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National pricing with local quality competition

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Abstract

We study the incentives of national retail chains to adopt national (uniform) prices across local markets that differ in size and competition intensity. In addition to price, the chains may also compete along a quality dimension, and quality is always set locally. We show that absent quality competition, the chains will never use national pricing. However, if quality competition is sufficiently strong there exist equilibria where at least one of the chains adopts national pricing. We also identify cases in which national pricing benefits (harms) all consumers, even in markets where such a pricing strategy leads to higher (lower) prices.

1 | INTRODUCTION

In a number of different retail industries we observe that firms sometimes adopt a uniform price across some or all of its stores, even though the different stores are facing vastly different market conditions at the local level. This type of pricing policy is sometimes referred to as "national pricing" or simply "uniform pricing."[1] The polar case to national pricing is that of local pricing, in which the price is allowed to optimally vary from store to store, according to local market and demand characteristics.

The degree to which chain-store groups adopt national or local prices varies from sector to sector, and sometimes also within a sector. A recent study by DellaVigna and Gentzkow (2019) finds that most US food, drugstore, and mass-merchandise chains charge national or regional prices, even though there is a large variation in both demographics and competition across the different local markets. Dobson and Waterson (2005) report that UK electrical goods retailers predominately use national prices, US office supply superstores adopt local prices, and in the UK supermarket sector some groups price uniformly and others price locally.[2] DellaVigna and Gentzkow (2019) also estimate that, all else being equal, many chains would substantially increase their annual profit by charging optimal local prices instead of national prices.[3] Thus, there likely are some potentially very strong unaccounted-for benefits of adopting a national price. However, the variation in the incidence of national pricing suggests that these benefits perhaps are not equally strong in every sector.

The choice of pricing policy (local or national) is obviously important from a business standpoint. Recognizing the type of market conditions that can make national pricing profitable is therefore of great value to managers. However, understanding national pricing is important also from a policy perspective. Competition authorities, for example, sometimes simplify their analysis when analyzing mergers, by assuming that retail chains set their prices locally, and that the firms thus optimally react to changes in local market conditions. Yet, we know that this assumption is likely to be wrong in many cases. This potentially has important implications for competition policy and in particular for merger control.

In this paper we analyze the incentives to adopt national prices in a spatial model with fixed total demand, where two retail chains compete against each other in two different local markets. The two markets differ both in their size (density of consumers) and degree of competition. Each chain operates a single store in each of the two markets. Unlike the received literature, we assume that the stores engage in both price and nonprice competition at the local level. We assume that nonprice competition takes the form of service or quality provision at the local level: a higher quality level increases the store's demand by attracting customers from the rival store. Moreover, because important dimensions of quality often are hard to measure, we assume that the chains' quality provisions are nonverifiable. This implies that it is not feasible for a chain to commit to a national service or quality standard, and the quality level is therefore decided locally at each store. Some examples of the type of nonverifiable quality or service that we are thinking of are the number of staff per customer, the quality of presale information and assistance, the frequency to which goods are checked and restocked (e.g., fresh produce), store cleanliness, and so forth. Unlike the quality level, the prices may be determined by each chain either locally or nationally—the latter meaning that the chain commits to adopt the same price in both markets.

We derive the following key results: Absent any nonprice competition, national pricing never arises as an equilibrium strategy in our model.[4] This is unlike the received literature: Dobson and Waterson (2005; DW henceforth), in a model with elastic total demand, but without nonprice competition, find that national pricing may arise as an equilibrium strategy. However, even in their model the potential profit gain from national pricing is quite small (in almost all cases, less than 1%), as suggested in their 2008 follow-up paper (Dobson & Waterson, 2008). This is not the case in our model: First, when we introduce quality competition locally, national pricing may become an equilibrium strategy also in our framework. Second, the potential profit gain from national pricing will in many cases be economically meaningful, even substantial.[5]

The intuition for why local quality competition can make national pricing profitable, may be described as follows: The inclusion of a second dimension of competition (quality) makes the best-response dynamics more involved compared with DW. As a first example, a commitment to national pricing by one chain may induce the rival chain to increase the price in one market and reduce the price in the other market, similar to what happens in DW. Without quality competition, this is never enough to make national pricing a profitable strategy overall in our model. When the stores engage in quality competition, however, the rival's own price and own quality become complementary strategies locally, which in turn implies that national pricing may induce the rival chain to reduce the quality level in one of their stores (in the same market where they chose to reduce their price). Thus, we may end up with a softening of price competition in one market, and a softening of quality competition in the other market. This is sometimes sufficient to make national pricing a profitable strategy overall, either for one or both chains. However, it is not the only way for national pricing to become profitable. As a second example, a commitment to national pricing by one chain may induce the rival chain to *reduce* its price in *both* markets. Again, because own prices and own qualities are complementary strategies, in each market the price reduction will be complemented by a reduction in the rival's quality. This second effect (a softening of quality competition) will sometimes dominate. Thus, national pricing can be a profitable strategy even if the rival's price goes down in both markets. This can never happen without nonprice competition.

The effects of national pricing on consumers are nontrivial. Typically, the consumers in one market may benefit at the expense of the consumers in the other market, similar to what would be the situation without quality competition. In these cases the total effect can be either positive or negative, depending on the parameter values. However, in our model it is also possible for national pricing to benefit (or harm) the consumers in both markets simultaneously. In this case, both price and quality will decrease in one market and increase in the other market. In this situation, for national pricing to benefit everyone, the effect of the price drop needs to dominate in the first market and the increase in quality needs to dominate in the second market. This can happen if the two markets are of sufficiently different sizes. Conversely, consumers in both markets may be harmed by a switch to national pricing if the quality reduction dominates in the first market and the price increase dominates in the second market. Again we find that this can happen if the two markets are of sufficiently different sizes. These results can only arise with multidimensional competition. Finally, we find that total welfare is always maximized under local pricing in our model. This implies that whenever the consumers in both markets benefit from national pricing, the firms will be harmed by it. Therefore, when this happens in equilibrium, national pricing will be an outcome of a Prisoner's Dilemma.

It follows from our results that managers should be worried about their choice between national or local pricing, in particular if nonprice competition (e.g., quality, service, …) forms an important part of their overall strategy. According to the received literature, if the chains only compete in prices, the potential profit gain from adopting national pricing appears to be modest, at best, while the potential profit loss can be large. In our model, the firms will *never* benefit from national pricing if pricing is the only relevant dimension of competition. This changes drastically as quality competition becomes more important. The profit gain from national pricing is then potentially quite large. This seems to be in line with some observations: For example, we often observe national pricing being adopted in retail industries in which quality and personal service play an important role, for example, markets for groceries, clothing, pharmaceuticals, and so forth. On the other hand, we rarely observe the adoption of national pricing in an industry, such as retail gasoline, where quality and personal service seem to be much less important, as illustrated by the extensive use of self-service pumps and stations. In line with this, and as a prediction of our model, we should expect to observe the adoption of local pricing more frequently in the future, as automation and self-service become more prevalent in an increasing number of retail industries (e.g., the grocery industry).

The remainder of the paper is organized in the following way. Section 2 reviews the related literature. Section 3 introduces the model and our main assumptions. In Section 4 we derive the Nash equilibrium outcome when both chains practice local pricing, and in Section 5 we derive the equilibrium prices and qualities when either one or both chains practice national pricing. The pricing strategies are then endogenized in Section 6, where we characterize the subgame-perfect Nash equilibria (SPNE) of a game where each chain initially commits to either a local or a national pricing strategy. In Section 7 we discuss some robustness checks and summarize the associated results. Section 8 briefly discusses the implications of national pricing for consumers' surplus and overall welfare. Section 9 gives a short discussion of our main results and presents some potential implications for different types of firms and industries. Finally, Section 10 concludes.

2 | RELATED LITERATURE

Our paper contributes to the literature on third-degree price discrimination in oligopoly. A seminal paper in this literature is Holmes (1989), who analyzes the effects of third-degree price discrimination in a differentiated-goods duopoly with two different consumer segments constituting a "weak" and a "strong" market, respectively.[6] He shows that the effects of price discrimination depend on differences in both cross-price elasticities and industry-demand elasticities across the two markets. Although the main focus is on the effects on total output, he also identifies cases in which profits are lower under price discrimination than under uniform pricing.[7] A more comprehensive analysis of the profit effects of price discrimination in a similar setting is made by Winter (1997), who studies firms' incentives to collude on limiting the degree of price discrimination (e.g., by agreeing to limit discounts offered to a class of consumers). Using the same modeling framework as Holmes (1989), he finds that firms have a joint incentive to limit price discrimination if the difference in cross-price elasticities is larger than the difference in industry-demand elasticities across the two markets.

The present paper differs from Holmes (1989) and Winter (1997) in two important respects. First, and most importantly, we introduce competition along two different dimensions (price and quality), which turns out to have significant and nontrivial effects on firms' incentives to price discriminate. Second, while both Winter (1997) and Holmes (1989) restrict their analyses to exploring multilateral incentives, that is, whether firms jointly lose or benefit from a change in the ability to price discriminate between different markets, we analyze unilateral incentives to commit to a particular pricing strategy. In other words, we derive the SPNE of a two-stage game in which retail chains can credibly commit to a national pricing strategy before price and quality choices are made. In a setting where such commitment is possible, the joint profit effects of uniform pricing versus price discrimination do not necessarily tell us anything about whether national pricing can arise as a Nash equilibrium outcome. Indeed, we identify parameter sets for which national pricing by both chains is a unique Nash equilibrium and where the game is a Prisoner's Dilemma. In such cases, the chains do not have an incentive to coordinate on restricting the degree of price discrimination (e.g., by agreeing to adopt national pricing), but national pricing is nevertheless a Nash equilibrium outcome because of unilateral incentives for such restrictions.

A similar type of precommitment to a uniform pricing strategy is also considered by Corts (1998), who, similarly to Holmes (1989) and Winter (1997), analyzes the effects of price discrimination in a differentiated-goods duopoly. However, differently from the aforementioned papers, Corts relaxes the assumption of symmetric demand in each market. This allows for the possibility of so-called best-response asymmetry, where one firm's strong market is the other firm's weak market, and vice versa, which has important implications both for the effects of price discrimination and for unilateral incentives to restrict such discrimination. Corts finds that, under best-response asymmetry, price discrimination might lead to lower prices for consumers in *both* markets. He also shows that best-response asymmetry facilitates unilateral commitments not to price discriminate, thus enlarging the scope for uniform pricing to emerge as an equilibrium outcome. In the present analysis we adopt the same symmetric-demand assumption as Holmes (1989) and Winter (1997). Nevertheless, we identify cases in which consumers in both markets are similarly affected by a change of pricing regime, where consumers' surplus in both markets is either higher or lower under uniform pricing than under price discrimination. This is not caused by best-response asymmetry, as in Corts (1998), but by the presence of sufficiently strong local quality competition.[8]

As already mentioned in Section 1, the paper closest to ours is arguably DW, who explicitly address the issue of national versus local pricing in retail markets. They analyze a model with a single upstream chain that serves a number of local markets. Each local market is either (i) a larger market where the chain-store faces competition from an independent local retailer, or (ii) a smaller market where the chain enjoys a monopoly position. In this model they show that the chain-store would sometimes prefer to use national prices. There are two countervailing effects. Whereas national pricing tends to soften competition in the larger duopoly markets, profits in the monopoly markets are reduced. This trade-off may favor national pricing if the monopoly markets are not too large (or not too many) compared with the competitive markets.

Our approach differs from DW in several respects. First, although DW have one chain and one independent retailer that can only be active in the larger markets, we have two chains that are active in all markets. Moreover, whereas DW assume competition only in the larger markets, we allow competition in all markets and we allow competition intensity to be independent of market size. Another difference is our demand model where we use a spatial model with fixed total demand. In fact, the characteristics of our model are such that national pricing emerges as an SPNE outcome only in the presence of our most important departure from DW and the other related papers in the oligopolistic price discrimination literature, namely, local quality competition. Thus, our key contribution to the literature is to show that multidimensional competition (i.e., competition on both price and quality) enlarges the scope for uniform pricing as an equilibrium phenomenon.[9]

While our paper offers an explanation for national pricing that is related to strategic competition incentives of the kind that is addressed in the oligopolistic price discrimination literature, as discussed above, other types of explanations might of course also be relevant. DellaVigna and Gentzkow (2019) suggest a series of alternative explanations for national pricing (none of them formalized). They argue that the two most plausible explanations, backed up by discussions and interviews with chain managers, consultants, and industry analysts, are (i) managerial inertia (various behavioral factors that prevent the firms from implementing optimal pricing policies), and (ii) brand image concerns (the idea being that different prices at different stores may lead to negative reactions from consumers, which ultimately may lead to reduced demand in the long run). These are not necessarily rival explanations, but could be seen as being complementary to the explanation offered in the present paper. The relative importance of different types of explanations is likely to vary across different industries and is ultimately an empirical question.

Finally, there is also a small empirical literature attempting to estimate the effects of national pricing on profits and welfare. Li et al. (2018) empirically analyze the profitability of national versus local chain-store pricing using data from the US digital camera industry. They conclude that the optimal pricing policy depends on the profile of the chains, with national pricing being more profitable for two of the three main chains in the industry analyzed. Adams and Williams (2019) quantify the welfare effects of national (zone) pricing with data from the US retail home-improvement industry. They conclude that national pricing softens competition in markets where firms compete, but it shields consumers from higher prices in rural markets. Overall, they conclude that national prices result in higher consumer surplus than local pricing.

3 | MODEL

Consider two national retail chains, indexed by $i = 1, 2$, that compete in two local markets, indexed by $j = A, B$. Each local market is a duopoly where the retail store of Chain 1 (2) is located at the left (right) endpoint of the unit line $Z^j = [0, 1]$. The store of Chain i in Market j offers a good with quality s_i^j at price p_i^j. Consumers are uniformly distributed along Z^j and each consumer demands one unit of the good from the most preferred retailer. The utility of a consumer located at $x \in Z^j$ is given by

$$U^j(x) = \begin{cases} v + bs_i^j - p_i^j - t^j x & \text{if} \quad i = 1, \\ v + bs_i^j - p_i^j - t^j(1-x) & \text{if} \quad i = 2, \end{cases} \tag{1}$$

where $b > 0$ is the marginal willingness to pay for quality and $t^j > 0$ is a transportation cost parameter that captures the degree of horizontal product differentiation, and therefore inversely captures the intensity of competition, in Market j. The utility parameter $v > 0$ is assumed to be sufficiently large such that both markets are always fully covered in equilibrium.

The two markets differ along two dimensions: competition intensity and market size. Differences along the former dimension are captured by $t^A \neq t^B$, whereas differences along the latter dimension are captured by assuming that the total mass of consumers in Market A (B) is given by m^A (m^B), where $m^A \neq m^B$. Thus, we allow for the possibility that the intensity of competition is stronger in either the larger or the smaller market. The market asymmetry created by the assumptions of $t^A \neq t^B$ and $m^A \neq m^B$ implies that the two chains compete in a "weak" market and a "strong" market, to use the terminology established in the literature (e.g., Holmes, 1989). However, since store locations are assumed to be symmetric in both markets, the demand functions in each market are also symmetric, implying that there is agreement between the chains about which market is weak and which is strong. Thus, in our main analysis we rule out the possibility of best-response asymmetry as defined by Corts (1998).[10]

Under the assumption that all consumers make utility-maximizing decisions, the demand facing Chain 1 in Market j is given by

$$q_1^j = m^j\left(\frac{1}{2} - \frac{p_1^j - p_2^j}{2t^j} + b\frac{s_1^j - s_2^j}{2t^j}\right). \tag{2}$$

The demand facing Chain 2 in Market j is then given by $q_2^j = m^j - q_1^j$. Note that t^j is a measure of "general" competition intensity between the stores in Market j where differences in both price and quality matter. On the other hand, for any given t^j, the parameter b scales up and down the importance of differences in quality relative to differences in price for consumers' choice. When we in the following discuss effects of more or less competition, this will refer to what we above dubbed as general competition intensity. In contrast, when we discuss stronger or weaker quality competition, this will refer to changes in the parameter b.

We will assume throughout that quality is observable but nonverifiable, given that important dimensions of quality often are hard to measure. This implies that it is not possible for a chain to commit to a national quality standard in our model.[11] This assumption deserves some comments before we move on. As mentioned in Section 1, some examples of what we refer to as "quality" are: the number of staff per customer (which affects queuing), the quality of the assistance you receive from the staff (the quality of information, advice, etc.), the frequency to which goods are checked and restocked (e.g., to ensure fresh produce), store cleanliness, and so forth. While these attributes can be observed and experienced, they are still difficult for both the customer and the store manager to measure and verify. Part of the problem may also be that the stores do not *fully* control certain aspects of the quality, such as queuing and number of staff per customer (which are affected by demand, which the store cannot fully control). Thus, it becomes difficult for the chains to commit to a specific level of quality across all their stores (at least for these specific aspects of quality).[12]

Thus, we assume that quality is decided at each store to maximize local payoff, which might include both monetary and nonmonetary (effort) costs of quality provision. These costs are assumed to be identical for all stores and given by the following cost function:

$$C\left(s_i^j\right) = cs_i^j q_i^j + \frac{k}{2}\left(s_i^j\right)^2, \tag{3}$$

where $k > 0$ and $c \in [0, b)$. Under these assumptions, higher quality provision implies a fixed (i.e., output-independent) cost and might also increase the marginal cost of supplying the good (if $c > 0$).[13] Furthermore, for a given supply of the good, it is increasingly costly to increase the level of quality. With the underlying assumption of constant marginal costs of supplying the good (for a given quality level), we set all other quality-independent costs equal to zero, without further loss of generality. The payoff of Store i in Market j is then given by

$$\pi_i^j = \left(p_i^j - cs_i^j\right)q_i^j - \frac{k}{2}\left(s_i^j\right)^2. \tag{4}$$

Whereas qualities are set to maximize local (store) payoff, prices are set to maximize chain profits, which are given by

$$\Pi_i = \sum_j \left(\pi_i^j + (1-\alpha)C\left(s_i^j\right)\right). \tag{5}$$

Here $\alpha \in [0, 1]$ represents the share of the local stores' total quality costs that are internalized by the chain (i) when it decides whether or not to set a uniform national price, and (ii) at the moment it decides its price level(s). The parameter α may, for example, represent contract frictions that can arise if the chain is using a franchise model and contracts are incomplete. Thus, $\alpha = 1$ represents situations in which there are no contract frictions between the chain and its local stores, such as, for example, when the local stores are fully owned by the chain. For simplicity, we will conduct our main analysis under the assumption of full cost internalization ($\alpha = 1$). In Appendix A.1 we show if and how our results are affected if this assumption is relaxed.

We assume that the players are engaged in a noncooperative game in which prices and qualities in each market are set simultaneously, where prices are set to maximize chain profits and qualities are set to maximize store payoffs. Although differences in local market conditions imply that, *all else equal*, the profits of Chain i are maximized by setting different prices in each market, we assume that each retail chain is able to commit to a *national pricing* strategy, for example, through national advertising campaigns, with a uniform price that applies to both markets, if this is unilaterally profitable.[14]

4 | LOCAL PRICING

Let us first consider the benchmark case of local pricing, where all decisions are market-specific (and thus store-specific). Before deriving the Nash equilibrium, it is highly instructive to spend some time detailing the nature of the strategic interaction between the players.

4.1 | Strategic price and quality interactions

Under local pricing, all the main insights on the nature of the two-dimensional strategic interaction between retail chains are obtained by focusing on one local market only. From the first-order conditions of the profit-maximization problems (and assuming $\alpha = 1$), we obtain the following best-response functions for Chain 1 in Market j:

$$p_1^j\left(p_2^j, s_1^j, s_2^j\right) = \frac{1}{2}\left(t^j + p_2^j + (b+c)s_1^j - bs_2^j\right), \tag{6}$$

$$s_1^j\left(p_1^j, p_2^j, s_2^j\right) = \frac{(b+c)p_1^j - cp_2^j + bcs_2^j - ct^j}{2(bcm^j + kt^j)}m^j. \tag{7}$$

Due to symmetry, the best-response functions for Chain 2 are obviously completely equivalent.

As expected, prices are strategic complements. A higher price by Chain 2 leads to a demand increase, and therefore less price-elastic demand, for Chain 1, which optimally responds by increasing the price. The qualities, however, are strategically independent as long as $c = 0$. When $c > 0$, on the other hand, the qualities also become strategic complements. This can be explained as follows: A quality increase by Chain 2 causes demand to fall for Chain 1. If $c > 0$, this demand reduction for Chain 1 causes the marginal cost of quality provision to go down as well, which implies that Chain 1's optimal response now is to increase the quality level (thus, causing qualities to become strategic complements).

While own price is a strategic complement to the rival's price, it is a strategic substitute to the rival's quality (i.e., $\partial p_1^j/\partial s_2^j < 0$). Increased quality provision by Chain 2 reduces the demand, and therefore reduces the price-elasticity of demand, for Chain 1. The optimal response by the latter chain is therefore to reduce the price. Conversely, own quality is a strategic substitute to the rival's price, but only if $c > 0$. A higher price by Chain 2 leads to increased demand for Chain 1. If $c > 0$, this demand increase leads to a higher marginal cost of quality provision, resulting in a lower optimal quality level by Chain 1.

Finally, notice that own price and own quality are what we dub *complementary strategies* (i.e., $\partial p_1^j/\partial s_1^j > 0$ and $\partial s_1^j/\partial p_1^j > 0$). All else equal, a higher price increases the price–cost margin, which makes it more profitable to increase quality to attract more customers. Conversely, an increase in quality leads to higher demand and therefore makes demand less price-elastic, implying that the profit-maximizing price also increases. The latter effect is reinforced if a quality increase also leads to higher marginal production costs for the chain (which requires $c > 0$).

All the above strategic interactions are derived holding *everything else constant*, including other decisions made by the same player. For example, the optimal price response is derived by keeping the quality decision of the same player constant, and vice versa. However, these best responses are potentially different when we take into account that each player optimizes along two different dimensions: price and quality. By internalizing the strategic relationship between price and quality for each player, we derive a new set of best-response functions that allow us to determine what we dub *net* strategic complementarity or substitutability.

These best-response functions, where each player's best response is solely a function of the rival player's decisions, are given by

$$p_1^j\left(p_2^j, s_2^j\right) = \frac{(2kt^j + c(b-c)m^j)\left(t^j + p_2^j - bs_2^j\right)}{4kt^j - m^j(b-c)^2}, \tag{8}$$

$$s_1^j\left(p_2^j, s_2^j\right) = \frac{m^j(b-c)\left(t^j + p_2^j - bs_2^j\right)}{4kt^j - m^j(b-c)^2}. \tag{9}$$

Whereas the strategic complementarity between prices remains, we see that this is not the case for qualities. Keeping the price of Chain 1 constant, a quality increase by Chain 2 is optimally met by a quality increase by Chain 1 (if $c > 0$). However, a quality increase by Chain 2 also gives Chain 1 an incentive to reduce the price, as explained above. Since price and quality are complementary strategies, Chain 1 will optimally respond to Chain 2's quality increase by reducing both price and quality. This is a dominating effect, making qualities *net strategic substitutes*. We also see from (9) that own quality is a net strategic complement to the rival's price. Strategic complementarity in prices, combined with the fact that own price and own quality are complementary strategies, imply that Chain 1 optimally responds to a price increase (by Chain 2) by increasing both price and quality.

The above-derived strategic interactions are useful to characterize what is a key mechanism determining many of the subsequently derived results in this paper. How does a unilateral price change affect the rival's optimal quality choice when we internalize all strategic interactions? The answer to this question is found by simultaneously solving $p_2^j(p_1^j, s_1^j, s_2^j)$, $s_1^j(p_1^j, p_2^j, s_2^j)$, and $s_2^j(p_1^j, p_2^j, s_1^j)$ to obtain s_2^j as a function of p_1^j only, given by

$$s_2^j\left(p_1^j\right) = \frac{\left((2kt^j - m^jb(b-c))p_1^j + (2kt^j + 3m^jbc)t^j\right)m^j(b-c)}{2kt^j(4kt^j - m^jb^2) + 2c(5b-c)m^jkt^j - cb(b-c)^2(m^j)^2}, \tag{10}$$

from which we derive

$$\frac{\partial s_2^j\left(p_1^j\right)}{\partial p_1^j} > (<)0 \text{ if } 2kt^j > (<)m^jb(b-c). \tag{11}$$

Notice that b measures the relative intensity of competition along the quality dimension, which allows us to reach the following conclusion:

Lemma 1. *In a given market, a unilateral price increase by one chain leads to a higher (lower) quality provision by the rival chain if the intensity of quality competition is sufficiently weak (strong) relative to the intensity of price competition.*

The sign of (11) is determined by two main effects that pull in opposite directions:

1. Keeping the quality of Chain 1 constant, a price increase by Chain 1 leads to a price increase by Chain 2 (because prices are strategic complements), which in turn leads to a quality increase by Chain 2 (because own price and own quality are complementary strategies). In other words, this is the effect of own quality being a net strategic substitute to the rival's price.
2. However, since price and quality are complementary strategies, a price increase by Chain 1 will be accompanied by a quality increase by the same chain. Since qualities are net strategic substitutes, this leads to a quality reduction by Chain 2.

The relative strength of these two effects depends on the intensity of quality competition, which crucially determines the magnitude of the second effect, which depends on the net strategic substitutability of qualities. The stronger the chains compete along the quality dimension, the larger is Chain 2's loss of demand when Chain 1 increases the quality. Consequently, the larger are the price and quality reductions by Chain 2. Thus, when b is sufficiently high, the second effect dominates, which means that each chain can induce a quality reduction at the other chain by increasing the price. Otherwise, if b is sufficiently low, a unilateral price increase will instead trigger a quality increase by the rival chain.

4.2 | Nash equilibrium

The symmetric Nash equilibrium is given by[15]

$$p_{LL}^{j} = t^{j} + \frac{c(b-c)m^{j}}{2k}, \tag{12}$$

$$s_{LL}^{j} = \frac{(b-c)m^{j}}{2k}. \tag{13}$$

A comparison of equilibrium prices and qualities across the two markets reveals that

$$p_{LL}^{A} > (<) p_{LL}^{B} \quad \text{if } t^{A} - t^{B} > (<) \frac{c(b-c)(m^{B}-m^{A})}{2k}, \tag{14}$$

and

$$s_{LL}^{A} > (<) s_{LL}^{B} \quad \text{if } m^{A} > (<) m^{B}. \tag{15}$$

The main features of the Nash equilibrium with local pricing by both chains can therefore be stated as follows:

Proposition 1. *Suppose that both retail chains set local prices. (i) If $c = 0$, the equilibrium price is higher in the market with less competition. If $c > 0$, the equilibrium price might be higher in the market with more competition if this market is sufficiently large relative to the market with less competition. (ii) Equilibrium quality is higher in the larger market.*

Proposition 1, whose proof follows from a straightforward inspection of (14) and (15), reveals that the relationship between competition intensity and equilibrium prices is not straightforward when the competition takes place along two different dimensions. In the absence of quality competition, equilibrium prices are uniquely determined by the intensity of competition (inversely measured by t^{j}). Thus, $p_{LL}^{A} > (<) p_{LL}^{B}$, implying that Market A is the strong (weak) market, if $t^A > (<) t^B$. This is a standard feature of spatial competition models with fixed total demand, where a unilateral price reduction has a pure business stealing effect. This result survives the introduction of quality competition as long as quality does not affect the chain's marginal production costs (i.e., $c = 0$). However, for $c > 0$, equilibrium prices also depend positively on market size. The reason is that incentives for quality provision are stronger in a larger market, all else equal. If $c > 0$, higher quality provision increases the marginal cost of supplying the good, which in turn increases the profit-maximizing price. If this effect is sufficiently strong, equilibrium prices are higher in the market with a lower degree of competition, if this market is sufficiently larger than the other market.

Whereas the optimal price always depends (at least in part) on the degree of competition, this is not the case for the optimal quality. There are two counteracting effects of competition intensity on quality choices. On the one hand, stronger competition makes demand more quality-elastic, which gives each store an incentive to increase quality. On the other hand, stronger competition also makes demand more price-elastic. This gives each chain an incentive to reduce the price, which in turn reduces the marginal gain of quality provision (recall that price and quality are complementary strategies). In a Hotelling model with linear demand, these two effects exactly cancel each other, implying that equilibrium quality provision is unaffected by the degree of competition.[16] Thus, in equilibrium, quality provision is solely determined by market size, and equilibrium quality is always higher in the larger market.

5 | NATIONAL PRICING

In this section we analyze if and how the previously derived results (under local pricing) change if either one or both chains adopt a national pricing strategy.

5.1 | National pricing by one chain

Suppose that Chain 1 sets a national price, denoted p_1, whereas Chain 2 practices local pricing and sets p_2^A and p_2^B. As before, qualities are set to maximize (local) store payoff. In this case, the best-response function for the pricing decision of Chain 1 is given by

$$p_1 = \frac{\sum_j m^j t^{-j}\left(p_2^j + t^j + b\left(s_1^j - s_2^j\right) + cs_1^j\right)}{2(m^A t^B + m^B t^A)}, \tag{16}$$

where $-j$ refers to the other market than Market j.

Naturally, the optimal national price set by Chain 1 depends on all decisions (prices and qualities) made by both players in both markets. Nevertheless, the strategic relationships are qualitatively similar to the ones analyzed in great detail in Section 4 under local pricing by both chains, in the sense that the optimal national price depends positively on the rival's prices and on its own qualities, but it depends negatively on the rival's qualities. All other best-response functions are identical to the ones under local pricing, and it can also be shown that the previously derived results on net strategic substitutability or complementarity carry over to the case of asymmetric pricing strategies.

The asymmetric Nash equilibrium, where one chain practices national pricing whereas the other chain practices local pricing, is given by a set of prices and qualities whose explicit expressions are highly involved and thus not presentable.[17] We can nevertheless gain some insights into the main mechanisms at play by considering the special case of $c = 0$. We also impose the parameter restriction $b^2 < \max\{3kt^A/m^A, 3kt^B/m^B\}$, which is a sufficient condition for equilibrium existence. In this case, the Nash equilibrium is given by[18]

$$p_{NL} = \begin{bmatrix} (m^A m^B b^4 + 12k^2 t^A t^B)\sum_j m^j \\ -b^2 k\left(3m^A m^B \sum_j t^j + 4\sum_j ((m^j)^2 t^{-j})\right) \end{bmatrix} \frac{t^A t^B}{\Theta}, \tag{17}$$

$$p_{LN}^j = \begin{bmatrix} 4m^j k (t^{-j})^2 (3kt^j - m^j b^2) + b^4 m^{-j} m^j t^{-j} \sum_j m^j \\ + m^{-j} k (6kt^j t^{-j} - b^2 (2m^{-j} t^j + 3m^j t^{-j})) \sum_j t^j \end{bmatrix} \frac{t^j}{\Theta}, \tag{18}$$

$$s^j_{NL} = \frac{m^j b}{2kt^j} p_{NL}, \tag{19}$$

$$s^j_{LN} = \frac{m^j b}{2kt^j} p^j_{LN}, \tag{20}$$

where

$$\Theta := \sum_j (m^j t^{-j} (3kt^j - m^j b^2)(4kt^{-j} - m^{-j} b^2)) > 0. \tag{21}$$

To see how prices and qualities in each market are affected by the adoption of a national pricing strategy by Chain 1, we define $\underline{\theta} := \min\{t^A/m^A, t^B/m^B\}$ and $\bar{\theta} := \max\{t^A/m^A, t^B/m^B\}$. This allows us to define three different regimes, depending on the intensity of quality competition. In all three regimes, national price setting leads to higher (lower) price and quality by Chain 1 in the market with more (less) competition, but the strategic response from Chain 2 differs across the three regimes[19]:

Regime 1. If $b^2 < 2k\underline{\theta}$, Chain 2 responds by increasing (reducing) price and quality in the market with more (less) competition.
Regime 2. If $2k\underline{\theta} < b^2 < 2k\bar{\theta}$, Chain 2 responds by either reducing or increasing price and quality in both markets.
Regime 3. If $b^2 > 2k\bar{\theta}$, Chain 2 responds by increasing (reducing) both price and quality in the market with less (more) competition.

By committing to a national price setting, Chain 1 can affect competition along two dimensions: price and quality. In the absence of quality competition, the strategic gain of national price setting is that the optimal national price is higher than the optimal price in the most competitive market under local price setting, which dampens competition in this market because of strategic complementarity. However, this strategic gain comes at a cost, which is the loss in profits due to the national price being suboptimally low in the market with less competition.

When the chains also compete along a second dimension, namely, quality, the strategic gains and costs of national price setting are affected in nontrivial ways. A key factor is the direction of the rival's equilibrium quality response to the price changes introduced by the national price setting. This strategic response is characterized by Lemma 1. If the intensity of quality competition (as measured by b) is sufficiently low, the rival chain responds to a price increase (reduction) by providing higher (lower) quality. In Regime 1, this is the nature of the strategic response in both markets. National price setting consequently implies that quality competition is reinforced (dampened) in the market with more (less) competition. Thus, the strategic gain of national price setting that is related to quality competition occurs in the market with *less* competition, whereas the cost occurs in the other market. In other words, quality competition reduces both the gain and the cost of national price setting, compared with the case where the chains are only engaged in price competition.

However, sufficiently high intensity of quality competition changes the direction of this strategic response. In Regime 2, the sign of $\partial s_2(p_1)/\partial p_1$ is different in the two markets, which implies that the direction of Chain 2's strategic response is reversed in one of the markets, compared with Regime 1. Consequently, Chain 2 will respond to national pricing by either reducing or increasing price and quality in both markets. A sufficient condition for a price and quality reduction by Chain 2 in both markets is that the competition intensity is higher in the larger market. Finally, in Regime 3, $\partial s_2(p_1)/\partial p_1 < 0$ in both markets, which implies that the strategic response of Chain 2 is completely reversed, compared with Regime 1.

The above analysis shows that, depending on the regime, the price and quality responses by Chain 2 either dampen or reinforce the effects of national price setting (by only Chain 1) on the price difference and quality difference between the two chains in each market. In Regime 1, the price and quality differences are dampened by the strategic response of Chain 2, whereas these differences are reinforced in Regime 3. However, in the asymmetric Nash equilibrium, regardless of the direction of the strategic responses, the price and the quality of Chain 1 are higher (lower) than the price and quality of Chain 2 in the market with more (less) competition.

5.2 | National pricing by both chains

Suppose now that both chains adopt a national price setting strategy, implying that Chain 1 chooses $\left(p_1, s_1^A, s_1^B\right)$ and Chain 2 chooses $\left(p_2, s_2^A, s_2^B\right)$. The symmetric Nash equilibrium is given by[20]

$$p_{NN} = \frac{\left[\begin{array}{l} 4k^2 t^A t^B \sum_j m^j + 2bckm^A m^B \sum_j t^j \\ +c(b-c)\left(2k\sum_j t^j (m^{-j})^2 + cbm^A m^B \sum_j m^j\right) \end{array}\right] t^A t^B}{4kt^A t^B\left(k\sum_j (t^j m^{-j}) + bcm^A m^B\right)}, \tag{22}$$

$$s_{NN}^j = \frac{(bp_{NN} - ct^j)m^j}{2kt^j + bcm^j}. \tag{23}$$

Comparing the equilibrium prices and qualities under local and national pricing, that is, comparing (12) and (13) with (22) and (23), we can express the price and quality differences as follows:

$$p_{NN} - p_{LL}^j = \frac{2kt^j t^{-j} m^{-j}(2kt^j + m^j bc)\left(p_{LL}^{-j} - p_{LL}^j\right)}{4kt^A t^B\left(k\sum_j (t^j m^{-j}) + bcm^A m^B\right)}, \tag{24}$$

$$s_{NN}^j - s_{LL}^j = \frac{m^j b\left(p_{NN} - p_{LL}^j\right)}{2kt^j + m^j bc}. \tag{25}$$

From these expressions, the following conclusions are immediate:

Proposition 2. *If both chains switch from local to national price setting, this leads to a price reduction (increase) in the market with the highest (lowest) price. In each market, quality and price changes go in the same direction.*

6 | NATIONAL VERSUS LOCAL PRICING

In this section we endogenize each chain's pricing strategy by considering an extended game that is played in two stages. In the first stage, each chain decides whether to commit to a national pricing strategy or to set local prices. In the second stage, prices and qualities are decided as in the previous sections. Using backwards induction, there are three possible pure-strategy SPNE:

1. Local pricing by both chains, which is an SPNE if $\Pi_{LL} \geq \Pi_{NL}$.
2. National pricing by both chains, which is an SPNE if $\Pi_{NN} \geq \Pi_{LN}$.
3. Local pricing by one chain and national pricing by the other chain, which is an SPNE if $\Pi_{NL} \geq \Pi_{LL}$ and $\Pi_{LN} \geq \Pi_{NN}$.

6.1 | Pure price competition

As a benchmark for comparison, consider first the special case in which there is no quality competition and the two chains compete purely in prices. This case is captured by $b = 0$, which also implies $c = 0$. Setting $b = c = 0$ and comparing equilibrium profits across the different pricing regimes, it is easily verified that

$$\Pi_{LL} - \Pi_{NL} = \frac{m^A m^B (t^A - t^B)^2}{2\sum_j m^j t^{-j}} > 0 \tag{26}$$

and

$$\Pi_{LN} - \Pi_{NN} = \frac{m^A m^B (t^A - t^B)^2}{8\sum_j m^j t^{-j}} > 0. \tag{27}$$

Thus:

Proposition 3. *In the absence of quality competition, local pricing by both chains is the unique SPNE.*

In other words, the results of Dobson and Waterson (2005) do not carry over to our spatial framework with fixed total demand. Regardless of the differences in size and competition intensity across the two markets, the profit gain obtained by relaxing competition in the more competitive market (through national price setting) is always outweighed by the profit loss suffered by a suboptimally low price in the less competitive market.[21]

6.2 | Price and quality competition

Consider now the more general case in which the two chains compete along two different dimensions: price and quality. Due to analytical intractability, we resort to numerical simulations, illustrated by graphical plots, to identify the SPNE. We will distinguish between two different scenarios, where the degree of local quality competition is relatively "weak" and "strong," respectively, and where the notions of "weak" and "strong" quality competition correspond to the different regimes identified in Section 5.1. In each of these scenarios, we will also consider different assumptions regarding the cost of quality provision, reflected by the magnitude of the parameter c. A supplementary set of graphical plots, using other numerical values of key parameters, is presented in Appendix A.3.

6.2.1 | "Weak" quality competition

We consider first a set of parameter configurations that correspond to Regime 1 in Section 5.1, in which the degree of local quality competition is sufficiently weak relative to the degree of price competition. This regime is characterized by a positive relationship, within a given market, between the price of one chain and the quality offered by the competing chain (cf. Lemma 1). In Figure 1a–d, we show the equilibrium configurations in (t^A, m^A)-space for $b = 1.5$ and $k = 0.85$, and for different values of the cost parameter c (successively increasing in each figure). In each figure we set $t^B = 4 - t^A$ and $m^B = 2 - m^A$, implying that we measure *relative* competition intensity and market size along the horizontal and vertical axes, respectively. By design, each figure is thus symmetric around the point $(t^A, m^A) = (2, 1)$. In the North-East and South-West quadrants (defined according to the symmetry point), competition is less intense in the larger market. In the remaining space (the North-West and South-East quadrants), competition is more intense in the larger market. In each figure, the red (orange) areas depict the parameter space in which the unique SPNE has national pricing by both chains (one chain). In the remaining (white) areas, the unique SPNE has local pricing by both chains.

Consider first Figure 1a, in which the level of quality provision does not affect marginal production costs ($c = 0$). Here we see that, in contrast to the case of no quality competition, national pricing by one or both chains appears as an equilibrium outcome, and the scope for national pricing in equilibrium is larger if the difference in market size is relatively high while the difference in competition intensity is relatively low. Notice, however, that an SPNE with national pricing occurs within the chosen parameter range only *if competition is more intense in the smaller market*.

We can explain this result by considering the incentives for a unilateral switch from local to national pricing, as in Section 5.1. Recall that such a switch implies a price and quality increase (reduction) in the market with more (less) intense competition. Recall also that the competing chain strategically responds in the same manner (in Regime 1). Thus, a unilateral switch to national pricing relaxes price competition but intensifies quality competition in one market, and intensifies price competition but relaxes quality competition in the other market. Put differently, the presence of quality competition reduces both the gains and costs of national price setting.

From Proposition 3 we know that national pricing is not unilaterally profitable in the absence of quality competition. Thus, for national pricing to be unilaterally profitable in the presence of quality competition, the gains

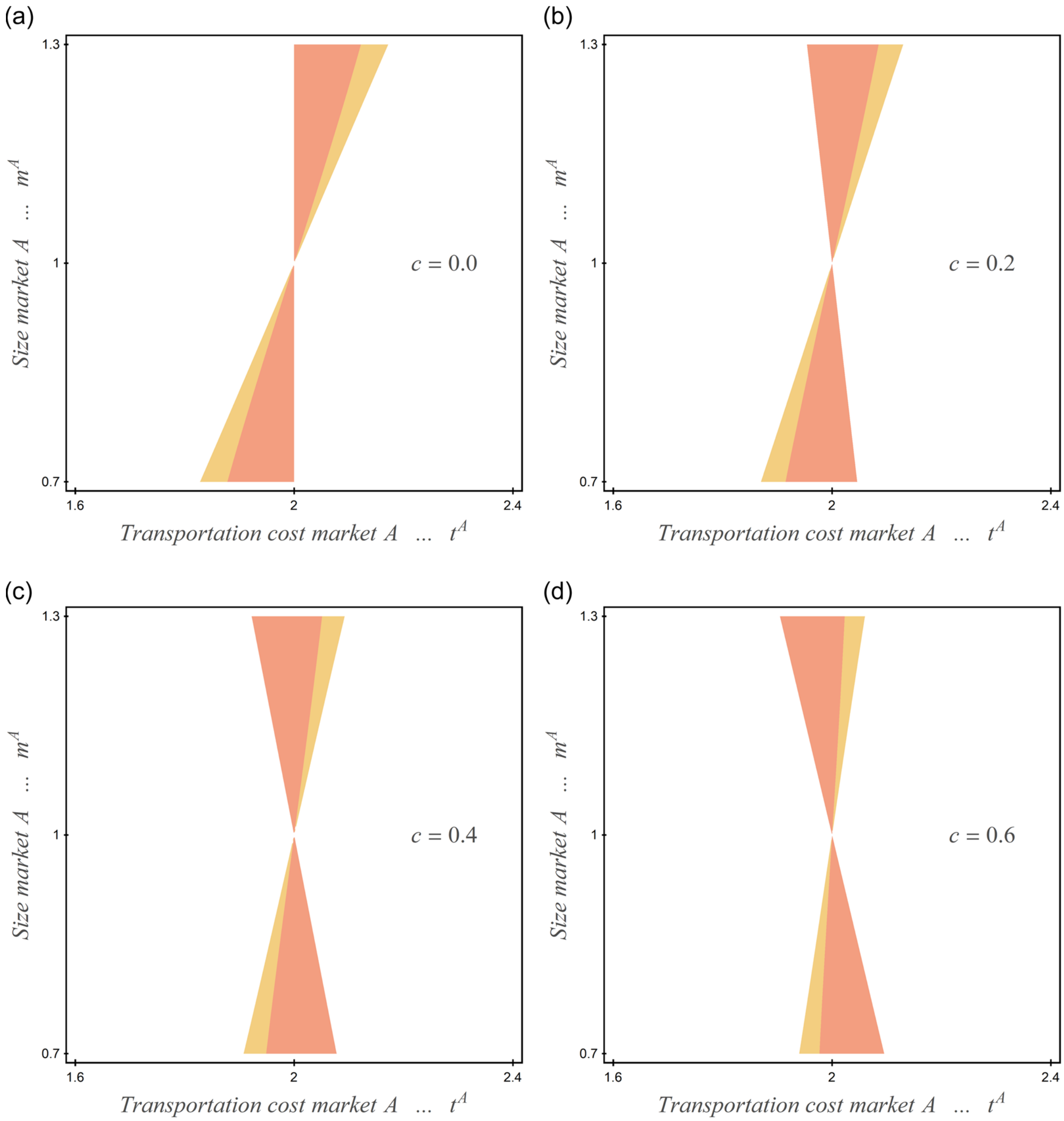

FIGURE 1 Equilibrium pricing strategies under "weak" quality competition and full cost internalization. The red (orange) area has national pricing by both chains (one chain). [Color figure can be viewed at wileyonlinelibrary.com]

from relaxed quality competition in one market must be sufficiently higher than the losses from intensified quality competition in the other market. This depends in turn on whether these gains occur in the larger or smaller market. Because of quality cost convexity, the profit gain from a marginal relaxation of quality competition is larger the higher the equilibrium quality level is to begin with. And vice versa, the profit loss from a marginal intensification of quality competition is lower the smaller the equilibrium quality level is to begin with. From Proposition 1 we know that, for $c = 0$, equilibrium quality is higher in the larger market under local pricing by both chains. This implies that a unilateral switch to national price setting can be profitable only if this leads to quality competition being relaxed in the larger market. But this requires that national price setting leads to lower prices in the larger market, which in turn requires that competition is less intense in this market.[22] Thus, in the absence of output-dependent costs of quality provision, national pricing (by one or both chains) is an SPNE only for parameter configurations where competition is less intense in the larger market.

This result changes if higher quality provision implies higher marginal production costs (i.e., if $c > 0$). In each of Figure 1b–d, there exists a parameter set with national pricing as equilibrium strategies in cases where competition is more intense in the larger market, and this set is larger when c is higher. The intuition is related to the ranking of equilibrium prices under local price setting, which is analytically given by (14) and summarized in Proposition 1. If c is strictly positive, and if market sizes are different, the equilibrium price (under local pricing) is higher in the market with more competition if this market is larger and if the difference in competition intensity between the markets is sufficiently low. Or equivalently, for a given difference in competition intensity, the equilibrium price is higher in the market with more competition if this market is sufficiently larger than the other market. In these cases, national price setting implies that price and quality go down in the larger market, which in turn paves the way for national pricing as an equilibrium outcome in cases where competition is more intense in the larger market.[23] The equilibrium configurations displayed in Figure 1b–d also reveal that, if national pricing is an equilibrium strategy in cases where competition is more intense in the larger market, it is an equilibrium strategy for both chains.

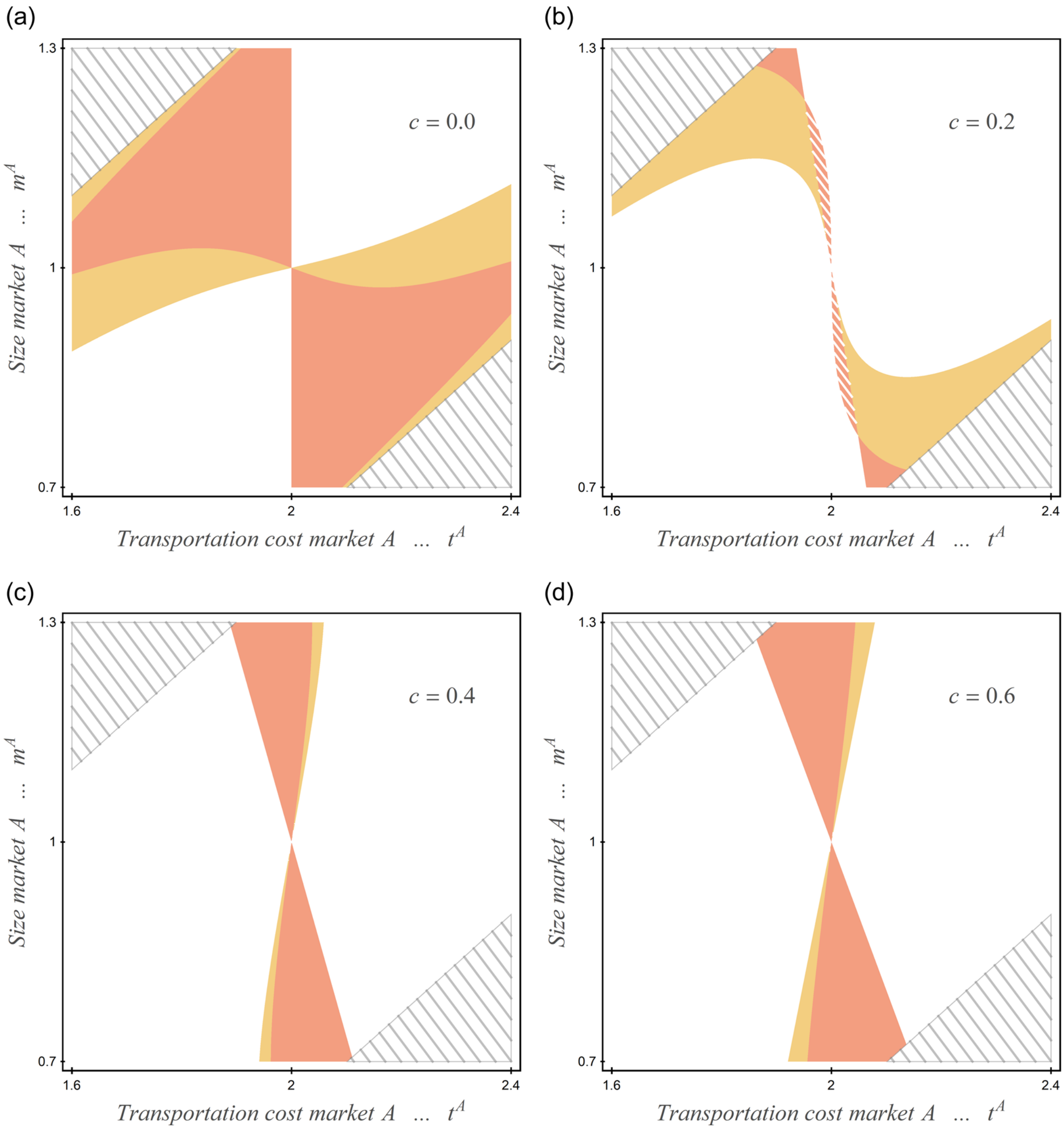

FIGURE 2 Equilibrium pricing strategies under "strong" quality competition and full cost internalization. The red (orange) area has national pricing by both chains (one chain). White stripes indicate that there are two equilibria, the second one with local pricing by both chains. (Gray stripes indicate that the stability conditions are violated). [Color figure can be viewed at wileyonlinelibrary.com]

6.2.2 | "Strong" quality competition

Now consider cases in which competition is relatively stronger along the quality dimension. In Figure 2a–d we display the equilibrium configurations for a higher value of b, namely, $b = 2$, while maintaining all other parameter values at the same levels as in Figure 1a–d. In addition to the previously defined color codes, black-striped areas depict parameter configurations for which no SPNE exists.

Consider first Figure 2a, which shows the equilibrium configurations for $c = 0$. Compared with Figure 1a, there are two notable differences. First, within the chosen parameter range, national pricing is an equilibrium strategy (by one or both chains) for a larger set of parameter values. Second, and perhaps more importantly, this set covers predominantly cases in which competition is more intense in the larger market. These differences are related to the nature of the strategic responses to national price setting, as analyzed in Section 5.1. The parameter configurations considered in Figure 2a correspond to Regimes 2 and 3 (as defined in Section 5.1), where a price increase (reduction) by one chain is met by a quality reduction (increase) by the competing chain in one (Regime 2) or both (Regime 3) markets.

Consider, for simplicity, the case of Regime 3. A unilateral switch from local to national pricing by one chain implies that the price and quality go up (down) in the market with more (less) intense competition (as long as $c = 0$). For parameter configurations corresponding to Regime 3, the competing chain will respond by reducing (increasing) price and quality in the market with more (less) competition. Since, by assumption, competition is strong along the quality dimension relative to the price dimension, the quality changes have a stronger effect than the price changes on demand reallocations between the two chains. The above-described quality responses imply that the chain that switches to a national price setting will experience a demand gain (loss) in the market with more (less) intense competition, and the gain will more than offset the loss if the market with more intense competition is sufficiently larger than the other market. This effect explains that national price setting can arise as an equilibrium outcome in cases where competition is more intense in the larger market, even if the costs of quality provision do not affect marginal production costs.

However, as we successively increase the value of c in Figure 2b–d, the parameter configuration eventually switches back to Regime 1. This can be seen from (11), which shows that a higher value of c increases the scope for a positive strategic relationship between own price and rival's quality, which is the characteristic feature of Regime 1 as defined in Section 5.1. Thus, the equilibrium configurations in Figure 2c,d are very similar to the ones displayed in Figure 1c,d. Although the value of b is higher in the former set of figures, the qualitative nature of the strategic relationship between the two chains is similar in both sets.

Summing up, the above numerical analysis has identified parameter sets for which national pricing by one or both chains is a Nash equilibrium outcome. A supplementary set of graphical plots in Appendix A.3 confirms that this observation is not restricted to the particular set of parameter values used in this section. On the other hand, we have already shown analytically (by Proposition 3) that national pricing is never a Nash equilibrium in the absence of quality competition. Due to continuity, this must also hold for values of b sufficiently close to zero. The above analysis, based on numerical simulations for $b > c \geq 0$, therefore allows us to reach the following conclusion:

Proposition 4. *If the degree of local quality competition is sufficiently strong, there exist parameter sets in which the SPNE implies national pricing by either one or both chains.*

When seen in conjunction, Propositions 3 and 4 suggest that the presence of local quality competition enlarges the scope for national pricing to be an equilibrium strategy. This is a key result emanating from our analysis.

7 | ROBUSTNESS CHECKS

We have considered different robustness checks for our analysis. In this section we summarize in turn what happens (i) if national quality standards are feasible, (ii) if the quality costs are externalized by the chain, and (iii) if the firms face asymmetric demands (in the sense that the chains disagree about which are the "strong" and "weak" markets, respectively). For brevity, most of the technical details have been relegated to Appendix A.

A potential concern with our analysis is that the chain is unable to commit to a national quality standard. Although we argue that this is a reasonable assumption due to nonverifiability of quality (or at least the nonverifiability of important *aspects* of quality), it might nevertheless be interesting to know whether equilibrium outcomes in which both chains set *local* qualities but one or both chains set a *national* price (indicated by the red and orange areas in Figures 1 and 2), survive if we allow either firm to commit to a national quality standard.

The answer to this question is largely "yes." The equilibrium outcomes depicted in Figure 1, with local qualities and either one or two national prices, all survive when a uniform quality standard is feasible. This suggests that our results are robust to the assumption of national quality standards, at least for some parameter values. When we analyze the cases in Figure 2, on the other hand, in which the degree of quality competition is stronger ($b = 2$), we find that the outcomes with local qualities and either one or two national prices will survive in part of the parameter space, but not everywhere. In Figure 3a we have replicated the case presented in Figure 2a ($b = 2$, $c = 0$). Next to it, in Figure 3b, we depict (in gray) the areas in which the outcomes with local qualities (and either one or two national prices) do not survive. In other words, in the gray areas it is profitable for at least one of the chains to deviate to a strategy that in some way involves a national quality standard. Nevertheless, we can see that, at least for this particular example, there are still large areas in the (t^A, m^A)-space in which the equilibrium outcome has local qualities with either one or two national prices.

Our main analysis was also conducted under the assumption that each store's quality cost was fully internalized by the chain (i.e., we assumed $\alpha = 1$). The numerical analysis in Appendix A.1 demonstrates that national pricing as an equilibrium outcome is not restricted to the case in which all quality costs are internalized. The qualitative result that (local) quality competition increases the scope for national pricing, still holds when $\alpha = 0$. Moreover, it seems that the scope for national pricing might even expand when the quality costs are not internalized by the chain, as seen in Figure A1 in Appendix A.

Finally, it is an assumption of our model that the firms face symmetric demand in each market, which implies that the ranking of strong and weak markets is the same for both chains. While this assumption helps facilitating the analysis, it is not critical for our main results. In Appendix A.4 we provide an example which demonstrates how we may obtain similar results also when demand is asymmetric and one chain's strong market is the other chain's weak market (as in Corts, 1998). Thus, to facilitate national pricing as an equilibrium outcome, it is not a necessary feature that the firms hold equal rankings of the two markets.

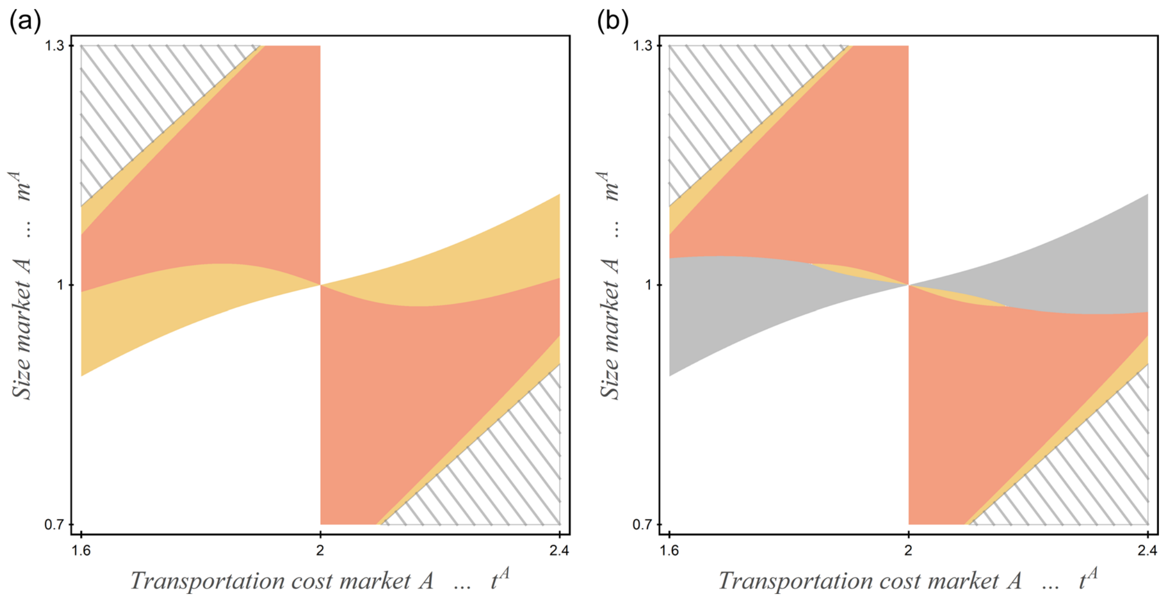

FIGURE 3 Gray region shows the area in which equilibria with national prices and local qualities do not survive (when a national quality standard is feasible). [Color figure can be viewed at wileyonlinelibrary.com]

8 | NATIONAL PRICING AND CONSUMER WELFARE

How are consumers in the two markets affected by the retail chains' choice of pricing strategy? In this section we briefly discuss the implications of national pricing for consumer welfare, with the supplementary technical analysis given in Appendix A.5.

Consider a switch from local pricing to national pricing by both chains, which yields lower prices in one of the markets and higher prices in the other. In the absence of local quality competition, there will always be both winners and losers among the consumers from such a switch of pricing strategy, with consumers benefiting (losing) in the market where the price goes down (up).

However, this is not necessarily the case in the presence of local quality competition, since the benefits (costs) of a lower (higher) price are counteracted by lower (higher) quality, as indicated by Proposition 2. In particular, national pricing might uniformly benefit or harm consumers in case of sufficiently large *market size asymmetries*. As we show in Appendix A.5, this occurs for parameter configurations such that a unilateral price increase in both markets by one of the chains spurs the rival chain to increase quality in one market but reduce quality in the other market, that is, what we have dubbed Regime 2 in Section 5.1. For example, suppose that $m^A < m^B$ and $t^A > t^B$, and that the parameters are such that $\partial s_i^A\left(p_{-i}^A\right)/\partial p_{-i}^A > 0$ and $\partial s_i^B\left(p_{-i}^B\right)/\partial p_{-i}^B < 0$. In this case, a switch to national pricing implies that price and quality go down in Market A but increase in Market B. However, in Market A the price reduction is sufficiently large to increase consumers' surplus, despite the corresponding drop in quality, while in Market B the quality increase more than outweighs the increase in price, leading to a larger surplus for consumers also in this market. Thus, in this example national pricing benefits consumers in both markets.

In Figures A4 and A5 in Appendix A.5, we replicate Figures 1a and 2a and identify the parameter subsets for which national pricing by both chains is a Nash equilibrium *and* either harms or benefits consumers in both markets, compared with local pricing. If the degree of local quality competition is sufficiently strong, consumers' surplus goes up in both markets under national pricing for a wide range of parameter values.

Notice however that, in this type of spatial competition model, the socially efficient outcome is always produced under local pricing, which implies that any increase in total consumers' surplus resulting from a deviation from local pricing is more than offset by a reduction in chain profits.[24] Thus, whenever national pricing benefits consumers in both markets, the chains would benefit from a joint commitment to abstain from such a pricing strategy. In other words, the pricing strategy game is a Prisoner's Dilemma for the firms.

9 | DISCUSSION

According to our model, national pricing is a significantly more profitable strategy for the firms in industries where nonprice competition (service, quality, …) is an important factor. The intuition for this is the following. Without any quality competition, when a chain switches to national pricing, the rival will respond by increasing their price in the market where the local price is low—the "weak" market, according to the terminology used by Holmes (1989)—and reduce their price in the market where the local price is high, that is, the "strong" market. In our model, relaxing price competition in one market is never enough (on its own) to make national pricing a profitable strategy overall. Here we should note that, even though DW find that national pricing can be profitable for the firms also without quality competition, even in their case the profitability of national pricing is quite small, as demonstrated in their 2008 follow-up paper. Our analysis, on the other hand, demonstrates that the profitability of national pricing may substantially increase when the firms engage in nonprice competition. In some of our numerical examples we find that the profit difference between national and local pricing can be as high as 10%–40%. The reason is that, with quality competition, a national price may induce the rival to respond by reducing the quality level in one of the markets. And together with the easing of price competition in one market, this may be enough to turn national pricing into a profitable strategy overall.

It follows from our model that firms should consider national pricing if nonprice competition is an important part of their overall strategy. The model thus predicts that we should observe a higher incidence of national pricing in the type of retail industries where, for example, personal service and the customer's "shopping experience" is as important as the price, or perhaps more important.[25,26] On the other hand, all else being equal, we expect to observe a smaller incidence of national pricing in markets where the shopping experience is less important to the customer, and where the service element is perhaps completely absent. One example of the latter is the market for retail gasoline. Prices for retail gasoline are almost exclusively set at the station level and thus vary a lot between different local markets.[27] Moreover, although many retail gasoline stations are manned and also have convenience stores that offer goods other than gasoline, the fuel pumps themselves are often unmanned and equipped with payment terminals (self-service). Hence, many gasoline customers will fill their tanks and pay for the gasoline without entering the convenience store.[28] We also see extensive use of self-service stations that are completely unmanned and thus without convenience stores. We may therefore argue that the service element and the customer's shopping experience are not as prominent in the retail gasoline industry (at least today) compared with in many other markets.

An example from the opposite end of the spectrum is the market for (nonprescription) pharmaceutical and medical products. In this market there is generally a much greater need for presale information and service, and the quality of the information is important for the customer. Moreover, because of the importance of presale service, queuing becomes a problem if the stores are not sufficiently staffed. In contrast to the gasoline example, pharmacies tend to use national pricing, as documented by DellaVigna and Gentzkow (2019). A recent merger case in the UK further indicates that national pricing in the pharmacy industry is not only a US phenomenon: When the pharmacy chain Celesio acquired the pharmacy business of Sainsbury's Supermarkets in 2016, the parties noted to the Competition and Markets Authority (CMA, 2016) that they both set their prices for over-the-counter drugs and products centrally, without any local or regional variation (and the CMA agreed with that observation).

One may object to these examples because of the different number of goods involved in the firms' pricing decisions. A pharmacy business has to manage the prices of hundreds or even thousands of goods, whereas a gasoline station only has to manage the prices of two or three types of fuel. Restaurants, however, are another example of businesses that sell relatively few goods (at least compared with many other retail businesses). And compared with retail gasoline, the service and quality element is obviously much more prominent in the restaurant business. Moreover, different from the gasoline example, and in agreement with our model, we sometimes observe uniform prices across different restaurant locales belonging to the same chain.

It is impossible to draw any conclusions based on these anecdotal examples, but at least the observations mentioned above seem to agree with the prediction from our model that industries in which nonprice competition plays a smaller role, should observe less national or regional pricing compared with markets in which nonprice competition is more important.

10 | CONCLUDING REMARKS

National pricing strategies are prevalent in many retail markets. At the same time it seems clear that competition in most markets is multidimensional; firms not only compete on the basis of prices, but on a wide range of other attributes ranging from opening hours to customer friendliness and a lot of other things. In this paper we have dubbed these attributes as quality. The basic question we ask is why firms may find it profitable to use a uniform national pricing strategy over a wide range of different market conditions in local markets.

The most prominent theory of the received literature is that national pricing may lead to a dampening-of-competition effect in markets with intense competition that may outweigh the loss from lower prices in more concentrated local markets. We show that this main result obtained from the previous literature is not particularly robust to different specifications of demand and local market structure. In our model, absent competition along the quality dimension, national pricing will never arise as an equilibrium outcome. This suggests that multidimensional competition can be an important factor in explaining why firms choose national pricing in some instances. We show that national pricing may be an equilibrium strategy for at least one of the chains provided that the local quality competition is sufficiently strong.

With multidimensional competition, welfare implications are more complicated and harder to assess. We show that national pricing might benefit consumers even in markets where such a pricing strategy leads to higher prices. This raises challenges for competition policy. Another important challenge to competition policy is how to assess mergers in markets where either one or all firms adopt national pricing. Modern merger policies tend to look at pricing pressure measures to evaluate the effects of mergers and sometimes mergers are remedied by requiring divestitures in local markets where the merging parties overlap. This policy seems to presume that competition is one-dimensional in price only, and that pricing is local. Needless to say, national pricing and multidimensional competition make the task of finding optimal merger remedies considerably more complicated. This and other interesting aspects of national pricing are left for future research.

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ENDNOTES

1 Sometimes the term "regional pricing" is used, when multiple stores that belong to the same geographical (subnational) area are grouped together and assigned the same price. Regional pricing is still different from local pricing, in which each store may charge its own price.

2 For more evidence of national pricing, see also Hitsch et al. (2017).

3 They estimate that, by adapting a local pricing policy, the median chain would increase its profit by 1.6%, when calculated as a fraction of *total revenue*. This number is likely to turn into a much larger number if we instead evaluate the change in profit as a fraction of the chain's *total profits*. This is, however, not possible without making assumptions about the size of fixed costs.

4 This result has some parallels to Thisse and Vives (1988) who find that price discrimination is the unique equilibrium in a setting of spatially continuous demand, where two competing firms choose between uniform and location-specific prices.

5 In some of our numerical examples with "strong" quality competition, the profit gain from national pricing will in many cases exceed 5% (while holding fixed the rival's choice of pricing strategy, local or national), and can also become much larger than that, exceeding 20%, when only one chain adopts national pricing.

6 According to the standard terminology in the third-degree price discrimination literature, as first introduced by Robinson (1933), the profit-maximizing price is higher (lower) in the stronger (weaker) market.

7 Armstrong and Vickers (2001) apply a similar model and show that oligopolistic firms benefit from price discrimination if the degree of competition is sufficiently strong.

8 Our result that consumers in all markets might benefit from uniform pricing is in stark contrast to the result derived by Adachi and Matsushima (2014), who study the welfare effects of third-degree price discrimination in oligopolistic markets with horizontal product differentiation and symmetric demand in each market. They find that uniform pricing leads to consumer losses in weak markets that are always higher than the corresponding consumer gains in strong markets, causing an overall reduction in consumers' surplus.

9 In the literature on third-degree price discrimination there are some papers that incorporate a quality dimension, but typically either in a monopoly framework (e.g., Ikeda & Toshimitsu, 2010) or with exogenous quality differences between firms (e.g., Galera et al., 2017). None of these papers analyze how the presence of local quality competition affects the incentives for national versus local pricing in retail markets.

10 In a robustness check (Section 7) we show that our main results do not critically hinge on the assumption of symmetric demand.

11 Allowing the chains the choice to introduce national quality standards would make the analysis much more involved. The full game would then include 16 subgames (instead of 4), and 10 unique types of subgames (instead of 3) that we would have to analyze. This is beyond the scope of this paper. However, a robustness check, which we present in Section 7, suggests that our equilibria with national pricing and local qualities in many cases will suvive even if we allow the chains to deviate to pricing policies that may include commitment to a uniform quality.

12 Of course, some dimensions of nonprice competition can more easily be subjected to a national standard, such as the types and range of products sold at the store, the stores' opening hours, and so forth.

13 The assumption $c < b$ is needed to ensure equilibrium existence with an interior solution.

14 Keep in mind that a uniform price (or quality) is generally not a "local best response" in either of the two markets. A Nash equilibrium with national pricing therefore requires some kind of commitment. A national advertising campaign can be a credible commitment device as long as the advertised information is verifiable, which is certainly the case for prices, but arguably not for quality. In Section 7 we explore if and how our main results would change if the chains were also able to commit to a national quality standard.

[15] We use subscript LL to denote equilibrium values of the variables in the case where both chains adopt a local pricing strategy.

[16] This is a well-known result from the spatial competition literature (e.g., Gravelle, 1999; Ma & Burgess, 1993). Brekke et al. (2010) have shown that this does not generally hold in the presence of income effects (which implies that price changes affect the marginal utility of consumers).

[17] The equilibrium solution was computed in Mathematica and further details are available upon request.

[18] We use subscript NL to denote equilibrium values of the chain practicing national pricing and subscript LN to denote equilibrium values of the competing chain (practicing local pricing).

[19] These regimes are defined by equilibrium price and quality differences when comparing the case of local pricing by both chains with the asymmetric case of national pricing by one of the chains. See Appendix A.2 for details.

[20] In line with previous notation, we use subscript NN to denote equilibrium values in the case where both chains adopt a national pricing strategy.

[21] There are several differences between our model framework and the one used by Dobson and Waterson (2005). For example, whereas they use a Bowley-type demand system based on a representative consumer, our analysis is conducted within a spatial competition framework with fixed total demand. The latter assumption, which implies that competition takes the form of pure business-stealing, tends to reinforce the profit gain (loss) of relaxed (intensified) price competition. In other words, both the gains and losses from a national price-setting strategy tend to be larger when total demand is fixed.

[22] If $c = 0$, equilibrium prices are always lower (higher) in the market with more (less) intense competition under local price setting (cf. Proposition 1).

[23] Notice that equilibrium quality is always higher in the larger market under local pricing, even if $c > 0$ (cf. Proposition 1).

[24] This follows directly from Ma and Burgess (1993), who also show that this result hinges critically on the assumption of simultaneous price and quality decisions.

[25] We should note that there are many other important dimensions to the quality of the consumer's shopping experience, aside from personal service: for example, the freshness of produce, quality of lighting, the layout and organization of store locales, cleanliness, and so forth. All of these are factors contributing to the overall value for the consumer.

[26] Some examples of markets in which personal service and the customer's shopping experience play a part are the markets for groceries, pharmaceuticals, clothes, and other mass-merchandise goods, as well as the markets for various specialty stores: for example, home improvement, electronics, audio equipment, jewelry, beauty products, and so forth. In many of these industries (if not all), an element of national pricing or zone pricing has been documented in the literature. See, for example, DellaVigna and Gentzkow (2019) for evidence on groceries, pharmaceuticals, and mass-merchandise goods, and Adams and Williams (2019) for evidence from the retail home-improvement industry.

[27] See, for example, Bergantino et al. (2020) and Tveito (2022).

[28] In a 2015 survey, the Norwegian Competition Authority found that only 14% of the stations' convenience store customers also purchased gasoline (Konkurransetilsynet, 2015). Moreover, Tveito (2022) documents that it is not possible to detect any association between the gasoline price set at the station and station's convenience store revenues, which indicates that these are largely separate markets.

[29] Without the locational asymmetry (i.e., if $x = 0$), Market B would be the strong market for both chains, because $t^A < t^B$.

[30] The four possible pricing regimes are local pricing by both chains (LL), national pricing by both chains (NN), local pricing by Chain 1 and national pricing by Chain 2 (LN), and national pricing by Chain 1 and local pricing by Chain 2 (NL).

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APPENDIX A

A.1 | Equilibrium pricing strategies when quality costs are not internalized

In the main analysis we have assumed that the costs of local quality provision are fully internalized by the chains, that is, where $\alpha = 1$ in the expression for chain profits given by (5). Here we explore the importance of this assumption by considering the polar case of $\alpha = 0$, where all quality costs are borne by the stores and not internalized by the chains at any stage of the game. Note that with $\alpha < 1$, because the chain does not fully internalize the stores' profits, the specific division of revenues and profits (the sharing rule) will affect the outcome (unlike the case when $\alpha = 1$). In the following we will assume that the chain and the stores use a 50–50 revenue sharing rule, but with all quality costs borne by the local stores ($\alpha = 0$). The equilibrium configurations in this scenario are displayed in Figure A1a–d, for the same parameter values (except for α) as in Figure 1a–d.

Compared with Figure 1a–d, there are two notable differences. First, national pricing is an equilibrium strategy for a much larger set of parameter values when quality costs are not internalized by the chains. Second, national pricing is an equilibrium mainly for cases in which competition is more intense in the larger market, even in the absence of output-dependent quality costs (as in Figure A1a).

To explain these results, consider the effect of a unilateral switch from local to national pricing. If local quality costs are not internalized by the chains, the pricing incentives are *as if* $c = 0$. This means that the price is lower in the market with more intense competition (cf. Proposition 1), implying that national pricing yields a price increase in this market and a price reduction in the other. Thus, for given quality levels, national pricing yields a gain (loss) in the most (less) competitive market. In the absence of quality competition, the gain is smaller than the loss (cf. Proposition 3). The presence of quality competition implies additional gains and losses related to changes in demand and in the costs of quality provision. However, changes in the costs of quality provision are irrelevant for the optimal pricing strategy of the chains, as long as these costs are not internalized. The only effects that matter for the chains, with respect to quality competition, is the demand effects brought about by changes in relative quality provision. Since prices are strategic complements, and since price and quality move in the same direction for each store, national pricing by one chain implies that both price and quality go up (down) for both chains in the market with more (less) intense competition. However, since the strategic responses are smaller in magnitude than the initial changes in price and quality by the chain that

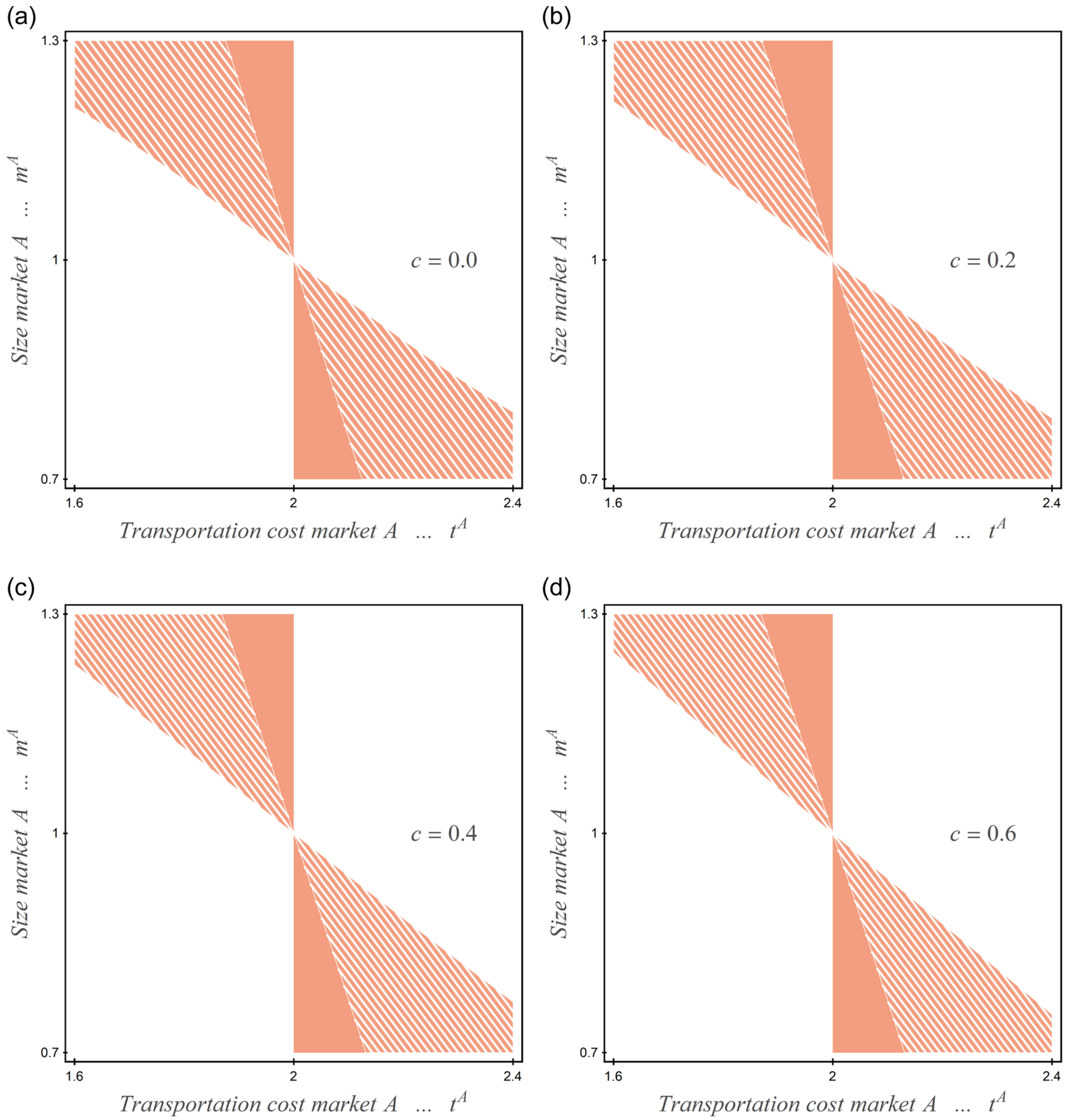

FIGURE A1 Equilibrium pricing strategies under "weak" quality competition and no cost internalization. The red area has national pricing by both chains. White stripes indicate that there are two equilibria, the second one with local pricing by both chains [Color figure can be viewed at wileyonlinelibrary.com]

switches to national pricing, the latter chain offers higher (lower) quality than its competitor in the more (less) competitive market. Thus, when quality costs are not internalized, the presence of quality competition *increases* both the gains and the costs of national pricing. It turns out that these added demand effects of changes in relative quality provision are sufficient to make the gains of national pricing outweigh the costs, if the market with more intense competition (where the gains occur) is larger than the other market (where the losses occur). Notice also that all equilibria with national pricing in Figure A1a–d have national pricing by both chains. Thus, if it is profitable for one chain to switch from local to national pricing, it is also profitable for the competing chain to follow suit.

A.2 | Definition of strategic regimes in Section 5.1

Notice first that, from (12) to (13), equilibrium quality in Market j when both chains practice local price setting can be written as $s_{LL}^j = (m^j b/2kt^j)p_{LL}^j$. Thus, the relationship between price and quality for each chain, in each market, is exactly the same in the two equilibria (local pricing by both chains vs. national price setting by one chain). This implies that equilibrium quality responses to national price setting always go in the same direction as the equilibrium price responses. Using (12), (17), and (18), the price differences across the two equilibria are given by

$$p_{NL} - p_{LL}^A = (t^B - t^A)(3kt^B - m^B b^2)(4kt^A - m^A b^2)\frac{m^B t^A}{\Theta}, \tag{A1}$$

$$p_{NL} - p_{LL}^B = -(t^B - t^A)(3kt^A - m^A b^2)(4kt^B - m^B b^2)\frac{m^A t^B}{\Theta}, \tag{A2}$$

$$p_{LN}^A - p_{LL}^A = (t^B - t^A)(2kt^A - m^A b^2)(3kt^B - m^B b^2)\frac{m^B t^A}{\Theta}, \tag{A3}$$

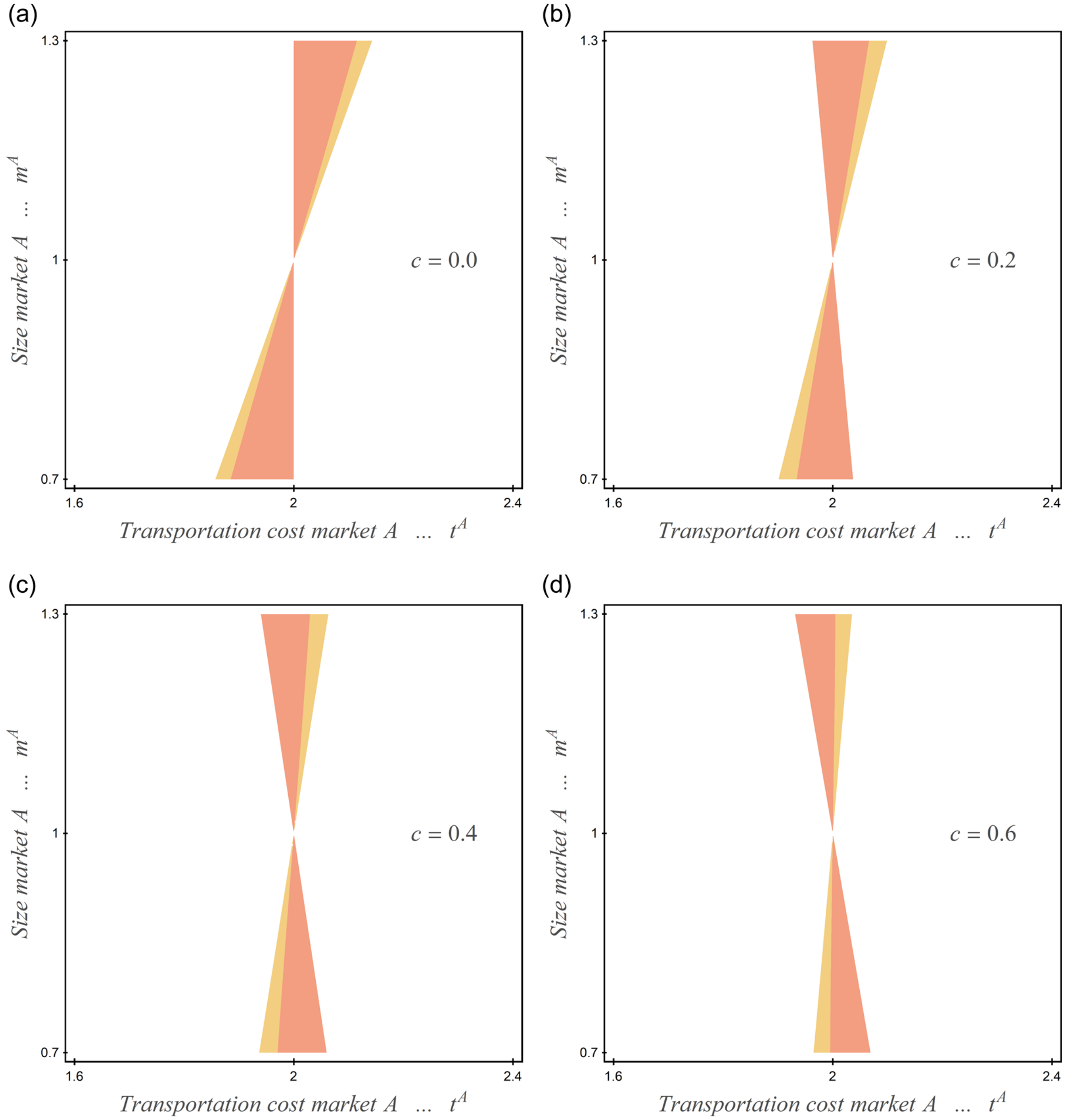

FIGURE A2 Equilibrium pricing strategies when $b = 1.25$. The red (orange) area has national pricing by both chains (one chain) [Color figure can be viewed at wileyonlinelibrary.com]

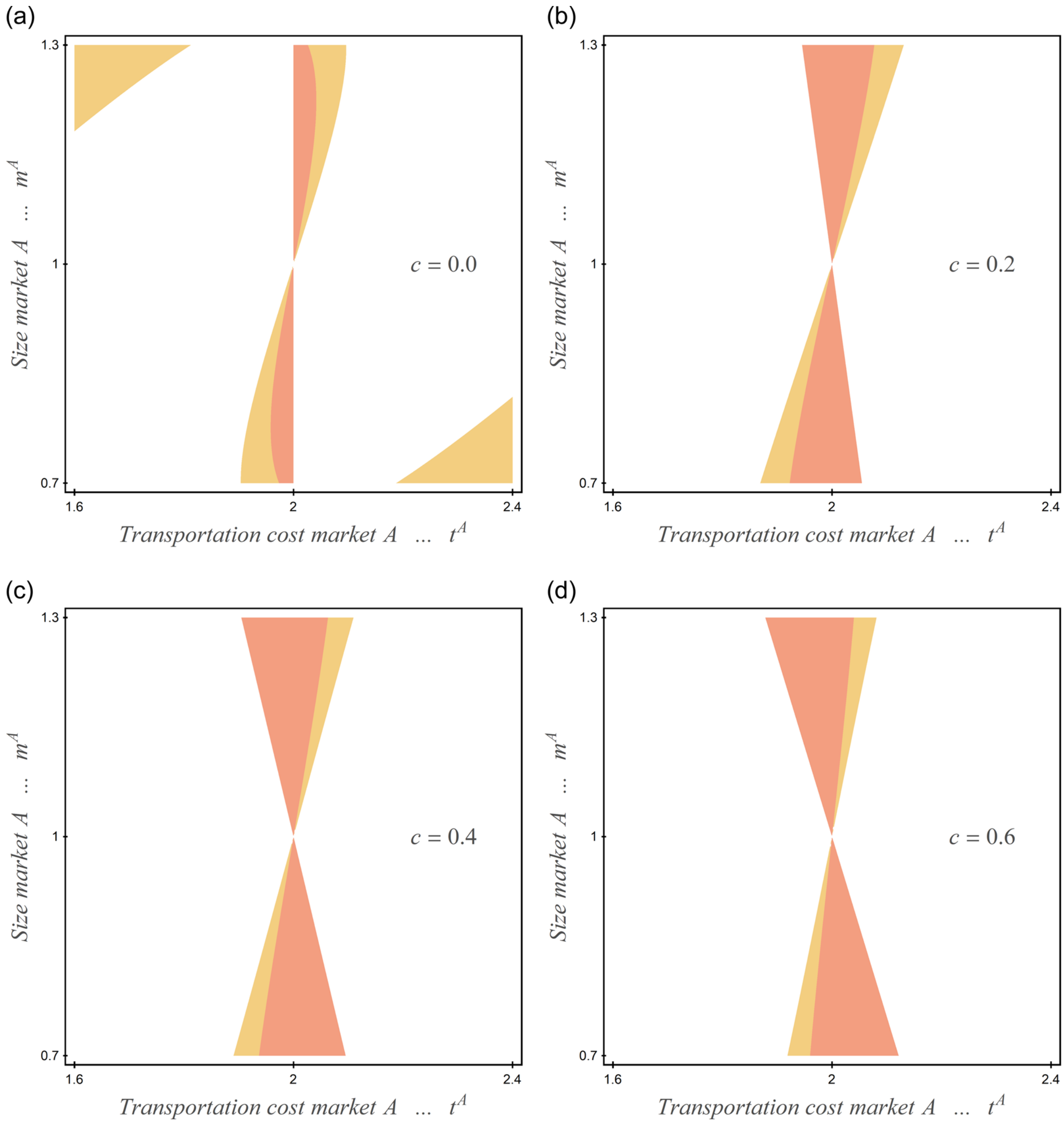

FIGURE A3 Equilibrium pricing strategies when $b = 1.75$. The red (orange) area has national pricing by both chains (one chain) [Color figure can be viewed at wileyonlinelibrary.com]

$$p_{LN}^B - p_{LL}^B = -(t^B - t^A)(3kt^A - m^A b^2)(2kt^B - m^B b^2)\frac{m^A t^B}{\Theta}. \tag{A4}$$

Given the condition $b^2 < \max\{3kt^A/m^A, 3kt^B/m^B\}$, it follows from (A1) to (A2) that $p_{NL} > (<) p_{LL}^A$ and $p_{NL} < (>) p_{LL}^B$ if $t^B > (<) t^A$. Furthermore, it follows from (A3) to (A4) that, if $b^2 < 2k\underline{\theta}$ (Regime 1), then $p_{LN}^A > (<) p_{LL}^A$ and $p_{LN}^B < (>) p_{LL}^B$ if $t^B > (<) t^A$; and if $b^2 > 2k\overline{\theta}$ (Regime 3), then $p_{LN}^A < (>) p_{LL}^A$ and $p_{LN}^B > (<) p_{LL}^B$ if $t^B > (<) t^A$. Finally, if $2k\underline{\theta} < b^2 < 2k\overline{\theta}$ (Regime 2), a closer inspection of (A3) and (A4) reveals that, if $t^j < t^{-j}$, then $p_{LN}^A < (>) p_{LL}^A$ and $p_{LN}^B < (>) p_{LL}^B$ if $t^j/m^j < (>) t^{-j}/m^{-j}$.

A.3 | Supplementary graphical plots

Here we present two supplementary figures for our equilibrium analysis in Section 6. Figures A2 and A3 are identical to Figure 1 ($b = 1.5$) and Figure 2 ($b = 2$) in the main text, but use different values for b: Figure A2 has $b = 1.25$ and Figure A3 has $b = 1.75$.

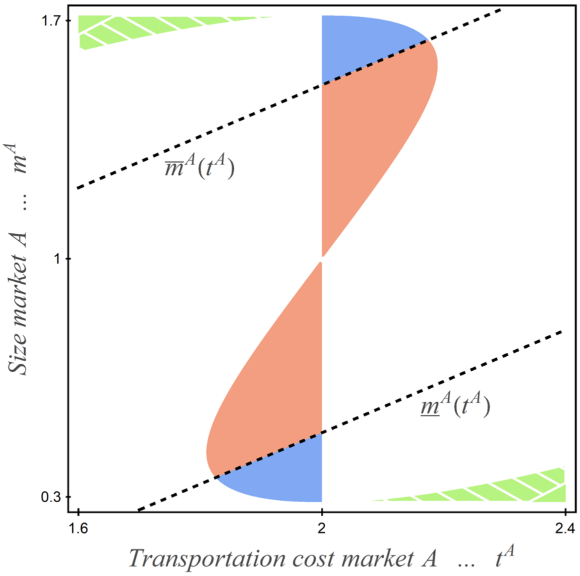

FIGURE A4 Figure replicates the example from Figure 1a, but allowing for a wider range of market sizes. The green (blue) area has consumers' surplus going up (down) in both markets when both chains adopt national pricing. (The red area has consumers' surplus going up in one market and down in the other). [Color figure can be viewed at wileyonlinelibrary.com]

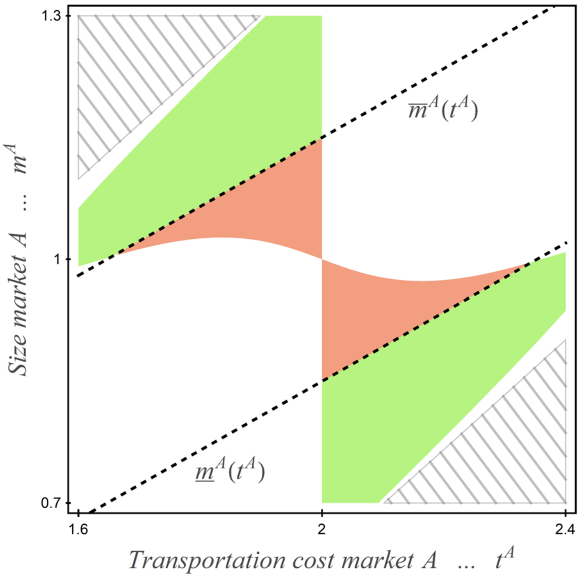

FIGURE A5 Figure replicates the example from Figure 2a. The green area has consumers' surplus going up in both markets when both chains adopt national pricing. (The red area has consumers' surplus going up in one market and down in the other). [Color figure can be viewed at wileyonlinelibrary.com]

A.4 | Asymmetric store locations

Consider a model identical to the one used in our main analysis, apart from store locations. Suppose that, in Market A, Chain 1 is located at $x > 0$ and Chain 2 is located at 1, whereas in Market B, Chain 1 is located at 0 and Chain 2 is located at $1 - x$. Thus, store locations are symmetrically asymmetric, with Chain 1 (Chain 2) having the superior store location in Market A (Market B).

The purpose of this extension is to show that our main results do not critically depend on the assumption that the two chains agree on what are the weaker and stronger market. For this purpose, a single numerical example suffices. Consider therefore the following parameter configuration: $m^B = 2 - m^A$, $t^B = 4 - t^A$, $m^A = 1.05$, $t^A = 1.95$, $c = 0$, $k = 0.85$, and $x = 0.02$. In this example, Chain 1 has a superior location in the market with larger size and stronger competition. In the following we report only the key equilibrium values needed to illustrate the example. Further details are available upon request.

Given the above-defined parameter values, we compare the equilibrium outcomes under two different values of b, namely, $b = 0$ and $b = 2$. If $b = 0$ and both chains practice local pricing, the equilibrium prices are given by $p_1^A = 1.963$, $p_2^A = 1.937$, $p_1^B = 2.036$, and $p_2^B = 2.064$. On the other hand, if $b = 2$ and both chains practice local pricing, the equilibrium prices are given by $p_1^A = 2.034$, $p_1^B = 2.000$, $p_2^A = 1.866$, and $p_2^B = 2.100$. Thus, for both values of b, and according to the established definition of weak and strong markets, Market A is the strong market for Chain 1, while Market B is the strong market for Chain 2.[29]

Suppose first that $b = 0$, which implies that there is no quality competition and the chains compete only on price. By Proposition 3 we know that, in the case of symmetric locations ($x = 0$), the unique SPNE is local pricing by both chains. In the case of asymmetric locations ($x = 0.02$), equilibrium profits in each of the four possible pricing regimes[30] are given by $\pi_1(LL) = 1.9983$, $\pi_2(LL) = 1.9969$, $\pi_1(NL) = 1.9976$, $\pi_2(NL) = 1.9959$, $\pi_1(LN) = 1.9976$, $\pi_2(LN) = 1.9949$, $\pi_1(NN) = 1.9976$, and $\pi_2(NN) = 1.9949$. It is straightforward to verify that local pricing by both chains (LL) is the unique SPNE also in this case, thus confirming Proposition 3.

Suppose now that $b = 2$, which implies that local quality competition is relatively strong. In the case of symmetric locations ($x = 0$), the unique SPNE is national pricing by both chains (cf. Figure 2). With asymmetric locations ($x = 0.02$), equilibrium profits in the different pricing regimes are $\pi_1(LL) = 0.830$, $\pi_2(LL) = 0.808$, $\pi_1(NL) = 0.829$, $\pi_2(NL) = 0.810$, $\pi_1(LN) = 0.815$, $\pi_2(LN) = 0.819$, $\pi_1(NN) = 0.816$, and $\pi_2(NN) = 0.811$. It is straightforward to verify that the unique SPNE is national pricing by both chains. Thus, sufficiently strong quality competition leads to national pricing in equilibrium also in cases where one chain's strong market is the other chain's weak market.

A.5 | National pricing and consumer welfare: Supplementary analysis

If we compare the two symmetric equilibria with, respectively, local and national pricing by both chains, relative prices and qualities are the same in both markets in both equilibria, so the effect of national pricing on consumers' surplus in Market j, denoted by ΔCS^j, is simply given by

$$\Delta CS^j = b\left(s_{NN}^j - s_{LL}^j\right) - \left(p_{NN} - p_{LL}^j\right). \tag{A5}$$

If prices go up as a result of national pricing, consumers' surplus increases only if consumers' valuation of the corresponding quality increase more than outweighs the price increase, and vice versa. Using (24) and (25), we derive

$$\Delta CS^j = \frac{m^{-j}t^j\left(p_{LL}^j - p_{LL}^{-j}\right)(2kt^j - b(b-c)m^j)2kt^{-j}}{\Phi}. \tag{A6}$$

Recall that $\Phi > 0$. The sign of (A6) is therefore determined by the signs of the first two bracketed factors in the numerator. Since $p_{LL}^j \neq p_{LL}^{-j}$ (as long as $t^j \neq t^{-j}$), a switch from local to national pricing has the same qualitative effect on consumers in both markets, where consumers either gain or lose, if the sign of $2kt^j - b(b-c)m^j$ differs across the two markets. From (11), this implies that the sign of $\partial s_i^j\left(p_{-i}^j\right)/\partial p_{-i}^j$ also differs across the two markets. Define

$$m := \frac{m^A + m^B}{2} \tag{A7}$$

and

$$t := \frac{t^A + t^B}{2}, \tag{A8}$$

which is the mean market size and the mean unit transportation cost of the two markets. Using (A6), we can identify the following two cases:

(i) Suppose that prices are lowest in Market j under local pricing, $p_{LL}^j < p_{LL}^{-j}$. National pricing by both chains then yields strictly higher consumers' surplus in both markets compared with local pricing, as long as Market j is sufficiently large (and Market $-j$ sufficiently small):

$$m^j > \max\left\{\frac{2kt^j}{b(b-c)}, \frac{2mb(b-c) - 2k(2t - t^j)}{b(b-c)}\right\} = \overline{m}(t^j). \tag{A9}$$

Similarly, national pricing by both chains yields strictly lower consumers' surplus in both markets compared with local pricing, as long as Market j is sufficiently small (and Market $-j$ sufficiently large):

$$m^j < \min\left\{\frac{2kt^j}{b(b-c)}, \frac{2mb(b-c) - 2k(2t - t^j)}{b(b-c)}\right\} = \underline{m}(t^j). \tag{A10}$$

(ii) Suppose instead that prices are highest in Market j under local pricing, $p_{LL}^j > p_{LL}^{-j}$. National pricing by both chains then yields strictly higher consumers' surplus in both markets compared with local pricing, as long as Market j is sufficiently small (and Market $-j$ sufficiently large), $m^j < \underline{m}(t^j)$, and strictly lower consumers' surplus in both markets as long as Market j is sufficiently large, $m^j > \overline{m}(t^j)$.

Figures A4 and A5 illustrate how national pricing affects consumers' surplus *in equilibrium*. Figure A4 replicates Figure 1a ($b = 1.5$, $c = 0$), except that we allow for a wider range of market sizes (on the vertical axis), and we now only color the areas in which national pricing by *both* chains is an equilibrium outcome. In the blue (green) area in Figure A4, consumers' surplus goes down (up) in both markets when both chains move from local to national pricing. In the red area, national pricing causes consumers' surplus to go up in one market and down in the other. Figure A5 replicates Figure 1a (using the same range of market sizes). In this example, in which the degree of quality competition is stronger ($b = 2$, $c = 0$), consumers' surplus goes up in both markets under national pricing for a wide range of parameter values (the green area). In concordance with the above analysis, we see that the green and blue areas in these figures are all characterized by sufficiently asymmetric markets, where competition is more intense in the larger market.