Organic Mergers and Acquisitions

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Abstract

This paper examines the competition between organic and non-organic firms, their incentives to undertake a horizontal merger, and the effect of mergers on firms' market shares. We also consider an alternative setting where one firm can acquire its rival. For generality, we allow for product differentiation, demand and cost asymmetries. Our results show that both organic and non-organic firms, despite their cost asymmetries and demand differentials, have incentives to merge under large conditions. When demand and cost differentials are significant, we identify settings under which a firm (either organic or non-organic) purchases its rival, to subsequently shut it down, and yet increase its profits. We then study under which conditions the merger can be welfare improving, which is more likely when goods are highly differentiated and their production costs are relatively symmetric.

KEYWORDS: Horizontal integration; Cost differential; Organic products; Mergers and Acquisition.

JEL CLASSIFICATION: L4; Q10; D4.

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1 Introduction

U.S. sales of organic products grew from \$28.4 billion in 2012 to \$47 billion in 2016. Importantly, this industry experienced a large amount of mergers and acquisitions since 2014, exceeding US\$20 billion.[1] In most cases, an established firm producing non-organic goods acquired a relatively new firm selling organic, natural, or healthy food in the same (or close) market, which could be understood as a strategy to ameliorate competition. In other cases, however, the acquired firm produced goods extremely differentiated from those of the acquirer, which could be rationalized on the basis of portfolio diversification. After the acquisition, both firms remained active, but their output levels were often adjusted under the new management. Recent examples include United Natural Foods Inc. purchasing Nor-Cal Produce (a distributor of organic produce and flowers) in March 2016 and Gourmet Guru (organic and better-for-you food) in August 2016; PepsiCo acquiring KeVita (which produces coconut-based probiotic drinks) in November 2016; and Coca Cola purchasing Suja Juice (organic cold-pressed juice) in August 2015, Blue Sky Beverage Company (organic, all natural soft drinks and energy drinks) in June 2015, and minority stakes in companies such as Aloe Gloe (organic aloe-water beverages).[2] Similarly, organic firms have acquired other organic companies during this short period, including Albert's Organics purchasing Global Organic Specialty Source (organic produce distributor) in March 2016; Nature Path's Foods acquiring Country Choice Organic (organic breakfast cereals and snacks) in July 2015; and Jusu Bars Inc. purchasing Cru Juice Inc. (organic cold-pressed juice, plant-based shots, and raw meals) in September 2016.[3]

In this paper, we seek to understand the incentives that drive both organic and non-organic firms to acquire other companies, how their market shares change after the acquisition, and how these results are affected by demand and cost differentials across firms. Our model considers two firms, one producing an organic good while its rival producing a non-organic good. For generality, we allow for differentiated products and for the demand intensities of organic and non-organic goods to differ.[4] The model also permits for different production costs, to account for the fact

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[1] Some of the largest operations include Danone purchasing WhiteWave in July 2016 for US\$12.5 billion, TreeHouse Foods acquiring Ralcorp (from ConAgra) in November 2015 for US\$2.7 billion, Hormel Foods Corporation purchasing Applegate Farms in May 2015 for US\$775 million, or Coca-Cola company acquiring AdeS from Unilever in June 2016 for US\$ 575 million.

[2] Other examples include Amplify Snack Brands purchasing Boundless Nutrition (an allergen-free, non-GMO, snack manufacturer) in May 2016; Preferred Popcorn acquiring K&W Popcorn (a producer of organic popcorn) in April 2016; ConAgra Foods purchasing Blake's All Natural Food (organic frozen meals) in May 2015; General Meals acquiring Annie's (organic foods and snacks) in September 2014; J.M. Smucker purchasing Sahale Snacks (gluten free and non-GMO snacks) in August 2014, and the Millstone Coffee Company (organic coffee manufacturer) in November 2008; and WhiteWave Foods acquiring So Delicious (organic and dairy-free foods and beverages) in September 2014.

[3] Other examples include SunOpta (a Canadian organic and specialty food company) acquiring Sunrise Growers (a leading producer of organic foods) and Niagara Natural Food Snacks (healthy fruit snacks) in October 2015; Natural American Foods purchasing Sweet Harvest Foods (a producer of organic peanut butter, honey, and syrups) in December 2016; and Fresca Foods acquiring Wonderfully Raw and Open Road Snacks (both firms produce organic, gluten-free and vegan snacks) in October 2015 and February 2017, respectively.

[4] Krissoff (1998) summarizes studies on consumer demand for organic food, indicating that a large proportion of consumers prefer organic foods because of taste, appearance, or personal health reasons. For other articles evaluating consumer perceptions of organic product quality, see Grunert (2007) and Agyekum et al. (2015).

that organic goods are often more costly to produce than non-organic varieties. We examine a two-stage game where, in the first stage, firms choose whether to merge and, in the second stage, they select their output levels (as part of the merger, or as independent firms if the merger does not occur). For completeness, we then consider an alternative first-stage setting, whereby one firm (e.g., the industry leader) chooses whether to acquire the other firm, to subsequently determine optimal production levels for both firms during the second stage.

In the second stage, we show that only the most efficient firm (and/or the firm with the strongest relative demand) produces a positive output when firms are relatively asymmetric in their production costs, while both firms remain active otherwise. In the first stage, we demonstrate that the merger can be supported for large parameter conditions, but firms stay active only if their production costs are relatively symmetric. Otherwise, the most inefficient firm substantially reduces its output, relative to prior to the merger, and can even shut down its operations if its cost disadvantage is sufficiently severe.[5] We then evaluate how our results are affected by firms' degree of product differentiation, as well as by their relative demand intensities and cost efficiencies.

Our findings provide several implications. First, similar to Salant et al. (1983), we show that inefficient firms also seek to merge, even if they anticipate that their output will substantially decrease after the merger; in the extreme case, shutting it down to zero. Intuitively, this type of firm expects to share merger profits with its more efficient rival. The latter reduces its current competition since its inefficient rival produces fewer units; yielding a monopoly market when the cost advantage of the efficient firm is sufficiently strong. Therefore, both firms, despite their initial differences, have incentives to merge.

Second, our results help predict changes in market shares upon a merger between firms producing organic and non-organic goods. Specifically, while the former are often more costly than the latter,[6] we find that the market share of organic (non-organic) products can increase (decrease, respectively) after the merger if the demand for organic varieties is sufficiently strong. Intuitively, the merged firm, by internalizing all sales, decreases the production of the relatively less profitable product (that with the weakest demand), increasing sales of the product with the strongest demand, which yields a larger profit margin per unit of output. If demand for the organic good is sufficiently strong and its cost is not significantly larger than that of the non-organic variety, the merger could have incentives to shut down the non-organic firm, selling the organic product as a monopoly.[7] Importantly, our results apply to the opposite case, whereby the organic product has

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[5] Our paper therefore connects with the literature on mergers between firms with asymmetric costs, such as Fauli-Oller (2002), which finds that the merger chooses to close the plant exhibiting a significant cost inefficiency, thus exclusively producing in the efficient plant. Our paper finds a similar result in equilibrium, but allowing for product differentiation and demand differentials, evaluating afterwards its welfare implications.

[6] Butler (2002) analyzes dairy production in California, reporting a 10-20% cost differential (on $U.S. per cow); Klonsky (2012) examines products such as field corn, broccoli, almonds and walnuts, finding cost differentials between $51 and $312 per acre; Taylor and Granatstein (2013) studies Washington State apples, reporting a cost differential of 5-10% per acre; and McBride et al. (2015), which examines corn, soybeans and wheat, finding cost differentials between $55-$125. Some empirical studies analyzing other products, however, find a negative cost differential, thus reflecting that organic goods are cheaper to produce than their nonorganic varieties, such as corn in Indiana, Clark (2009), alfalfa and lettuce in California, Klonsky (2012), and Idaho and Washington State potatoes, Ecotrust (2016).

[7] Hershey Co. acquired the organic non-GMO companies Dagoba in October 2006, Krave Pure Foods in February

a similar demand to the non-organic good, perhaps because it is still in its infancy or consumers do not yet know about its properties, and it suffers a cost disadvantage relative to the non-organic variety. In this setting, the non-organic firm would have incentives to acquire the organic company to, essentially, shut it down thus limiting its competition.[8] We demonstrate that these results are emphasized when products are relatively homogeneous, where our findings can be sustained under larger parameter conditions.

We compare equilibrium output after the merger against the socially optimal output (first best). While the merger reduces output relative to pre-merger outcomes, we show that post-merger production can be socially insufficient or excessive. A socially insufficient output arises under large parameter conditions, and becomes more likely to occur when firms sell highly differentiated goods, or when their costs are sufficiently symmetric. In this setting, mergers can be welfare reducing, leading antitrust authorities to block mergers under large conditions. In contrast, when firms sell relatively homogeneous goods and/or their costs are relatively asymmetric, output approaches the first-best outcome, implying that the merger is welfare improving and should be allowed.

Finally, we extend our model to a setting with several organic and non-organic firms, showing that our results are qualitatively unaffected. Our findings, however, can be emphasized when more organic firms enter the industry (expanding the region of parameter values where the merger chooses to shut down the non-organic firm/s) or when more non-organic firms join the market (making more prevalent the settings where the merger shuts down the organic firm/s).

Related literature. Our model builds on the literature on horizontal mergers, as in Salant et al. (1983) and Farrell and Shapiro (1990), which consider homogeneous goods and cost symmetry among firms. The literature was then extended to allow for product differentiation, as in Norman and Pepall (2000) and Escrihuela-Villar (2011), and both product differentiation with cost asymmetries, as in Zanchettin (2006), Kao and Menezes (2010), and Gelves (2014). Unlike our paper, Zanchettin (2006) does not examine firms' incentives to merge; Kao and Menezes (2010) consider that demand and cost asymmetries are small enough to guarantee a positive output; and Gelves (2014) only considers horizontal product differentiation.[9] Other studies consider the possibility that merging firms benefit from a cost-reducing effect; as in Norman et al. (2005).

2015, and barkTHINS in April 2016. In addition, Hershey has been replacing sugar from sugar beets for non-GMO cane sugar, accounting for more than 75% of its sugar use in February 2016. A similar argument applies to Flower Foods, Inc. (a firm mainly selling non-organic products before 2015), which acquired two organic producers, Dave's Killer Bread in August 2015 and Alpine Valley Bread in September 2015. After these acquisitions, the acquirer, Flower Foods, Inc., significantly reduced its non-organic output while increasing the production of Dave's Killer Bread by 4 times relative to pre-acquisition levels. See Howard (2009), Gutierrez (2016), and MarketLine (2017).

[8] The J.M. Smucker Company (seller of non-organic products in 2008) acquired the organic firm Millstone Coffee in November 2008. The acquirer, however, discontinued Millstone Coffee in September 2016, citing lack of sustainable demand. Their organic coffee brand, therefore, disappeared since the company did not acquire another organic coffee brand, nor developed its own; as reported by The Vending Times in August 25th, 2016

[9] Gelves (2014) considers an oligopoly setting with N firms similar to that in Salant et al. (1983), but allowing for cost asymmetries and product differentiation. While Salant et al. (1983) show that mergers can only be profitable if merging firms represent a large percentage of companies in the industry (i.e., the “80% rule”), Gelves (2014) demonstrates that cost asymmetry increases firms' incentives to merge even if they sustain a relatively small percentage of industry sales.

We analyze mergers between firms selling organic and non-organic goods, allowing for cost asymmetries, product differentiation, and different demand intensities. These three dimensions of asymmetries separates us from most papers on this literature, which focus on one or two of these dimensions. Häckner (2000), for instance, considers differentiated goods, but does not analyze firms' incentives to merge with their rivals. Norman et al. (2005) allows for firms to face different demand intensities, and evaluates their incentives to merge, but does not allow for product differentiation or cost asymmetries. Finally, Savorelli (2012) examines under which settings firms have incentives to collude when facing asymmetric production costs, but does not allow for product differentiation or distinct demands across products.

Section 2 presents the model, Section 3 describes the time structure of the game, and solves for equilibrium output (second stage) and for merger and acquisition decisions (first stage). Section 4 evaluates equilibrium welfare, to understand in which contexts mergers can become welfare improving. Section 5 extends our model to settings with several organic and non-organic firms. Finally, section 6 discusses our findings.

2 Model

Consider that firm O produces an organic good, with marginal cost $c_O > 0$, while firm NO produces a non-organic good with marginal cost c_{NO}, where $c_O \geq c_{NO}$. The production of organic goods can affect the demand for non-organic products when both goods are sufficiently homogeneous. In particular, firm 1's (firm 2's) inverse demand function for the non-organic (organic) product, q_{NO} (q_O, respectively) is[10]

$$p(q_{NO}, q_O) = a_{NO} - q_{NO} - \lambda q_O \quad \text{and} \quad p(q_O, q_{NO}) = a_O - q_O - \lambda q_{NO}$$

Demand intercept a_k captures consumers' overall preference for organic and non-organic products, where $k = \{O, NO\}$. We assume that $a_O \geq a_{NO}$ thus indicating that consumers regard organic goods as (weakly) superior, i.e., if both goods had the same price, consumers would opt for the organic variety. Furthermore, $a_k > c_k$ for every firm k. In addition, parameter $\lambda \in [0, 1]$ describes the degree of product differentiation between both goods. Specifically, if $\lambda = 0$ products are completely differentiated, and sales of organic goods do not affect the demand of non-organic products; as in two separate monopolies. However, when $\lambda = 1$ products are homogeneous. Therefore, we consider representative consumers for each product.

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[10] This demand specification is, thus, similar to that of Singh and Vives (1984) for the analysis of firms' incentives to compete in either quantities or prices when they produce differentiated products. These demand functions assume, for simplicity, that price sensitivities are symmetric between goods. Assuming asymmetric price sensitivities, however, leads to highly intractable results, which do not allow for a clear economic interpretation.

3 Equilibrium analysis

We consider the following two-stage game:

1. In the first stage, every firm decides whether or not to merge with its rival. A merger only occurs if both firms choose to merge.
2. In the second stage, if firms did not merge, they compete in output. Otherwise, they coordinate their production decisions, which may entail shutting down the operations of one firm.

For completeness, we first examine the setting in which firms, during the first stage, choose whether to merge; and then analyze an alternative scenario where one firm has the ability to acquire its rival. The game is solved by backward induction.

3.1 Second-stage output

Case 1, No merger. If one or both firms chose to not merge during the first period, a merger does not occur, leading each firm to simultaneously and independently set its own output. In particular, every firm k solves

$$\pi_k^{NM} \equiv \max_{q_k} p(q_k, q_j)q_k - c_k q_k. \tag{1}$$

where $j \neq k$ indicates firm k's rival, π_k^{NM} is the value function arising from this problem (i.e., maximal profits for firm k under no merger), and superscript NM denotes "no merger." This problem yields output

$$q_k^{NM} = \frac{2(a_k - c_k) - \lambda(a_j - c_j)}{4 - \lambda^2} \text{ for every firm } k.$$

Intuitively, when goods are completely differentiated, $\lambda = 0$, this production level collapses to that under standard monopoly, $\frac{a_k - c_k}{2}$; but as goods become more homogeneous, this output becomes $\frac{2(a_k-c_k)-(a_j-c_j)}{3}$ when $\lambda = 1$.[11] Firm k's output under no merger is positive if its cost satisfies $c_k < c_k^{NM} \equiv \left(a_k - \frac{\lambda a_j}{2}\right) + \frac{\lambda c_j}{2}$; which collapses to the standard condition $c_k < a_k$ when firms sell completely differentiated goods, $\lambda = 0$, but becomes more restrictive as their products are more homogeneous (higher λ). Similarly firm j produces a positive output if only if $c_j < c_j^{NM}$.[12]

Last, we can evaluate profits emerging from problem (1), as follows

$$\pi_k^{NM} = \left[\frac{2(a_k - c_k) - \lambda(a_j - c_j)}{4 - \lambda^2}\right]^2.$$

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[11] Furthermore, if demands satisfy $a_k = a_j$, and both products are equally costly, $c_k = c_j$, this output level reduces to the standard result in duopoly markets with symmetric firms and homogeneous products, i.e., $\frac{a_k - c_k}{3}$.

[12] Note that both cutoffs c_k^{NM} and c_j^{NM} are less demanding than all the cutoffs we identify in subsequent sections of the paper, which implies that conditions $c_k < c_k^{NM}$ and $c_j < c_j^{NM}$ hold throughout our analysis.

Since this profit can be alternatively represented as $\pi_k^{NM} = \left(q_k^{NM}\right)^2$, we can extend similar comparative statics results as those for output in our above discussion.

Case 2, Merger. A merger occurs if both firms agree to merge during the first period. Therefore, firms coordinate their production decisions (choice of q_k and q_j) to maximize their joint profits, which entails either of three options: (i) produce positive units of both goods, obtaining profits $\pi^{M,Both}$, where the superscript indicates a merger where both plants are active; (ii) produce a positive amount of good k alone, yielding profits $\pi^{M,k}$; or (iii) produce positive units of good j alone, earning $\pi^{M,j}$. We analyze each case separately below, and subsequently compare profits.

Both firms are active. When both firms are active, they maximize their joint profits as follows

$$\pi^{M,Both} \equiv \max_{q_k, q_j} \left[p(q_k, q_j)q_k - c_k q_k\right] + \left[p(q_j, q_k)q_j - c_j q_j\right]. \tag{2}$$

where $\pi^{M,Both}$ denotes the overall profits for the merged firm (which explains why it does not include a firm's subscript). Differentiating with respect to q_k and q_j, and simultaneously solving, we obtain

$$q_k^{M,Both} = \frac{(a_k - c_k) - \lambda(a_j - c_j)}{2(1-\lambda^2)}.$$

Like in Case 1, where firms did not merge, output in this setting converges to monopoly output $\frac{a_k - c_k}{2}$ when firms sell completely differentiated products, $\lambda = 0$. Firm k's output under the merger is positive if its cost satisfies $c_k < c_k^M \equiv (a_k - \lambda a_j) + \lambda c_j$. The intuition behind cutoff c_k^M is similar to that behind c_k^{NM} in Case 1, but since cutoffs satisfy $c_k^M < c_k^{NM}$, the condition for both firms to be active, $c_k < c_k^M$, is more restrictive than that in the no merger case, $c_k < c_k^{NM}$. Intuitively, since the merged firm seeks to limit production to raise prices, merged firms are willing to stay active for a wider range of costs than non-merged firms.

Last, we can evaluate profits emerging from problem (2), as follows

$$\pi_k^{M,Both} = \frac{(a_k - c_k)\left[(a_k - c_k) - \lambda(a_j - c_j)\right]}{4\left(1-\lambda^2\right)} = \frac{(a_k - c_k)}{2} q_k^M$$

and similarly for firm j. Therefore, overall profits for the merged firms are

$$\pi^{M,Both} = \frac{(a_k - c_k)\left[(a_k - c_k) - 2\lambda(a_j - c_j)\right] + (a_j - c_j)^2}{4\left(1-\lambda^2\right)}$$

Only firm k is active. If the merged firm shuts down firm j, its profit-maximization problem becomes

$$\pi_k^{M,k} \equiv \max_{q_k} p(q_k, 0)q_k - c_k q_k \tag{3}$$

yielding the standard monopoly output $q_k^{M,k} = \frac{a_k - c_k}{2}$, with associated profits $\pi_k^{M,k} = \frac{(a_k - c_k)^2}{4}$. A similar argument applies to the case in which the merger shuts down firm k, entailing profits of

$\pi_j^{M,j} = \frac{(a_j - c_j)^2}{4}$.

Comparing the profits that the merged firm obtains from keeping producing both goods, $\pi^{M,Both}$, against those where only firm k remains active, $\pi_k^{M,k}$, we obtain the following lemma. For presentation purposes, recall that firm j's output under the merger is positive if its cost c_j satisfies $c_j < a_j - \lambda(a_k - c_k)$.[13]

While the previous discussion allowed for a generic firm k, our subsequent analysis considers firm k as the organic producer, firm O, and its rival j as the non-organic firm, NO; which helps in the interpretation of results.

Lemma 1. *The following three regions can arise in the (c_{NO}, c_O)-quadrant:*

1. *Region I. Only the organic firm produces positive output if* $c_O < c_{NO}^M$.
2. *Region II. Both firms produce positive output if* $c_{NO}^M \leq c_O < c_O^M$.
3. *Region III. Only the non-organic firm produces positive output if* $c_O \geq c_O^M$.

Figure 1 depicts cutoffs c_O^M and c_{NO}^M, to identify the three regions in Lemma 1, where we focus on admissible cost pairs $c_O \geq c_{NO}$ above the 45-degree line. Since $a_O > c_O$ for every organic firm, we only focus on (c_{NO}, c_O)-pairs in the left-hand corner of the figure below a_O. In Region I, the organic firm suffers a small cost disadvantage, relative to the non-organic producer, while its demand is stronger, leading the merged firm to produce organic goods alone. The opposite case emerges in Region III, where now the non-organic firm is the only one producing a positive output.[14] Last, when the costs of both firms are relatively low, they both remain active after the merger; as depicted in Region II.[15]

Insert Figure 1 here.

Cutoffs c_O^M and c_{NO}^M cross at point (a_{NO}, a_O), thus lying above the 45-degree line. Because the demand for organic goods is stronger than that of non-organics, Region I is larger than III, since the merged firm can extract a larger margin from every unit of the organic good. In words, the

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[13] In addition, we solve for c_k in this inequality to obtain $c_k > c_j^M \equiv \left(a_k - \frac{a_j}{\lambda}\right) + \frac{c_j}{\lambda}$. Graphically, cutoff c_j^M is easier to plot in the (c_j, c_k)-quadrant, and to compare against other cutoffs found above.

[14] Comparing cutoff c_O^M against that under no mergers, c_O^{NM}, we find that $c_O^{NM} \equiv \left(a_O - \frac{\lambda}{2} a_{NO}\right) + \frac{\lambda}{2} c_{NO}$ originates above the vertical intercept of cutoff c_O^M, $a_O - \lambda a_{NO}$. In addition, cutoff c_O^{NM} crosses c_O^M at $c_{NO} = a_{NO}$ and a height of $c_O = a_O$. Therefore, cutoff c_O^{NM} divides Region III into two areas: (1) if $c_O^M \leq c_O < c_O^{NM}$, the organic firm shuts down under the merger, but would produce a positive output if no merger occurs; and (2) if $c_O \geq c_O^{NM}$, the organic firm shuts down both when the merger occurs and when it does not. Since we have showed that a merger can be sustained in Region III, the discussion about whether the organic firm would have been active had the merger not occurred is inconsequential. A similar argument applies to cutoff c_{NO}^{NM}, which splits Region I into two areas.

[15] Note that cutoff c_O^M originates in the positive quadrant if $a_O - \lambda a_{NO} \geq 0$, or $a_O \geq \lambda a_{NO}$; while cutoff c_{NO}^M does when $a_O - \frac{a_{NO}}{\lambda} \geq 0$, or $a_O \geq \frac{a_{NO}}{\lambda}$. That is, when a_O is low, $a_O < \lambda a_{NO}$, both cutoffs originate in the negative quadrant; when a_O takes intermediate values, $\lambda a_{NO} \leq a_O < \frac{a_{NO}}{\lambda}$, only cutoff c_O^M originates in the positive quadrant; and when a_O is relatively high, $a_O \geq \frac{a_{NO}}{\lambda}$, both cutoffs start at the positive quadrant.

stronger demand for the organic product justifies shutting down the non-organic firm, despite its relative cost advantage, keeping only the organic firm active under larger parameter conditions.

We can apply our result to special cases, such as when products are homogeneous, $\lambda = 1$. As depicted in Figure 2a, in this case both cutoffs collapse to the same line (i.e., they both originate at $a_O - a_{NO}$, and have a slope of 1), yielding only two possible outcomes: Region I, where the organic firm is the only active plant, if $c_O < c_O^M = c_{NO}^M$; or Region III, where only the non-organic firm operates.[16]

Insert Figures 2a and 2b here.

Figure 2b considers another special case, where both firms face the same demand, $a_O = a_{NO} = a$. In this context, cutoff c_O^M originates at $(1-\lambda)a$, cutoff c_{NO}^M originates in the negative quadrant, i.e., at $\left(1 - \frac{1}{\lambda}\right) a$, and both cutoffs cross at the 45-degree line, i.e., at $c_O = c_{NO} = a$. In this context, Region I cannot be sustained since both firms exhibit the same demand intensity and the organic firm suffers from a cost disadvantage. Therefore, under no circumstances the merger chooses to keep only the organic plant active. Region II, however, can be sustained where the organic firm's cost disadvantage is relatively small, and thus both plants are active; as well as Region III where this cost disadvantage is larger, and only the non-organic firm is active.

3.2 First stage

For each (c_{NO}, c_O)-pair, every firm k anticipates the output profile that will emerge in the second stage of the game, i.e., Regions I-III. For completeness, we consider that during the first stage firms choose whether to merge; and subsequently examine how the results would change if, instead, one firm is allowed to acquire its rival.

3.2.1 Mergers

In the first stage, every firm k chooses whether to merge or not. In particular, for each region I-III, the firm compares the profits that it currently obtains as an independent firm, π_k^{NM}, against the profits it would obtain under the merger: $\frac{\pi_k^{M,k}}{2}$ in Region I where only firm k remains active, $\frac{\pi^{M,Both}}{2}$ in Region II where both firms stay active, and $\frac{\pi_j^{M,j}}{2}$ in Region III, where only firm $j \neq k$ is active. For simplicity, we assume that firms evenly share merger profits.[17]

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[16] If, in addition, firms face the same demand, i.e., $a_O = a_{NO} = a$, both cutoffs originate at zero, thus coinciding with the 45-degree line. In this context, when the non-organic firm enjoys even a minor cost advantage, the merged firm chooses only this plant to be active.

[17] An alternative sharing rule could assign every firm k a larger share of profits when it produces a larger share of output, as follows: $\frac{\pi_k^{M,k}}{q_k^{M,k}/Q^{M,k}}$ in Region I, $\frac{\pi^{M,Both}}{q_k^{M,Both}/Q^{M,Both}}$ in Region II, and $\frac{\pi_j^{M,j}}{q_j^{M,j}/Q^{M,j}}$ in Region III, where $Q^{M,x}$ denotes aggregate output in setting $x = \{O, Both, NO\}$. However, this profit sharing rule entails that the non-organic (organic) firm would not receive any profits from the organic (non-organic) plant, which is the only firm remaining active after the merger in Region I (III, respectively).

Proposition 1. *During the first stage, the organic firm chooses to merge as follows:*

1. *If* (c_{NO}, c_O)*-pairs lie in Region I, the organic firm merges if and only if* $c_O \in [c_1, c_2]$*;*
2. *If* (c_{NO}, c_O)*-pairs lie in Region II, the organic firm merges if and only if* $c_O \in [c_3, c_4]$*; and*
3. *If* (c_{NO}, c_O)*-pairs lie in Region III, the organic firm merges if and only if* $c_O \in [c_5, c_6]$.

For compactness, cutoffs $c_1 - c_6$ *are defined in the appendix.*

While the proposition allows for several patterns to emerge, in specific settings mergers may only be sustained if firms expect one of the three regions to arise during the second-period game. To understand this point, consider, for instance, parameter values $a_O = 1$, $a_{NO} = 2/3$, $\lambda = 1/2$, and $c_{NO} = 1/4$. As shown in the first row of Table I (benchmark set of parameters), the cutoffs identifying Regions I-III in Proposition 1 become $c_O^M = 0.79$ and $c_{NO}^M = 0.16$. For illustration purposes, Figure 3 depicts cutoffs c_O^M and c_{NO}^M in this setting, along with cutoffs c_1 through c_6.

Insert Figure 3 here.

Since $c_O > c_{NO}$ by definition, c_O must satisfy $c_O > 0.25$ in this setting, entailing that Region I cannot be sustained in equilibrium. A similar argument applies to the left segment of Region II for all $c_O < 0.25$. We can then conclude that: (1) the range of parameters $[c_3, c_4] = [0.57, 1.51]$ is compatible with Region II as long as $c_O \in [0.57, 0.79]$, which entails that this region can be supported in equilibrium when costs are relatively high; and (2) the range of parameters $[c_5, c_6] = [0.61, 1.17]$ is compatible for all values of c_O in Region III, implying that this region can be sustained in equilibrium. Overall, a merger can only be sustained in Region III and in Region II (as long as $c_O > c_3 = 0.57$). Intuitively, when the organic firm is relatively inefficient (in Region III and in the right-hand portion of Region II, as depicted in Figure 3), it prefers to join the merger rather than continue operating as an independent firm. In other words, the most inefficient firm seeks to ameliorate the tough competition it faces from its rival by entering the merger. If the merger is successful, this firm accepts to shut down its operations when its cost disadvantage is sufficiently large (in Region III), but continues producing a positive output level when such cost disadvantage is minor.

	c_O^M	c_{NO}^M	c_1	c_2	c_3	c_4	c_5	c_6
Benchmark	0.79	0.16	0.69	0.93	0.57	1.51	0.61	1.17
Lower cost, $c_{NO} = 1/10$	0.71	-0.13	0.57	0.91	0.41	1.69	0.48	1.23
Higher demand, $a_{NO} = 1$	0.62	-0.50	0.44	0.88	0.23	1.92	0.31	1.31
Homogeneous goods, $\lambda = 1$	0.58	0.58	0.55	0.86	0.58	0.58	0.57	1.01
$\lambda = 1$ and $a_{NO} = 1$	0.25	0.25	0.20	0.75	0.25	0.25	0.22	0.10

Table I. Cutoffs from Propositions 1.

Appendix 1 provides a detailed analysis of the regions that can/cannot be sustained in equilibrium for each row in Table I. Overall, the merger finds it profitable to produce using the organic firm alone when products become more homogeneous and the demand for the organic good becomes stronger.

3.2.2 Acquisitions

In this subsection, we consider an alternative setting for the first-stage game. We now allow the non-organic firm to make a take-it-or-leave-it offer to acquire the organic firm. The non-organic firm might have more experience in the industry, and thus act as the leader, making an offer to the organic firm, who observes the offer and responds accepting it or not. If the organic firm accepts the offer, the non-organic firm manages both firms, seeking to maximize joint profits. If, instead, the organic firm rejects the offer, both firms continue to operate independently, competing in quantities.

In this setting, the organic firm accepts an offer from the non-organic firm if and only if it weakly exceeds its profits under no merger, π_O^{NM}. Anticipating this decision rule by the organic firm, the non-organic company makes its acquisition offer. To understand the non-organic firm's willingness to pay to acquire the organic firm, let us separately consider (c_{NO}, c_O)-pairs lying in Region I, II, and III. In Region I, the non-organic firm anticipates that only the organic firm remains active after the acquisition, obtaining profits of $\pi^{M,O}$. (Unlike in the merger, the non-organic firm now earns all profit $\pi^{M,O}$, rather than half of it.) If this profit exceeds that from competing as an independent firm, π_{NO}^{NM}, the non-organic firm acquires the organic firm, and its maximum willingness to pay is captured by profit gain $WP_I \equiv \pi^{M,O} - \pi_{NO}^{NM}$. A similar argument applies when (c_{NO}, c_O)-pairs lie in Region II, as in this case the non-organic firm can expect both firms remaining active after the acquisition, yielding profits of $\pi^{M,Both}$. Therefore, the non-organic firm is willing to pay up to $WP_{II} \equiv \pi^{M,Both} - \pi_{NO}^{NM}$. Finally, when (c_{NO}, c_O)-pairs lie in Region III, the non-organic firm anticipates that, given the substantial cost disadvantage of the organic firm, it will shut this company down after the acquisition, operating the non-organic firm as a monopolist, earning profit $\pi^{M,NO}$. In this context, the non-organic firm is willing to pay $WP_{III} \equiv \pi^{M,NO} - \pi_{NO}^{NM}$ to acquire its organic rival.

Figure 4 depicts the three regions of willingness to pay considering the same parameter values as in Table I (benchmark). Region I cannot be sustained, as discussed in Figure 3 above. Region II, however, can be supported for all $0.57 \leq c_O < c_O^M = 0.79$ (intermediate values of c_O at the center of the figure). In this region, the non-organic firm chooses to acquire the organic given that curve WP_{II} is positive. Finally, Region III can exist for all $c_O \geq 0.79$ (right-hand side of figure), which leads the non-organic firm to acquire the organic since curve WP_{III} lies in the positive quadrant as well.

Insert Figure 4 here.

While our above discussion analyzes the profit gain that the non-organic firm experiences from acquiring its organic rival, it was silent about the specific offer that the non-organic firm makes in equilibrium. In particular, the non-organic firm is willing to make an acceptable offer if its willingness to pay exceeds the organic firm's profits from continuing as an independent firm, π_O^{NM}. That is, if $WP_x \geq \pi_O^{NM}$ holds in Region $x = \{I, II, III\}$, the non-organic firm makes an offer of exactly π_O^{NM} to the organic company. This offer yields a (weak) Pareto improvement: on one hand, it weakly compensates the organic firm for its foregone profits; and, on the other hand, the non-organic firm's profit gain (as captured by WP_x) exceeds the monetary outlay π_O^{NM} provided to the organic firm.

Figure 5 depicts the above discussion. In Region II, the difference $WP_{II} - \pi_O^{NM}$ is positive for all admissible c_O, which implies that the non-organic firm has incentives to offer π_O^{NM} to the organic firm as well. In this context, an equilibrium arises in which both firms are active. Finally, in Region III, the difference $WP_{III} - \pi_O^{NM}$ is only positive for relatively low costs, entailing that the non-organic firm has incentives to offer π_O^{NM} to the organic firm when the former is sufficiently efficient, but does not otherwise.

Insert Figure 5 here.

When the costs of the non-organic firm decrease to $c_{NO} = 1/10$ (i.e., second row of Table I), Region II can be supported for intermediate values of c_O, and the curve $WP_{II} - \pi_O^{NM}$ of Figure 5 still lies on the positive quadrant, indicating that the non-organic firm has incentives to acquire the organic company as prescribed in Proposition 1, and subsequently keeping both firms active. Region III can be sustained, but like in our above discussion, only leads the non-organic firm to acquire the organic firm if the former is relatively efficient (low values of c_{NO}). A similar argument applies when the non-organic firm's demand increases (third row of Table I), since the non-organic firm is relatively inefficient and, upon acquiring the organic firm, does not find it profitable to become the only active firm in the industry.

4 Welfare analysis

This section investigates if equilibrium output is excessive or insufficient (relative to the social optimum) for each region of cost pairs, where firms have incentives to merge or not to merge. The following lemma identifies the welfare-maximizing output pair. Social welfare is given by the sum of consumer and producer surplus, $W = CS + PS$, where $CS \equiv \frac{1}{2}(q_O^2 + q_{NO}^2 + 2\lambda q_O q_{NO})$ and $PS \equiv \pi_O + \pi_{NO}$.

Lemma 2. *The socially optimal output for the organic firm is* $q_O^{SO} = \frac{a_O - c_O - \lambda(a_{NO} - c_{NO})}{1-\lambda^2}$*, which is positive if and only if* c_O *satisfies* $c_O \leq c_O^{SO} \equiv a_O - \lambda(a_{NO} - c_{NO})$*; and that of the non-organic firm is* $q_{NO}^{SO} = \frac{a_{NO} - c_{NO} - \lambda(a_O - c_O)}{1-\lambda^2}$*, which is positive if and only if* $c_O \geq c_{NO}^{SO} \equiv \left(a_O - \frac{a_{NO}}{\lambda}\right) + \frac{c_{NO}}{\lambda}$*. Therefore, it is socially optimal that:*

1. *Only the organic firm produces a positive output if* $c_O < \min\{c_O^{SO}, c_{NO}^{SO}\}$*;*
2. *Both firms produce a positive output if* $\min\{c_O^{SO}, c_{NO}^{SO}\} \leq c_O < \max\{c_O^{SO}, c_{NO}^{SO}\}$*; and*
3. *Only the non-organic firm produces a positive output if* $c_O \geq \max\{c_O^{SO}, c_{NO}^{SO}\}$*.*

Graphically, Lemma 2 divides the (c_{NO}, c_O)-quadrant into three areas; as depicted in Figure 6. First, when the organic firm's costs are low relative to those of the non-organic's, the social planner assigns a positive production level to this firm alone, leaving the non-organic firm inactive. (This argument is emphasized when the organic product exhibits a significantly stronger demand than the non-organic.) A symmetric argument applies when the organic firm's costs are high relative to the non-organic's, where $q_O^{SO} = 0$ while $q_{NO}^{SO} > 0$. Finally, when firms' costs are relatively symmetric, the social planner assigns a positive output to both firms.

Insert Figure 6 here.

Therefore, for every (c_{NO}, c_O)-pair, Lemma 2 informs us about which output profile to implement (q_O^{SO}, q_{NO}^{SO}) to maximize social welfare. Our results are, however, silent about whether such output is higher than that emerging in equilibrium (as examined in Lemma 1 and Proposition 1), which entails that equilibrium output is socially insufficient; or whether socially optimal output is lower than that in equilibrium, thus giving rise to a socially excessive production. We analyze that below.

Proposition 2. *Equilibrium output is socially insufficient when* $c_O < c_O^{SO}$*, but socially excessive otherwise.*

Figure 6 illustrates the results in Proposition 2, indicating that equilibrium output is lower than the social optimum when the organic firm's costs satisfy $c_O < c_O^{SO}$, which occurs in Regions I and II. Specifically, the organic firm behaves as a monopolist (if only this firm is active after the merger, in Region I) or firms produce a smaller output than prior to the merger (if both firms are active, in Region II). In both cases, aggregate output lies below what a social planner would assign, yielding insufficient production. In contrast, equilibrium output is socially excessive in the entire Region III.

For illustration purposes, the next corollary identifies the regions where equilibrium output is socially insufficient or excessive in the extreme cases of completely differentiated products ($\lambda = 0$) or homogeneous goods ($\lambda = 1$).

Corollary 1. *When* $\lambda = 1$*, socially insufficient output arises when* $c_O < c_O^{SO}$*, whereas socially excessive production arises otherwise. When* $\lambda = 0$*, only socially insufficient production can be sustained, which occurs in Region I (i.e.,* $c_O < c_{NO}^{M}$*).*

When firms sell a completely differentiated product, $\lambda = 0$, several cutoffs coincide, i.e., $c_O^M = c_{NO}^M = c_O^{SO} = c_{NO}^{SO}$. As a result, only Region I emerges in the (c_{NO}, c_O)-quadrant, where only the organic firm is active after the merger, ultimately leading a socially insufficient output level. In contrast, when firms sell homogeneous products, $\lambda = 1$, all cutoffs coincide, giving rise to only Regions I and III. In this context, we can still find costs for which insufficient or excessive production occurs; as in Proposition 2. In particular, socially insufficient output exists when the organic firm's cost advantage is sufficiently strong, $c_O < c_O^{SO}$;[18] whereas socially excessive production emerges when c_O takes relatively high values, $c_O \geq c_O^{SO}$.

5 Extension to more firms

For presentation purposes, previous sections consider one organic and one non-organic firm. Appendix 2 allows for $N \geq 1$ organic and $M \geq 1$ non-organic firms, and we verbally describe our results next. First, we show that, when the industry has the same number of each type of firm, $M = N \geq 1$, our results in Lemma 1 still apply, regardless of how many firms of each type exist. Graphically, the findings in figure 1 readily apply in this context.

However, as non-organic firms become relatively more common (as captured by the difference $M - N$), organic firms produce a positive output under more restrictive conditions. As a result, when the costs of organic firms are extremely high, as in Region III of figure 1, the merged firm produces non-organic goods alone. When the costs of both firms are relatively similar and high, as in Region II, they both remain active after the merger. Otherwise, the merged firm produces organic goods alone, as depicted in Region I.

When products are homogeneous, $\lambda = 1$, our results in the main body of the paper still apply when the number of organic and non-organic firms coincides, $M = N$, as depicted in figure 2a. However, when $M > N$, Region II can be sustained, where both firms are active; a result that could not be sustained when products are homogeneous and $M = N$. In contrast, when products are completely differentiated, $\lambda = 0$, all cutoffs identified simplify to a_O (i.e., they all become a horizontal line originating at a_O), yielding only one possible outcome in equilibrium: Region I, where the organic firm is the only active plant.

We then identify results analogous to Proposition 1, but in the context of several firms of each type. The position of these cutoffs allows for several regions to emerge in equilibrium, but become more difficult to interpret analytically. For presentation purposes, we consider the same parameter values as in the benchmark (see first row of Table I in the main body of the paper), first fixing the number of non-organic firms at $M = 1$, and increasing the number of organic firms (N) one at a time; as illustrated in Table II. This helps us understand the effect of introducing more organic firms in previous sections. Both cutoffs c_O^M and c_{NO}^M shift downwards, shrinking Region I (which can become not sustainable in equilibrium) and Region II, while expanding Region III. Intuitively, when more than one organic firm ($N > 1$) merge with a non-organic firm ($M = 1$), the organic firms suffer from a cost disadvantage, leading the merged firm to shut down the organic firms;

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[18] However, since $\lambda = 1$, cutoff c_O^{SO} originates at a low vertical intercept, $a_O - a_{NO}$, which lies in Region I. Therefore, insufficient output can only arise if the organic firm's cost advantage is extremely strong.

graphically represented by a smaller Region I and a larger Region III. However, both firms are active after the merger when the organic firms' cost disadvantage is relatively small.

	c_O^M	c_{NO}^M	c_1	c_2	c_3	c_4	c_5	c_6
$M = 1$, $N = 1$	0.79	0.16	0.69	0.93	0.57	1.51	0.61	1.17
$M = 1$, $N = 2$	0.68	-0.11	0.76	0.93	0.55	1.56	0.56	1.22
$M = 1$, $N = 3$	0.58	-0.25	0.78	0.93	0.51	1.71	0.51	1.27
$M = 1$, $N = 4$	0.479	-0.33	0.79	0.93	0.476	1.90	0.476	1.31

Table II. Introducing more organic firms (higher N).

Table III considers, in contrast, that the number of organic firms is fixed at $N = 1$, while that of non-organic firms (M) increases. In this setting, cutoffs c_O^M and c_{NO}^M shift upwards, shrinking Region II and III while expanding Region I. Intuitively, when an organic firm ($N = 1$) merges with more than one non-organic firm ($M > 1$), the merged firm chooses to keep only the non-organic firm active when the organic firm' s cost disadvantage is severe; graphically represented by a shrink in Region III. Since the demand for the organic product is relatively stronger, the merged firm produces more organic products resulting a smaller Region II. When the organic firm suffers from a small cost disadvantage, the merged firm choose to shut down the non-organic firms keeping only the organic firm active (Region I).

	c_O^M	c_{NO}^M	c_1	c_2	c_3	c_4	c_5	c_6
$M = 1$, $N = 1$	0.79	0.16	0.69	0.93	0.57	1.51	0.61	1.17
$M = 2$, $N = 1$	0.84	0.44	0.70	0.90	0.67	1.07	0.70	1.01
$M = 3$, $N = 1$	0.86	0.58	0.71	0.89	0.70	0.96	0.73	0.95
$M = 4$, $N = 1$	0.86	0.66	0.72	0.88	0.71	0.92	0.74	0.91

Table III. Introducing more non-organic firms (higher M).

Finally, when both M and N increase, as reported in Table IV, we first find that cutoff c_1 shifts upwards while c_2 shifts downwards, expanding Region I as a consequence. After the merger, the organic firms remain active under larger conditions since the profit gain from the organic firms' stronger demand becomes more significant as N grows. Second, we obtain that cutoff c_3 shifts upwards while c_4 shifts downwards resulting in Region II shrinking. As in Region I, this result can be interpreted as that the merger is less likely to keep both types of firm active. Third, we find that cutoff c_5 shifts upwards while c_6 shifts downwards, shrinking Region III. Intuitively, when the organic firm's cost disadvantage is severe, organic firms choose to merge anticipating that their plants will be shut down (as the merger only keep the non-organic firms active). As in the baseline model, this occurs because the profit that organic firms earn from the merger exceed that from competing as independent firms.

	c_O^M	c_{NO}^M	c_1	c_2	c_3	c_4	c_5	c_6
$M = N = 1$	0.79	0.16	0.69	0.93	0.57	1.51	0.61	1.17
$M = N = 2$	0.79	0.16	0.737	0.90	0.65	1.13	0.66	1.05
$M = N = 3$	0.79	0.16	0.737	0.88	0.66	1.05	0.67	1.01
$M = N = 4$	0.79	0.16	0.734	0.87	0.67	1.01	0.67	0.98
$M = N = 5$	0.79	0.16	0.732	0.87	0.67	0.99	0.68	0.97

Table IV. Introducing more firms of both types.

6 Discussion

Changing production profiles. Our results suggest that all firms remain active only if their production costs are relatively symmetric. Otherwise, the new management (i.e., the merged firm or the acquirer) chooses to shut down the most inefficient company, only leaving the relatively efficient firm active, which operates as a monopolist. In less extreme cases, a similar result emerges, whereby the most inefficient firm is active after the merger but producing substantially fewer units than prior to the merger. In most real-world examples, we observe both firms being active after the merger, even if they alter their market shares, thus indicating that, while organic products are more costly than its non-organic rivals, their cost differentials are not extreme and/or their demand is substantially stronger than that of the non-organic variety. This, however, can be empirically confirmed in future studies.

Inefficient firms also seek to merge. Our findings also highlight that companies have incentives to merge regardless of their relative efficiency. Specifically, inefficient firms seek to merge, even if they anticipate that their output will significantly decrease after the merger. When their inefficiency is sufficiently severe, this type of firm expects to shut down its operations after the merger, yet obtain a share of merger profits that exceeds its small profits when operating as an independent firm.

Larger production of more costly organic products? If the demand for the organic good is sufficiently strong (such as for organic milk or certain berries), our results indicate that the merger chooses to increase output for this product, while reducing that of its non-organic rival. This finding can be emphasized when the organic product receives a certification from a third-party agency, such as USDA. When the demand differential between organic and non-organic varieties is sufficiently large, we demonstrate that the merger might shut down the production of the non-organic variety. Importantly, the increase (decrease) in organic (non-organic) production occurs despite the organic product being more costly to produce than its non-organic rival. The current demand trend for organic products explains the increase in mergers between non-organic and organic firms during 2015-17.

Purchasing a company to shut it down? Our results also suggest that a non-organic firm, often benefiting from lower production costs than organic companies, has incentives to acquire its organic competitor. After the acquisition, we showed that both firms can coexist producing a positive output when the non-organic cost advantage is not extreme; otherwise, the acquirer would choose to shut down the organic firm, as when the J.M. Smucker Company acquired the organic firm Millstone Coffee in 2008 to subsequently shut it down. In this case, the non-organic company undergoes a costly acquisition just to shut down its organic rival after the purchase. Intuitively, the benefit from the acquisition, in the form of lower competition for the non-organic good which in this case becomes nil, offsets the cost of the purchase.

Antimerger implications. We also show that the output reduction that arises after the merger yields underproduction relative to the socially optimal output under larger parameter conditions. This is more likely to occur when firms sell highly differentiated goods, or when their costs are sufficiently asymmetric. In this setting, antitrust authorities can have incentives to block mergers and acquisitions, as they anticipate welfare reducing outcomes. However, we also identify that, when firms sell relatively homogeneous goods and/or their costs are not extremely asymmetric, a socially excessive output can arise after the merger. In this context, while output decreases as a result of the merger, it approaches the first-best output (q_O^{SO}, as identified in Lemma 2), indicating that the merger is welfare improving.

Our model assumed a representative consumer for each type of product, but further research could allow for a continuum of horizontally differentiated consumers.

7 Appendix

7.1 Appendix 1 - Numerical example

Benchmark case. Applying Lemma 1 to this parametric example yields cutoffs $c_O^M = 0.79$ and $c_{NO}^M = 0.16$. Since $c_O \geq c_{NO}$ by definition, $c_O \geq 0.25$. As a consequence, Region I cannot be sustained in equilibrium; Region II can be supported for all costs satisfying $0.25 \leq c_O < 0.79$; and Region III for all $c_O \geq 0.79$. From Proposition 1, we obtain cutoffs c_1 through c_6 (see first row of Table I). Figure 3 depicts all nine cutoffs to facilitate their comparison. We can then conclude that: (1) the range of parameters $[c_3, c_4] = [0.57, 1.51]$ is compatible with Region II as long as $c_O \in [0.57, 0.79]$, which entails that this region can be supported in equilibrium when costs are relatively high; and (2) the range of parameters $[c_5, c_6] = [0.61, 1.17]$ is compatible for all values of c_O in Region III, implying that this region can be sustained for all admissible c_O.

We next examine the previous cutoffs on rows 2-5 of Table I.

Lower cost, $c_{NO} = 1/10$. Applying Lemma 1 to this parametric example yields cutoffs $c_O^M = 0.71$ and $c_{NO}^M = -0.13$. Since $c_O > 0$ and $c_O \geq c_{NO}$ by definition, Region I cannot be sustained in equilibrium. Region II can be sustained for all cost satisfying $0.1 \leq c_O < 0.71$; and Region III for all $c_O \geq 0.71$. Proposition 1 implies that: (1) the range of parameters $[c_3, c_4] = [0.41, 1.69]$

is compatible with Region II as long as $c_O \in [0.41, 0.71]$, which entails that this region can be supported in equilibrium when costs are moderately high; and (2) the range of parameters $[c_5, c_6] = [0.48, 1.23]$ is compatible for all values of c_O in Region III, entailing that this region can be sustained for all admissible c_O.

Higher demand, $a_{NO} = 1$. Applying Lemma 1 to this parametric example yields cutoffs $c_O^M = 0.62$ and $c_{NO}^M = -0.5$. Since cutoff $c_{NO}^M < 0$ and costs must be positive by definition, Region I cannot be sustained in equilibrium. Since $c_O \geq c_{NO}$ by definition, Region II can be sustained for all costs satisfying $0.25 \leq c_O < 0.62$; and Region III for all remaining costs $c_O \geq 0.62$. Proposition 1 implies that: (1) the range of parameters $[c_3, c_4] = [0.23, 1.92]$ is compatible with Region II as long as $c_O \in [0.23, 0.62]$; and (3) the range of parameters $[c_5, c_6] = [0.31, 1.31]$ is compatible for all values of c_O in Region III, implying that this region can be sustained for all admissible c_O.

Homogeneous goods, $\lambda = 1$. Applying Lemma 1 to this parametric example yields cutoffs $c_O^M = c_{NO}^M = 0.58$. Since $c_O \geq c_{NO}$ by definition, $c_O \geq 0.25$. As a consequence, Region I can be sustained for all costs satisfying $0.25 \leq c_O < 0.58$. Region II cannot be sustained since cutoffs coincide $c_{NO}^M = c_O = c_O^M$; and Region III can be sustained for all $c_O \geq 0.58$. Proposition 1 implies that: (1) the range of parameters $[c_1, c_2] = [0.55, 0.86]$ is compatible with Region I as long as $c_O \in [0.55, 0.58]$; and (2) the range of parameters $[c_5, c_6] = [0.57, 1.01]$ is compatible for all values of c_O in Region III, implying that this region can be sustained for all admissible c_O.

$\lambda = 1$ **and** $a_{NO} = 1$. Applying Lemma 1 to this parametric example yields cutoffs $c_O^M = c_{NO}^M = 0.25$. Since $c_O \geq c_{NO}$ by definition, $c_O \geq 0.25$. As a consequence, Region I cannot be sustained in equilibrium. Region II cannot be sustained since cutoffs c_O^M and c_{NO}^M coincide; and Region III can be sustained for all $c_O \geq 0.25$. Proposition 1 implies that the range of parameters $[c_5, c_6] = [0.22, 0.10]$ is not compatible with Region III.

7.2 Appendix 2 - Extension to N organic and M non-organic firms

7.2.1 Second-stage output

Case 1, No merger. If one or more firms chose to not merge during the first period, a merger does not occur, leading each firm to simultaneously and independently set its own output. In particular, every organic firm chooses its output level q_k to solve

$$\pi_k^{NM} \equiv \max_{q_k} \; (a_k - q_k - q_{-k} - \lambda Q_j)q_k - c_k q_k$$

where $q_{-k} = \sum_{i \neq j}^{N} q_i$ denotes the aggregate output by the other $N-1$ organic firms, and $Q_j = \sum_{r=1}^{M} q_r$ represents the aggregate output by all non-organic firms. Differentiating with respect to q_k, we obtain a best response function

$$q_k(q_{-k}, Q_j) = \frac{1}{2}\left(a_k - c_k - q_{-k} - \lambda Q_j\right)$$

Invoking symmetry ($q_k = q_i$ for every pair of organic firms k and i), we find

$$q_k(Q_j) = \frac{a_k - c_k - \lambda Q_j}{N+1}. \tag{A1}$$

Solving a similar problem for every non-organic firm j, we have

$$\pi_j^{NM} \equiv \max_{q_j} \ (a_j - q_j - q_{-j} - \lambda Q_k)q_j - c_j q_j$$

which yields a symmetric best response function to $q_k(q_{-k}, Q_j)$, that is,

$$q_j(q_{-j}, Q_k) = \frac{1}{2}\left(a_j - c_j - q_{-j} - \lambda Q_k\right).$$

Invoking symmetry ($q_j = q_r$ for every pair of non-organic firms j and r), we find

$$q_j(Q_k) = \frac{a_j - c_j - \lambda Q_k}{M+1}. \tag{A2}$$

In a symmetric equilibrium, aggregate output from organic firms is $Q_k = Nq_k$ while that from non-organic firms is $Q_j = Mq_j$. Inserting these two properties in expressions (A1) and (A2), and simultaneously solving, yields

$$q_k^{NM} = \frac{(M+1)(a_k - c_k) - (a_j - c_j)M\lambda}{(N+1)(M+1) - MN\lambda^2} \quad \text{and} \quad q_j^{NM} = \frac{(N+1)(a_j - c_j) - (a_k - c_k)N\lambda}{(N+1)(M+1) - MN\lambda^2}.$$

Last, equilibrium profits under no merger for the organic and non-organic firms are

$$\pi_k^{NM} = \left[\frac{(M+1)(a_k - c_k) - (a_j - c_j)M\lambda)}{(N+1)(M+1) - MN\lambda^2}\right]^2 = \left(q_k^{NM}\right)^2$$

and

$$\pi_j^{NM} = \left[\frac{(N+1)(a_j - c_j) - (a_k - c_k)N\lambda)}{(N+1)(M+1) - MN\lambda^2}\right]^2 = \left(q_j^{NM}\right)^2.$$

Firm k's output under no merger is positive if its cost satisfies $c_k < c_{N,k}^{NM} \equiv \left(a_k - \frac{M\lambda a_j}{M+1}\right) + \frac{M\lambda c_j}{M+1}$. Similarly firm j produces a positive output if only if $c_j < c_{M,j}^{NM} \equiv \left(a_j - \frac{N\lambda a_k}{N+1}\right) + \frac{N\lambda c_k}{N+1}$.

Case 2, Merger. As in the model with only one firm of each type, we next examine each case separately.

Both firms are active. When all types of firm are active, they maximize their joint profits as follows

$$\pi^{M,Both} \equiv \max_{q_k, q_j} \ [(a_k - q_k - q_{-k} - \lambda Q_j)q_k - c_k q_k] + [(a_j - q_j - q_{-j} - \lambda Q_k)q_j - c_j q_j]$$

Differentiating with respect to q_k and q_j, and invoking symmetry for organic firms, $q_{-k} = (N-1)q_k$, and for non-organic firms, $q_{-j} = (M-1)q_j$, we obtain

$$q_k^{M,Both} = \frac{2M(a_k - c_k) - (a_j - c_j)(M+N)\lambda}{4MN - (M+N)^2\lambda^2} \quad \text{and} \quad q_j^{M,Both} = \frac{2M(a_j - c_j) - (a_k - c_k)(M+N)\lambda}{4MN - (M+N)^2\lambda^2}.$$

yielding equilibrium profits of

$$\pi_k^{M,Both} = \frac{N\left[(a_j - c_j)(M+N)\lambda - 2M(a_k - c_k)\right]\left[(a_j - c_j)(M-N)\lambda + ((M+N)\lambda^2 - 2M)(a_k - c_k)\right]}{\left[4MN - (M+N)^2\lambda^2\right]^2}$$

and

$$\pi_j^{M,Both} = \frac{M\left[(a_k - c_k)(M+N)\lambda - 2N(a_j - c_j)\right]\left[(a_j - c_j)((M+N)\lambda^2 - 2N) - (a_k - c_k)(M-N)\lambda\right]}{\left[4MN - (M+N)^2\lambda^2\right]^2}.$$

Firm k's output under the merger is positive if its cost satisfies $c_k < c_{N,k}^M \equiv \left(a_k - \frac{(M+N)\lambda a_j}{2M}\right) + \frac{(M+N)\lambda c_j}{2M}$.

Only firm k is active. If the merged firm shuts down all non-organic firms j, its profit-maximization problem becomes

$$\pi_k^{M,k} \equiv \max_{q_k} (a_k - q_k - q_{-k})q_k - c_k q_k.$$

Differentiating with respect to q_k and invoking symmetry, $q_{-k} = (N-1)q_k$, yields output

$$q_k^{M,k} = \frac{a_k - c_k}{2N},$$

with associated profits

$$\pi_k^{M,k} = \frac{(a_k - c_k)^2}{4N}.$$

Comparing the profits that the merged firm obtains from keeping producing both goods, $\pi^{M,Both}$, against those where only firm k remains active, $\pi_k^{M,k}$, we obtain the following lemma. For presentation purposes, recall that firm j's output under the merger is positive if its cost c_j satisfies $c_j < a_j - \frac{(M+N)\lambda}{2N}(a_k - c_k)$ which is equivalent to $c_k < c_{M,j}^M \equiv \left(a_k - \frac{2Na_j}{(M+N)\lambda}\right) + \frac{2Nc_j}{(M+N)\lambda}$.

As in the main body of the paper, our subsequent analysis considers firm k as the organic producer, firm O, and its rival j as the non-organic firm, NO.

Lemma A1. *The following three regions can arise in the (c_{NO}, c_O)-quadrant:*

1. *Region I. Only firm O produces positive output if* $c_O < c_{M,NO}^M$.
2. *Region II. Both firms produce positive output if* $c_{M,NO}^M \leq c_O < c_{N,O}^M$.

3. *Region III. Only firm NO produces positive output if* $c_O \geq c_{N,O}^M$.

Proof of Lemma A1. The profit difference $\pi^{M,Both} - \pi_O^{M,O}$ yields a U-shaped curve, which becomes zero at exactly $c_O = c_{M,NO}^M \equiv \left(a_O - \frac{2Na_{NO}}{(M+N)\lambda}\right) + \frac{2Nc_{NO}}{(M+N)\lambda}$. As a consequence, $\pi^{M,Both} \geq \pi_O^{M,O}$ holds for all parameter values. For the non-organic firm, the profit difference $\pi^{M,Both} - \pi_{NO}^{M,NO}$ exhibits a similar shape, becoming zero at $c_O = c_{N,O}^M$; thus implying that $\pi^{M,Both} \geq \pi_{NO}^{M,NO}$ also holds for all parameter values. Summarizing, it is profitable to maintain both firms active, rather than shutting one of them down.

We can now compare cutoffs $c_{N,O}^M$ and $c_{M,NO}^M$. First, cutoff $c_{N,O}^M$ originates above $c_{M,NO}^M$ since their vertical intercepts satisfy $a_O - \frac{(M+N)\lambda a_{NO}}{2M} > a_O - \frac{2Na_{NO}}{(M+N)\lambda}$, which holds given that $\lambda \in [0,1]$ by definition. Second, the positive slope of cutoff $c_{N,O}^M$ is $\frac{(M+N)\lambda}{2M}$, whereas that of cutoff $c_{M,NO}^M$ is $\frac{2N}{(M+N)\lambda}$, thus indicating that cutoff $c_{M,NO}^M$ grows faster than $c_{N,O}^M$ does. In addition, cutoffs $c_{N,O}^M$ and $c_{M,NO}^M$ cross each other at $c_{NO} = a_{NO}$ and a height of $c_O = a_O$. Recalling that $a_O > c_O$ for every firm O, only three regions can be sustained in the (c_{NO}, c_O)-quadrant: (1) when $c_O < c_{M,NO}^M$, only firm O is active; (2) when $c_{M,NO}^M \leq c_O < c_{N,O}^M$, both firms are active; and (3) when $c_O \geq c_{N,O}^M$, only firm NO is active. Q.E.D.

We next examine how the results in Lemma A1 differ relative to its analogous result in the main body of the paper, Lemma 1.

Corollary A1. *When the number of organic and non-organic firms coincide,* $M = N$*, cutoff* $c_{N,O}^M$ *becomes* c_O^M *and cutoff* $c_{M,NO}^M$ *becomes* c_{NO}^M*. When the difference* $M - N$ *increases, both cutoffs* $c_{M,NO}^M$ *and* $c_{N,O}^M$ *shift upwards, shrinking Regions II and III while expanding Region I.*

Therefore, our results in Lemma 1 (which assumes one firm of each type) coincide with those where M firms of each type exist, regardless of how large the number of firms is, i.e., for all $M = N \geq 1$. The findings depicted in figure 1 readily apply in this context.

However, as the difference in the number of non-organic and organic firms (as captured by $M - N$) increases, organic firms produce a positive output under more restrictive cost conditions. As a result, when the costs of organic firms are extremely high, as in Region III (see figure 1 in the main body of the paper), the merged firm produces non-organic goods alone. When the costs of both firms are relatively similar and high, as in Region II, they both remain active after the merger. In the rest of the cases, the merged firm produces organic goods alone as in Region I.

When products are homogeneous, $\lambda = 1$, our results in the main body of the paper still apply when the number of organic and non-organic firms coincides, $M = N$, as depicted in figure 2a. However, when $M > N$, cutoff $c_{N,O}^M$ originates below $c_{M,O}^M$, giving rise to Region II, where both firms are active; a result that could not be sustained when products are homogeneous and $M = N$. In contrast, when products are completely differentiated, $\lambda = 0$, all cutoffs identified in Lemma A1 simplify to a_O (i.e., they all become a horizontal line originating at a_O), yielding only one possible outcome in equilibrium: Region I, where the organic firm is the only active plant.

7.2.2 First stage

For each (c_{NO}, c_O)-pair, every firm O anticipates the output profile that will emerge in the second stage of the game, i.e., Regions I-III. For completeness, we consider that during the first stage firms choose whether to merge; and subsequently examine how the results would change if, instead, one firm is allowed to acquire its rival.

In the first stage, every firm chooses whether to merge or not. In particular, for each region I-III, the firm compares the profits that it currently obtains as an independent firm, $\pi_{N,O}^{NM}$, against the profits it would obtain under the merger: $\frac{\pi_{N,O}^{M,O}}{M+N}$ in Region I, $\frac{\pi_{N,M}^{M,Both}}{M+N}$ in Region II, and $\frac{\pi_{M,NO}^{M,NO}}{M+N}$ in Region III. For simplicity, we assume that firms evenly share merger profits.

Proposition A1. *During the first stage, every firm O chooses to merge as follows:*

1. *If (c_{NO}, c_O)-pairs lie in Region I, firm O merges if and only if $c_O \in [c_1, c_2]$;*
2. *If (c_{NO}, c_O)-pairs lie in Region II, firm O merges if and only if $c_O \in [c_3, c_4]$; and*
3. *If (c_{NO}, c_O)-pairs lie in Region III, firm O merges if and only if $c_O \in [c_5, c_6]$.*

For compactness, cutoffs $c_1 - c_6$ are defined in the proof below.

Proof of Proposition A1. First, consider (c_{NO}, c_O)-pairs in Region I, i.e., $c_O < c_{M,NO}^{M}$. In this region, only firm O operates under a merger in the second stage. Therefore, every firm O chooses to merge in the first stage if and only if its share of profits under the merger, $\frac{\pi_{N,O}^{M,O}}{M+N}$, exceeds the profits it would obtain as an independent firm, $\pi_{N,O}^{NM}$. Setting $\frac{\pi_{N,O}^{M,O}}{M+N} \geq \pi_{N,O}^{NM}$, and solving for cost c_O, we find that $\frac{\pi_{N,O}^{M,O}}{M+N} \geq \pi_{N,O}^{NM}$ holds for all $c_O \in [c_1, c_2]$, where

$$c_1 \equiv \frac{(4a_O N(M+N)(M+1)^2 - a_O\big((N+1)(M+1) - M\lambda^2\big)^2}{4N(M+N)(M+1)^2 - \big((N+1)(M+1) - MN\lambda^2\big)^2}$$

$$-\frac{4MN(M+N)(M+1)\lambda(a_{NO} - c_{NO})}{4N(M+N)(M+1)^2 - \big((N+1)(M+1) - MN\lambda^2\big)^2}$$

$$-\frac{\frac{2M(a_{NO}-c_{NO})\lambda\big((N+1)(M+1)-MN\lambda^2\big)}{\sqrt{N(M+N)}}}{4N(M+N)(M+1)^2 - \big((N+1)(M+1) - MN\lambda^2\big)^2}.$$

and

$$c_2 \equiv \frac{(4a_O N(M+N)(M+1)^2 - a_O\big((N+1)(M+1) - M\lambda^2\big)^2}{4N(M+N)(M+1)^2 - \big((N+1)(M+1) - MN\lambda^2\big)^2}$$

$$-\frac{4MN(M+N)(M+1)\lambda(a_{NO} - c_{NO})}{4N(M+N)(M+1)^2 - \big((N+1)(M+1) - MN\lambda^2\big)^2}$$

$$+\frac{\frac{2M(a_{NO}-c_{NO})\lambda\big((N+1)(M+1)-MN\lambda^2\big)}{\sqrt{N(M+N)}}}{4N(M+N)(M+1)^2-\big((N+1)(M+1)-MN\lambda^2\big)^2}.$$

Second, consider (c_{NO}, c_O)-pairs in Region II, i.e., $c^M_{M,NO} \leq c_O < c^M_{N,O}$. In this region, both firms are active under a merger in the second stage. Therefore, every firm O chooses to merge in the first stage if and only if its share of profits under the merger, $\frac{\pi^{M,Both}_{N,M}}{M+N}$, exceeds the profits it would obtain as an independent firm, $\pi^{NM}_{N,O}$. Setting $\frac{\pi^{M,Both}_{N,M}}{M+N} \geq \pi^{NM}_{N,O}$, and solving for cost c_O, we find that $\frac{\pi^{M,Both}_{N,M}}{M+N} \geq \pi^{NM}_{N,O}$ holds for all $c_O \in [c_3, c_4]$, where

$$c_3 \equiv \frac{\frac{2a_OM-(a_{NO}-c_{NO})(M+N)\lambda}{(M+N)(4MN-(M+N)^2\lambda^2}}{\left(\frac{2M}{(M+N)\big(4MN-(M+N)^2\lambda^2\big)}-\frac{2(M+1)^2}{\big((N+1)(M+1)-MN\lambda^2\big)^2}\right)}$$

$$-\frac{\frac{(a_O-c_O)(M+1)\sqrt{1+N(2-4MN-3N^2)}-\sqrt{2M(N-2(M+N)(M+N+MN))}\lambda+MN\lambda^2}{(M+N)\big((N+1)(M+1)-MN\lambda^2\big)\sqrt{4MN-(M+N)^2\lambda^2}}}{\left(\frac{2M}{(M+N)\big(4MN-(M+N)^2\lambda^2\big)}-\frac{2(M+1)^2}{\big((N+1)(M+1)-MN\lambda^2\big)^2}\right)}$$

$$-\frac{\frac{2a_O(M+1)^2-2M(M+1)(a_O-c_O)\lambda}{\big((N+1)(M+1)-MN\lambda^2\big)^2}}{\frac{2M}{(M+N)\big(4MN-(M+N)^2\lambda^2\big)}-\frac{2(M+1)^2}{\big((N+1)(M+1)-MN\lambda^2\big)^2}}$$

and

$$c_4 \equiv \frac{\frac{4Ma_O-2(a_{NO}-c_{NO})(M+N)\lambda}{(M+N)(4MN-(M+N)^2\lambda^2)}}{\left(\frac{4M}{(M+N)\big(4MN-(M+N)^2\lambda^2\big)}-\frac{4(M+1)^2}{\big((N+1)(M+1)-MN\lambda^2\big)^2}\right)}$$

$$+\frac{\frac{2(a_O-c_O)(M+1)\sqrt{1+N(2-4MN-3N^2)}-\sqrt{2M(N-(2M+N)(M+N+MN))}\lambda+MN\lambda^2}{(M+N)\big((N+1)(M+1)-MN\lambda^2\big)\sqrt{4MN-(M+N)^2\lambda^2}}}{\left(\frac{4M}{(M+N)\big(4MN-(M+N)^2\lambda^2\big)}-\frac{4(M+1)^2}{\big((N+1)(M+1)-MN\lambda^2\big)^2}\right)}$$

$$-\frac{\frac{4(M+1)(a_O(M+1)-(a_{NO}-c_{NO})M\lambda)}{\big((N+1)(M+1)-MN\lambda^2\big)^2}}{\left(\frac{4M}{(M+N)\big(4MN-(M+N)^2\lambda^2\big)}-\frac{4(M+1)^2}{\big((N+1)(M+1)-MN\lambda^2\big)^2}\right)}$$

Third, consider (c_{NO}, c_O)-pairs in Region III, i.e., $c_O \geq c^M_{N,O}$. In this region, only firm NO operates under a merger in the second stage. Therefore, every firm O chooses to merge in the first stage if and only if its share of profits under the merger, $\frac{\pi^{M,NO}_{M,NO}}{M+N}$, exceeds the profits it would obtain as an independent firm, $\pi^{NM}_{N,O}$. Setting $\frac{\pi^{M,NO}_{M,NO}}{M+N} \geq \pi^{NM}_{N,O}$, and solving for cost c_O, we find that this inequality holds for all $c_O \in [c_5, c_6]$, where

$$c_5 \equiv a_O - \frac{(a_{NO}-c_{NO})M\lambda}{M+1}$$

$$-\frac{a_{NO}-c_{NO}}{\sqrt{M(M+N)}(N+1)(M+1)-MN\lambda^2}\left(\frac{(M+1)(N+1)^2}{2}+\frac{M^2\lambda^2}{2(M+1)}+\lambda^2-1\right)$$

and

$$c_6 \equiv a_O - \frac{(a_{NO}-c_{NO})M\lambda}{M+1}$$

$$+\frac{a_{NO}-c_{NO}}{\sqrt{M(M+N)}(N+1)(M+1)-MN\lambda^2}\left(\frac{(M+1)(N+1)^2}{2}+\frac{M^2\lambda^2}{2(M+1)}+\lambda^2-1\right).$$

Q.E.D.

7.2.3 Numerical example

We evaluate cutoffs c_1 through c_6 at $M = N = 5$ firms throughout this appendix. A similar analysis applies to settings with different numbers of firms.

Benchmark case. Applying Lemma 1 to this parametric example yields cutoffs $c_O^M = 0.79$ and $c_{NO}^M = 0.16$. Since $c_O \geq c_{NO}$ by definition, $c_O \geq 0.25$. As a consequence, Region I cannot be sustained in equilibrium; Region II can be supported for all $0.25 \leq c_O < 0.79$; and Region III for all $c_O \geq 0.79$. From Proposition 1, we obtain cutoffs c_1 through c_6 (see last row of Table IV). We can then conclude that: (1) the range of parameters $[c_3, c_4] = [0.67, 0.99]$ is compatible with Region II as long as $c_O \in [0.67, 0.79]$, which entails that this region can be supported in equilibrium when costs are relatively high; and (2) the range of parameters $[c_5, c_6] = [0.68, 0.97]$ is compatible for all values of c_O in Region III, implying that this region can be sustained for all admissible c_O.

We next examine the previous cutoffs on rows 2-5 of Table I.

Lower cost, $c_{NO} = 1/10$. Applying Lemma 1 to this parametric example yields cutoffs $c_O^M = 0.71$ and $c_{NO}^M = -0.13$. Since $c_O > 0$ and $c_O \geq c_{NO}$ by definition, Region I cannot be sustained in equilibrium. Region II can be sustained for all costs satisfying $0.1 \leq c_O < 0.71$; and Region III for all $c_O \geq 0.71$. Proposition 1 implies that: (1) the range of parameters $[c_3, c_4] = [0.55, 0.99]$ is compatible with Region II for all costs $c_O \in [0.55, 0.71]$, which entails that this region can be supported in equilibrium when costs are moderately high; and (2) the range of parameters $[c_5, c_6] = [0.56, 0.96]$ is compatible for all values of c_O in Region III, entailing that this region can be sustained for all admissible c_O.

Higher demand, $a_{NO} = 1$. Applying Lemma 1 to this parametric example yields cutoffs $c_O^M = 0.62$ and $c_{NO}^M = -0.5$. Since cutoff $c_{NO}^M < 0$ and costs must be positive by definition, Region I cannot be sustained in equilibrium. Region II can be sustained for all costs satisfying $0.25 \leq c_O < 0.62$; and Region III for all remaining costs $c_O \geq 0.62$. Proposition 1 implies that: (1) the range of parameters $[c_3, c_4] = [0.41, 0.98]$ is compatible with Region II as long as $c_O \in [0.41, 0.62]$; and (2) the range of parameters $[c_5, c_6] = [0.42, 0.95]$ is compatible for all values of c_O in Region III, implying that this region can be sustained for all admissible c_O.

Homogeneous goods, $\lambda = 1$. Applying Lemma 1 to this parametric example yields cutoffs $c_O^M = c_{NO}^M = 0.58$. Since $c_O \geq c_{NO}$ by definition, $c_O \geq 0.25$. As a consequence, Region I can be sustained for all costs satisfying $0.25 \leq c_O < 0.58$. Region II cannot be sustained since cutoffs coincide $c_{NO}^M = c_O = c_O^M$; and Region III can be sustained for all $c_O \geq 0.58$. Proposition 1 implies that: (1) the range of parameters $[c_1, c_2] = [0.60, 0.69]$ is not compatible in Region I, implying that this region cannot be sustained in equilibrium; and (2) the range of parameters $[c_5, c_6] = [0.59, 0.70]$ is compatible for all values of c_O in Region III, implying that this region can be sustained for all admissible c_O.

$\lambda = 1$ **and** $a_{NO} = 1$**.** Applying Lemma 1 to this parametric example yields cutoffs $c_O^M = c_{NO}^M = 0.25$. Since $c_O \geq c_{NO}$ by definition, $c_O \geq 0.25$. As a consequence, Region I cannot be sustained in equilibrium; Region II cannot be sustained since cutoffs c_O^M and c_{NO}^M coincide; and Region III can be sustained for all $c_O \geq 0.25$. Proposition 1 implies that the range of parameters $[c_5, c_6] = [0.27, 0.47]$ is compatible for all values of c_O in Region III, entailing that this region can be sustained for all admissible c_O.

7.3 *Proof of Lemma 1*

First, note that the profit difference $\pi^{M,Both} - \pi_O^{M,O}$ yields a U-shaped curve, which becomes zero at exactly $c_O = a_O - \frac{a_{NO} - c_{NO}}{\lambda}$. As a consequence, $\pi^{M,Both} \geq \pi_O^{M,O}$ holds for all parameter values. For the non-organic firm, the profit difference $\pi^{M,Both} - \pi_{NO}^{M,NO}$ exhibits a similar shape, becoming zero at $c_O = c_O^M$; thus implying that $\pi^{M,Both} \geq \pi_{NO}^{M,NO}$ also holds for all parameter values. Summarizing, it is profitable to maintain both firms active, rather than shutting one of them down. However, conditions $c_O < c_O^M$ and $c_{NO} < c_{NO}^M$ still apply yielding different regions in the (c_{NO}, c_O)-quadrant.

We can now compare cutoffs c_O^M and c_{NO}^M. First, cutoff c_O^M originates above c_{NO}^M since their vertical intercepts satisfy $a_O - \lambda a_{NO} > a_O - \frac{a_{NO}}{\lambda}$, which holds given that $\lambda \in [0, 1]$ by definition. Second, the positive slope of cutoff c_O^M is λ, whereas that of cutoff c_{NO}^M is $1/\lambda$, thus indicating that cutoff c_{NO}^M grows faster than c_O^M does. In addition, cutoffs c_O^M and c_{NO}^M cross each other at $c_{NO} = a_{NO}$ and a height of $c_O = a_O$. Recalling that $a_O > c_O$ for the organic firm, only three regions can be sustained in the (c_{NO}, c_O)-quadrant: (1) when $c_O < c_{NO}^M$, only the organic firm is active; (2) when $c_{NO}^M \leq c_O < c_O^M$, both firms are active; and (3) when $c_O \geq c_O^M$, only the non-organic firm is active.

7.4 *Proof of Proposition 1*

First, consider (c_{NO}, c_O)-pairs in Region I, i.e., $c_O < c_{NO}^M$. In this region, only the organic firm operates under a merger in the second stage. Therefore, the organic firm chooses to merge in the first stage if and only if its share of profits under the merger, $\frac{\pi_O^{M,O}}{2}$, exceeds the profits it would obtain as an independent firm, π_O^{NM}. Setting $\frac{\pi_O^{M,O}}{2} \geq \pi_O^{NM}$, and solving for cost c_O, we find that $\frac{\pi_O^{M,O}}{2} \geq \pi_O^{NM}$ holds for all $c_O \in [c_1, c_2]$, where

$$c_1 \equiv \frac{a_O(16 + 8\lambda^2 - \lambda^4) - 16\lambda(a_{NO} - c_{NO}) - 2\sqrt{2}(a_{NO} - c_{NO})\lambda(4 - \lambda^2)}{16 + 8\lambda^2 - \lambda^4}$$

and

$$c_2 \equiv \frac{a_O(16+8\lambda^2-\lambda^4)-16\lambda(a_{NO}-c_{NO})+2\sqrt{2}(a_{NO}-c_{NO})\lambda(4-\lambda^2)}{16+8\lambda^2-\lambda^4}.$$

Second, consider (c_{NO}, c_O)-pairs in Region II, i.e., $c_{NO}^M \leq c_O < c_O^M$. In this region, both firms are active under a merger in the second stage. Therefore, the organic firm chooses to merge in the first stage if and only if its share of profits under the merger, $\frac{\pi^{M,Both}}{2}$, exceeds the profits it would obtain as an independent firm, π_O^{NM}. Setting $\frac{\pi^{M,Both}}{2} \geq \pi_O^{NM}$, and solving for cost c_O, we find that $\frac{\pi^{M,Both}}{2} \geq \pi_O^{NM}$ holds for all $c_O \in [c_3, c_4]$, where

$$c_3 \equiv \frac{(a_{NO}-c_{NO})\lambda^3(8+\lambda^2)+a_O(16-24\lambda^2-\lambda^4)+(a_{NO}-c_{NO})(4-\lambda^2)\left[16-32\lambda^2+15\lambda^4+\lambda^6\right]^{1/2}}{16-24\lambda^2-\lambda^4}$$

and

$$c_4 \equiv \frac{(a_{NO}-c_{NO})\lambda^3(8+\lambda^2)+a_O(16-24\lambda^2-\lambda^4)-(a_{NO}-c_{NO})(4-\lambda^2)\left[16-32\lambda^2+15\lambda^4+\lambda^6\right]^{1/2}}{16-24\lambda^2-\lambda^4}.$$

Third, consider (c_{NO}, c_O)-pairs in Region III, i.e., $c_O \geq c_O^M$. In this region, only the non-organic firm operates under a merger in the second stage. Therefore, the organic firm chooses to merge in the first stage if and only if its share of profits under the merger, $\frac{\pi_{NO}^{M,NO}}{2}$, exceeds the profits it would obtain as an independent firm, π_O^{NM}. Setting $\frac{\pi_{NO}^{M,NO}}{2} \geq \pi_O^{NM}$, and solving for cost c_O, we find that $\frac{\pi_{NO}^{M,NO}}{2} \geq \pi_O^{NM}$ holds for all $c_O \in [c_5, c_6]$, where

$$c_5 \equiv \frac{4[2a_O-\lambda(a_{NO}+c_{NO})]+\sqrt{2}(a_{NO}-c_{NO})(4-\lambda^2)}{8}$$

and

$$c_6 \equiv \frac{4[2a_O-\lambda(a_{NO}+c_{NO})]-\sqrt{2}(a_{NO}-c_{NO})(4-\lambda^2)}{8}.$$

7.5 *Proof of Lemma 2*

As discussed in the main body of the paper, social welfare is given by the sum of consumer and producer surplus, $W = CS + PS$, where $CS \equiv \frac{1}{2}(q_O^2 + q_{NO}^2 + 2\lambda q_O q_{NO})$ and $PS \equiv [p(q_O, q_{NO})q_O - c_O q_O] + [p(q_{NO}, q_O)q_{NO} - c_{NO}q_{NO}]$. Using the inverse demands $p(q_O, q_{NO})$ and $p(q_{NO}, q_O)$, the expression of producer surplus, PS, collapses to $PS = a_O q_O + q_{NO}(a_{NO} - c_{NO} - q_{NO}) - q_O(q_O + c_O + 2\lambda q_{NO})$. Differentiating welfare W with respect to q_O, we obtain

$$a_O - c_O - q_O - \lambda q_{NO} = 0$$

and a symmetric expression when we differentiate W with respect to q_{NO}, $a_{NO} - c_{NO} - q_{NO} - \lambda q_O = 0$. Simultaneously solving for q_O and q_{NO}, yields $q_O^{SO} = \frac{a_O - c_O - \lambda(a_{NO} - c_{NO})}{1-\lambda^2}$ and $q_{NO}^{SO} = \frac{a_{NO} - c_{NO} - \lambda(a_O - c_O)}{1-\lambda^2}$.

Comparing q_O^{SO} against $q_O^{M,Both}$, we obtain that $q_O^{SO} \geq q_O^{M,Both}$ for all $c_O \leq c_O^A \equiv (a_O - \lambda a_{NO}) +$

λc_{NO}, where the term in parenthesis indicates the vertical intercept of cutoff c_O^A in the $(c_{NO}, c_O)-$quadrant (see Figure 1 for a reference), while λ represents its positive slope. Similarly, comparing q_O^{SO} against $q_O^{M,O}$, we obtain that $q_O^{SO} \geq q_O^{M,O}$ for all $c_O \leq c_O^B \equiv \left(a_O - \frac{2\lambda a_{NO}}{1+\lambda^2}\right) + \frac{2\lambda}{1+\lambda^2} c_{NO}$, where the term in parenthesis indicates the vertical intercept of cutoff c_O^B in the $(c_{NO}, c_O)-$quadrant (such as that in Figure 1), while $\frac{2\lambda}{1+\lambda^2}$ represents its positive slope. A similar argument for the output levels of the non-organic firm yields that $q_{NO}^{SO} \geq q_{NO}^{M,NO}$ if and only if $c_O \leq \left(a_O - \frac{(1+\lambda^2)a_{NO}}{2\lambda}\right) + \frac{(1+\lambda^2)c_{NO}}{2\lambda} \equiv c_{NO}^B$.

7.6 *Proof of Proposition 2*

Let us now analyze each of the regions in Figure 1. Although we are simultaneously plotting several cutoffs for c_O, their ranking does not depend on λ.

As depicted in Figure A1, cutoffs c_O^M, c_O^A, and c_O^{SO} coincide and originate above cutoff c_O^B since $a_O - \lambda a_{NO} > a_O - \frac{2\lambda a_{NO}}{1+\lambda^2}$, cutoff c_O^B originates above c_{NO}^B since $a_O - \frac{2\lambda a_{NO}}{1+\lambda^2} > a_O - \frac{(1+\lambda^2)a_{NO}}{2\lambda}$, and cutoff c_{NO}^B originates above c_{NO}^M since $a_O - \frac{(1+\lambda^2)a_{NO}}{2\lambda} > a_O - \frac{a_{NO}}{\lambda}$. Furthermore, cutoffs c_O^M and c_O^{SO} coincide and originate above cutoffs c_{NO}^M and c_{NO}^{SO} since $a_O - \lambda a_{NO} > a_O - \frac{a_{NO}}{\lambda}$.

Insert Figure A1 here.

Starting at Region I, where $c_O < c_{NO}^M$, only the organic firm is active in equilibrium. The social planner would also have only the organic firm being active since in this region c_O satisfies $c_O < c_O^{SO}$ and $c_O < c_{NO}^{SO}$. We can then compare equilibrium and socially optimal output, $q_O^{M,O}$ and q_O^{SO}, obtaining that $q_O^{SO} \geq q_O^{M,O}$ since Region I lies entirely below cutoff c_O^B. Therefore, a socially insufficient output emerges in Region I, relative to the social optimum.

In Region II, where $c_{NO}^M \leq c_O < c_O^M$, both firms are active in equilibrium where $q_O^{M,Both}, q_{NO}^{M,Both} > 0$. The social planner would also recommend that both firms are active since $c_{NO}^{SO} \leq c_O < c_O^{SO}$. Comparing equilibrium and optimal output, we obtain that $q_O^{SO} \geq q_O^{M,Both}$ since $c_O \leq c_O^A$. Therefore, a socially insufficient output emerges in Region II.

In Region III, only the non-organic firm is active in equilibrium, which coincides with the social optimum since $c_O \geq c_O^{SO}$ and $c_O \geq c_{NO}^{SO}$. Comparing output levels, we find that $q_{NO}^{SO} < q_{NO}^{M,NO}$ since Region III lies entirely above cutoff c_{NO}^B. Therefore, a socially excessive output emerges for all costs in Region III.

In summary, socially insufficient production occurs in two regions: (a) Region I, where $c_O < c_{NO}^M = c_{NO}^{SO}$; and (b) Region II, where $c_{NO}^M \leq c_O < c_O^M = c_O^{SO}$. Furthermore, we can collapse the conditions to just $c_O < c_O^{SO}$. Socially excessive production occurs in Region III, where $c_O \geq c_O^M = c_O^{SO}$.

7.7 *Proof of Corollary 1*

Undifferentiated products, $\lambda = 1$. In this context, all cutoffs collapse to the same line (i.e., they are all originating at $a_O - a_{NO}$), dividing into two regions, Region I and Region III; as depicted in Figure A2.

Insert Figure A2 here.

Starting at Region I, where $c_O < c_{NO}^{M}$, only the organic firm is active in equilibrium. The social planner would also have only the organic firm being active since in this region c_O satisfies $c_O < c_O^{SO}$ and $c_O < c_{NO}^{SO}$. Comparing equilibrium and socially optimal output, we obtain that $q_O^{SO} \geq q_O^{M,O}$ since Region I lies entirely below cutoff c_O^B. As a result, a socially insufficient output emerges in Region I.

In Region III, only the non-organic firm is active in equilibrium. The social planner would also have only the non-organic firm being active since c_O satisfies $c_O \geq c_{NO}^{SO}$. Comparing output levels, we find that $q_{NO}^{SO} < q_{NO}^{M,NO}$ since Region III lies entirely above c_{NO}^B. Therefore, a socially excessive output emerges in Region III.

Completely differentiated products, $\lambda = 0$. As depicted in Figure A3, in this setting, all cutoffs collapse to the same line (i.e., they are all horizontal line originating at a_O), yielding only one possible outcome: Region I, where the organic firm is the only active plant if $c_O < c_{NO}^{M}$.

Insert Figure A3 here.

In Region I, where $c_O < c_{NO}^{M}$, only the organic firm is active in equilibrium. The social planner would also have only the organic firm being active since in this region c_O satisfies $c_O < c_O^{SO}$ and $c_O < c_{NO}^{SO}$. We can then compare equilibrium and socially optimal output, $q_O^{M,O}$ and q_O^{SO}, obtaining that $q_O^{SO} \geq q_O^{M,O}$ since Region I lies entirely below cutoff c_O^B. Therefore, a socially insufficient output emerges in Region I, relative to the social optimum.

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