P'(Q) - P''(Q)\, q_e\right] q_e \\
&= -\left[MC_f'(q_e) - P'(Q)\right] q_e < 0,
\end{aligned}$$

it thus follows that $P(Q) - w < c_d$. **Q.E.D.**

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