Should We Expect Uncertain Merger Synergies To Be Passed Through to Consumers?

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Abstract

Methods used to predict post-merger outcomes assume that synergies are common knowledge and imply that synergies will be at least partially passed through to consumers, potentially offsetting anticompetitive merger effects. However, the common knowledge assumption is inconsistent with other features of the merger review process and its implications are potentially inconsistent with the evidence of merger retrospectives. We relax the assumption in a simple model of post-merger competition and show that strategic incentives can lead a merged firm to not pass through quite large synergies arising in both horizontal and vertical mergers.

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*Sweeting (corresponding author): 3114 Tydings Hall, University of Maryland, College Park MD 20742, USA. Email: atsweet@umd.edu. All estimates and analysis using IRI data are the work of the authors and not IRI. The results reported in Section 3 are from theoretical simulations, and do not constitute real market statistics or measures of performance for the firms considered in this paper. This research was supported by US National Science Foundation Grant SES-1658670 (Sweeting) and National Natural Science Foundation of China Grant 72003120 (Tao). Xinlu Yao's work on this paper was conducted when she was a graduate student at the University of Maryland. All errors are our own.

1 Introduction

When balancing anticompetitive and procompetitive incentives arising from mergers, antitrust agencies use simulations and pricing pressure calculations based on models that assume complete information static Nash equilibrium (CISNE) pricing. This requires that the realization of any procompetitive synergy, such as a marginal cost reduction, is commonly known to all firms, and it implies that synergies and anticompetitive effects will be passed through to consumers at similar rates (Froeb, Tschantz and Werden (2005)). Practitioners have used this feature to argue that is "entirely at odds with the basic economic theory upon which modern antitrust law is based" to require merging parties to show that they will pass through synergies to consumers (Yde and Vita (1995), p. 735).

While oligopoly pass-through analysis usually assumes that cost changes are commonly known (Weyl and Fabinger (2013)), we believe this is a poor assumption for some types of merger synergies. We consider a simple model of repeated post-merger pricing where the merged firm has private information on the realized synergy. The positive effect on the merged firm's profits of raising rivals' prices creates a strategic incentive to price "as if" it has benefited from the smallest possible synergy. While the existence of this incentive follows naturally from the strategic complementarity of prices, we believe we are the first to show that this incentive can lead to *large* synergies, of a magnitude that a CISNE analysis would view as sufficient to make a large merger procompetitive, not being passed through to consumers at all.

We illustrate this result for horizontal mergers using a stylized example and numerical simulations that use a demand system that has previously been used to analyze synergies. We also show that the strength of the strategic incentive, and its effects, depend on the concentration of the rest of the market. This contrasts with the conclusions of Nocke and Whinston (forthcoming) who show that, under CISNE pricing, the size of the synergies required to avoid anticompetitive effects will typically only depend on the shares and markups of the merging firms.

We also present a vertical merger example where the strategic incentive results in an elimination of double marginalization (EDM) efficiency not being passed through. This example is relevant given current controversies surrounding EDM, as well as more general interest in the appropriate treatment of efficiencies and pass-through.[1]

There are two reason why we believe that common knowledge is a poor assumption for merger synergies. First, empirical merger retrospectives have found that horizontal mergers typically raise productivity (Haynes and Thompson (1999), Groff, Lien and Su (2007), Braguinsky et al. (2015), Kulick (2017), Grieco, Pinkse and Slade (2018), Walia and Boudreaux (2019) and Yan et al. (2019), although Blonigen and Pierce (2016) estimate productivity decreases), while also finding that they often raise prices (Ashenfelter, Hosken and Weinberg (2014) provide a survey). Therefore, while agencies have been criticized for being overly generous in crediting efficiencies (Rose and Sallet (2019)), the evidence is also consistent with efficiencies being realized but not passed through to the extent agencies expect.[2]

Second, agency experience and practice suggest it is unlikely that rivals will know the realized values of some types of synergy, even though the calculations of agency economists assume common knowledge. The 2010 Horizontal Merger Guidelines describe how "[e]fficiencies are difficult to verify and quantify, in part because much of the information relating to efficiencies is uniquely in the possession of the merging firms. Moreover, efficiencies projected reasonably and in good faith by the merging firms may not be realized."[3] In fact, even with access to "clean room" data that even the merging firms' managers may not be privy to, agency estimates of plausible efficiencies often have a relatively wide range.[4] Agencies also go to great lengths to avoid any disclosure about efficiencies to rivals, and after consummation,

[1]Economists typically expect EDM to be passed through quite generally (Shapiro and Hovenkamp (2021)), but the Democratic FTC majority withdraw support for the 2020 Vertical Merger Guidelines arguing that their "reliance on EDM ... is theoretically flawed because the economic model predicting EDM is limited to very specific factual scenarios" and "[e]mpirical evidence suggests that we should be highly skeptical that EDM will even be realized—let alone passed on to end-users." (`https://www.ftc.gov/system/files/documents/public_statements/1596396/statement_of_chair_lina_m_khan_commissioner_rohit_chopra_and_commissioner_rebecca_kelly_slaughter_on.pdf`). Paragraph 14 of the FTC and US Department of Justice's January 2022 "Request for Information on Merger Enforcement", `https://www.regulations.gov/document/FTC-2022-0003-0001`, highlights many questions concerning efficiencies, including pass-through.

[2]No retrospectives have estimated a specific rate of merger efficiency pass-through, althoug Ashenfelter et al. (1998) and Muehlegger and Sweeney (2019) estimate that, in the normal course of competition, the pass-through rate of firm-specific marginal cost reductions is small.

[3]`https://www.justice.gov/sites/default/files/atr/legacy/2010/08/19/hmg-2010.pdf`

[4]See `https://www.weil.com/~/media/files/pdfs/2017/clean-team-agreement.pdf` for a discussion of clean rooms and Section 4D of Sweeting et al. (2020) for an example where analysis provided a range.

merged firms rarely disclose information that would allow individual product margins to be calculated.

We build on a small literature considering oligopoly pricing with asymmetric information. The one-shot models of Shapiro (1986), Vives (2011) and Amir, Diamantoudi and Xue (2009) (where a merger synergy is uncertain) do not capture the strategic incentive to raise rivals' future prices that drives our results. Sweeting, Tao and Yao (2022) consider a game where several oligopolists simultaneously use separating strategies to signal information about marginal costs that evolve over time.[5] A computationally intensive analysis shows that these strategies can raise margins. However, separating equilibria only exist when marginal costs are restricted to narrow ranges, making it impossible to analyze large synergies. The current paper provides a more tractable analysis of how uncertainty about a possibly large synergy affects post-merger pricing.

2 Model of a Horizontal Merger

Pre-merger, $F \geq 3$ firms sell $N \geq F$ differentiated, substitute products. c_i is the marginal cost of product i, owned by $f(i)$, and we assume that pre-merger costs are common knowledge. Demand for i, which is also commonly known, is $q_i(\mathbf{p})$ where $\mathbf{p}$ is the vector of all prices. We assume throughout that prices are observed perfectly.

We assume an exogenous merger between firms 1 and 2, creating a firm M, which continues to sell the same brands. The merger has no effect on demand or the marginal costs of the non-merging firms, which remain commonly known, but M's post-merger marginal costs are either $\mathbf{c}_M = \underline{\mathbf{c}}$ (high synergy), with known probability q, $1 > q > 0$, or $\mathbf{c}_M = \overline{\mathbf{c}}$ (low synergy), where every element of $\underline{\mathbf{c}}$ is less than $\overline{\mathbf{c}}$. M knows the realized $\mathbf{c}_M$, but rivals do not.

Our interest is in what happens in an infinitely repeated pricing game that takes place after the merger, where we assume no further changes to demand, costs or market structure. Firms simultaneously set prices each period with no menu costs.

To describe the equilibrium, we introduce some notation and assumptions. M's discount

[5] This approach builds on the limit pricing model of Sweeting, Roberts and Gedge (2020).

factor is δ_M. δ_M will reflect time preference, but it could also reflect a probability each period that M's true marginal costs are publicly revealed, causing our asymmetric information game to end. $\mathbf{p}_M$ ($\mathbf{p}_{-M}$) is the price vector for M's (non-merging rivals') products. The price of an individual product is p_i. $\mathbf{p}^\dagger(\mathbf{c_M})$ denotes CISNE prices given the post-merger ownership structure and costs. $\pi_M(\mathbf{c_M}, \mathbf{p}_M, \mathbf{p}_{-M})$ are the merged firm's profits, as a function of its costs, prices and rival prices. $\mathbf{p}_M^{BR}(\mathbf{c}_M, \mathbf{p}_{-M})$ are the prices that maximize M's one period profits given costs and rival prices.

We will also refer to "equilibrium best response" prices for a subset of firms, by which we mean the prices that maximize the per-period profits of each firm in the subset given its costs and the prices of the other firms in the subset, and specific prices for firms outside the subset that may not be optimal.

Assumption 1 *For any vector of marginal costs, there are unique CISNE prices and unique equilibrium best response prices for any subset of firms.*

Multinomial logit (MNL) and CES demand systems with an outside good will satisfy Assumption 1 (Nocke and Schutz (2018)).[6] When we analyze a random coefficient logit model we will assume this assumption holds, as is standard in the empirical literature.

Pooling MPBE. We consider whether a particular kind of pooling Markov Perfect Bayesian Equilibrium (MPBE) exists. Following Toxvaerd (2008) and Roddie (2012), an MPBE specifies an expected payoff-maximizing pricing strategy for each firm as a function of its type and, where relevant, its beliefs, where beliefs are consistent with Bayesian updating given the history of play on the equilibrium path. The Markovian restriction is that history matters only through beliefs, ruling out collusion if M's type is revealed. In our game, only M's type may vary, and only the non-merging firms have history-dependent beliefs. In this paper, we consider the following pooling equilibrium.

Definition 1 ***Pooling MPBE.*** *M sets prices $\mathbf{p}_M^\dagger(\overline{\mathbf{c}})$ for its products in the first period and when it has done so in each previous period, and otherwise it sets prices $\mathbf{p}_M^{BR}(\mathbf{c}_M, \mathbf{p}_{-M}^\dagger(\underline{\mathbf{c}}))$.*

[6]The equilibrium best response result follows from the fact that the attractiveness of the outside good can be re-defined to reflect fixed prices of the firms that are outside the subset.

All other firms believe that $\mathbf{c}_M = \underline{\mathbf{c}}$ *with probability* q *and set prices* $\mathbf{p}^{\dagger}_{-M}(\overline{\mathbf{c}})$ *in the first period and when* M *has set prices* $\mathbf{p}^{\dagger}_{M}(\overline{\mathbf{c}})$ *in every period. Otherwise, other firms believe that* $\mathbf{c}_M = \underline{\mathbf{c}}$ *with probability 1 and set prices* $\mathbf{p}^{\dagger}_{-M}(\underline{\mathbf{c}})$.

Proposition 1 *The Pooling MPBE will exist if and only if*

$$\delta_M \geq \frac{\pi_M(\underline{\mathbf{c}}, \mathbf{p}^{BR}_M(\underline{\mathbf{c}}, \mathbf{p}^{\dagger}_{-M}(\overline{\mathbf{c}})), \mathbf{p}^{\dagger}_{-M}(\overline{\mathbf{c}})) - \pi_M(\underline{\mathbf{c}}, \mathbf{p}^{\dagger}_{M}(\overline{\mathbf{c}}), \mathbf{p}^{\dagger}_{-M}(\overline{\mathbf{c}}))}{\pi_M(\underline{\mathbf{c}}, \mathbf{p}^{BR}_M(\underline{\mathbf{c}}, \mathbf{p}^{\dagger}_{-M}(\overline{\mathbf{c}})), \mathbf{p}^{\dagger}_{-M}(\overline{\mathbf{c}})) - \pi_M(\underline{\mathbf{c}}, \mathbf{p}^{\dagger}_{M}(\underline{\mathbf{c}}), \mathbf{p}^{\dagger}_{-M}(\underline{\mathbf{c}}))}. \tag{1}$$

Proof. The stated strategies imply that non-merging firms are always best responding (i.e., maximizing their one-period profits) to each other and the prices they expect M to set in any period and, given that other firms' prices do not affect future play, this is optimal. Prices $\mathbf{p}^{\dagger}_{M}(\overline{\mathbf{c}})$ are the best response of a $\mathbf{c}_M = \overline{\mathbf{c}}$-type M. Following the logic of the calculation of the critical discount factor in a model of tacit collusion, condition (1) is necessary and sufficient for a $\mathbf{c}_M = \underline{\mathbf{c}}$-type M not to deviate. $\mathbf{p}^{BR}_M(\mathbf{c}_M, \mathbf{p}^{\dagger}_{-M}(\underline{\mathbf{c}}))$ are optimal for M following a deviation, given the behavior of the non-merging firms. ■

Equation (1) implies that the pooling MPBE will exist for some $\delta_M < 1$ if and only if $\pi_M(\underline{\mathbf{c}}, \mathbf{p}^{\dagger}_{M}(\overline{\mathbf{c}}), \mathbf{p}^{\dagger}_{-M}(\overline{\mathbf{c}})) > \pi_M(\underline{\mathbf{c}}, \mathbf{p}^{\dagger}_{M}(\underline{\mathbf{c}}), \mathbf{p}^{\dagger}_{-M}(\underline{\mathbf{c}}))$. Only a sufficiently patient high-synergy M will be willing to set a price higher than a static best response in order to prevent the non-merging firms from lowering their prices in future periods. The patience of non-merging firms does not matter because they are always setting best response prices.

While equation (1) is derived using similar logic to the calculation of the critical discount factor in a model of tacit collusion, some standard features of tacitly collusive equilibria will not apply here. For example, as we illustrate below, pooling can happen in the first period of a two period game. This is, of course, a feature of games where there is asymmetric information about players' types (Kreps and Wilson (1982)).

Proposition 2 *The Pooling MPBE will exist, for some* $\delta_M < 1$, *when the differences between* $\underline{\mathbf{c}}$ *and* $\overline{\mathbf{c}}$ *are small enough with MNL or CES demand with an outside good. If the Pooling MPBE is played then expected consumer surplus (CS) will be lower with asymmetric information than with complete information.*

Proof. Online Appendix A provides a proof, using a straightforward application of the results in Nocke and Schutz (2018). ■

Online Appendix C.1 shows a similar result for symmetric merging products and linear demand, deriving an analytic formula for the cost range that supports pooling.

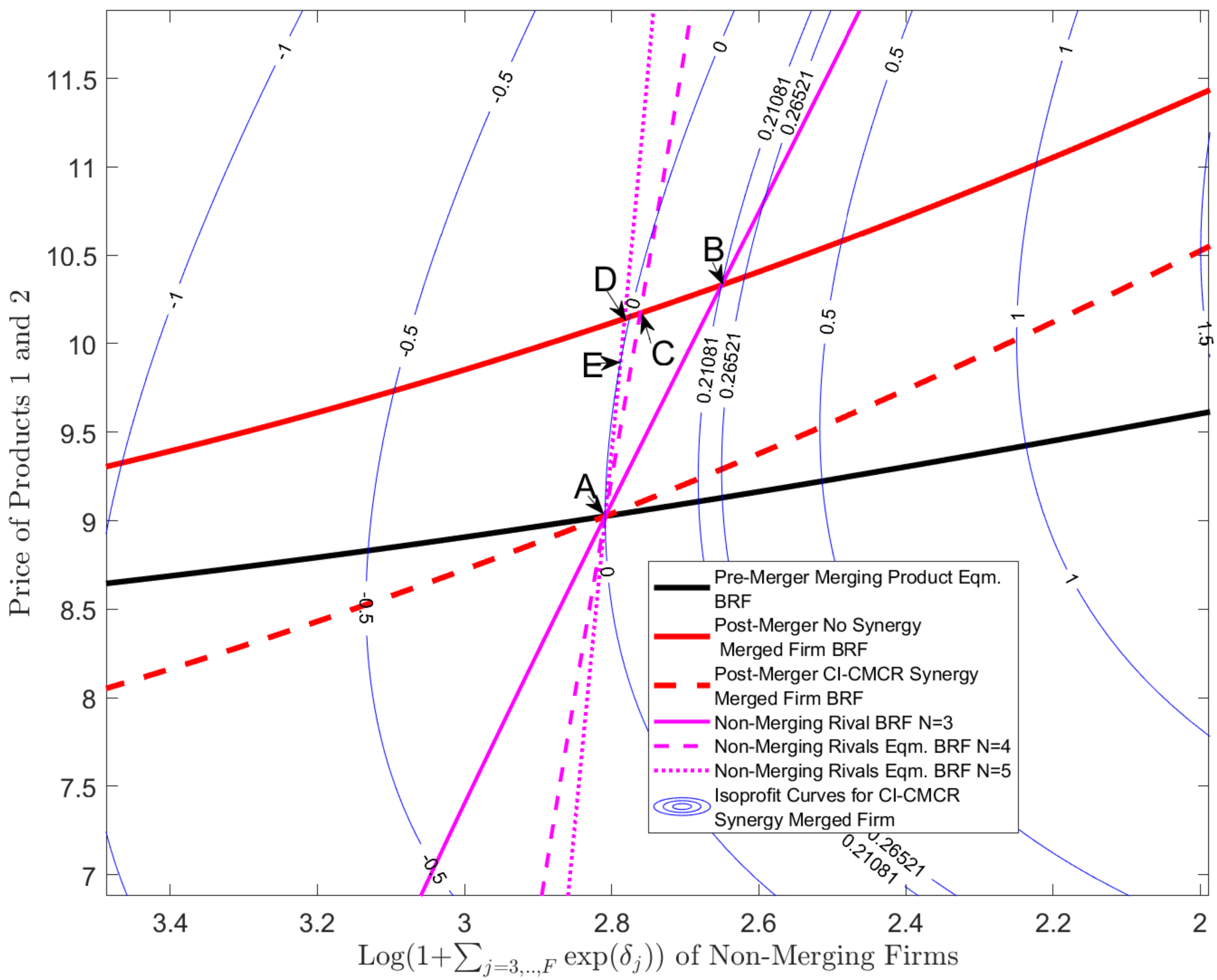
Multinomial Logit Example. We illustrate the intuition graphically in Figure 1. Assume that, prior to the merger, there are $N = F = 3$ single-product firms (we will change this number below) with marginal costs of 4 and that there is multinomial logit demand where consumer j's indirect utility for good i, with price p_i, is $u_{ij} = a_i - 0.25p_i + \varepsilon_{ij} = \delta_i + \varepsilon_{ij}$ with $a_1 = a_2 = 4$, $a_3 = 6$, and ε_{ij} is an iid logit draw. $u_{0j} = \varepsilon_{0j}$ for the outside good. We assume a market size of 1.

Suppose that firms 1 and 2 merge to form M. The black solid line in Figure 1 depicts the pre-merger static equilibrium best response prices of these firms to a value of $\log(1+\exp(\delta_3))$ (the "inclusive value" of good 3 and the outside good). The solid magenta line shows the $\log(1 + \exp(\delta_3))$ implied by the static best response price of firm 3 given the price charged for products 1 and 2. The pre-merger equilibrium is at point A (with $p_1^\dagger = p_2^\dagger = 9.03$, $p_3^\dagger = 13.01$).

Suppose that M's marginal costs are either 4, i.e., no synergy, or 2.27, the "compensating marginal cost reduction" (CI-CMCR) synergy which, if firms use CISNE pricing, would keep prices at exactly their pre-merger levels. The red solid and red dashed lines show the merged firm's CI best response functions in each of these cases with CISNE outcomes at A and B respectively. Our pooling MPBE involves an outcome at B given either level of synergy, including if q, the probability of the CI-CMCR synergy, is close to 1. $q > 0.5$ cases are especially relevant as merger review often focuses on assessing whether harm from a merger is "more likely than not," rather than assessing the expected harm, so that a CISNE analysis would suggest that a merger could be allowed to proceed.

The values on the blue isoprofit curves show the differences in M's profits when it benefits from the CI-CMCR synergy, from its profits at A. The pooling MPBE raises a high synergy M's per-period profits by 0.21081 (by 7.6% relative to A, and 10.2% relative to pre-merger profits). While setting one-period best response prices would further increase its profits by (0.26521-0.21081), subsequent play at A would cause this deviation to reduce M's discounted

Figure 1: Horizontal Merger Example. BRF is a “best response function”. The values on the isoprofit curves show differences in the per-period profits of a merged firm that benefits from a CI-CMCR synergy from its profits at A.



future profits if $\delta_M > \frac{0.26521-0.21081}{0.26521} = 0.21$. Play at B, rather than at A, raises firm 3's profit by 0.68 (13%), and lowers CS by 0.89. One could also sustain pooling at B for much larger high-case synergies than the CI-CMCRs: for example, if the possible synergies were either no marginal cost reduction or a reduction in M's marginal costs to zero, an MPBE with pooling on no synergy prices would exist if $\delta_M > 0.33$.

The formula in equation (1) reflects the assumption that the post-merger pricing game is infinitely repeated. Suppose, instead, that there are just two post-merger pricing periods and consider an equilibrium where the merged firm sets the same price in the first period whatever the realized synergy, and, in the second period, the firms play a Bayesian Nash equilibrium where they maximize their static profits given their cost and the price(s) that they expect the other firm to set. If the non-merging firm interprets any first period deviation from the low synergy price by the merged firm as reflecting a high synergy, then, with a discount factor of 0.95, this equilibrium will exist when the prior probability that the synergy is high is less than 0.8.[7] This example illustrates how the potential effect of pooling on prices does not depend on the post-merger pricing game being infinite or long.

The figure also illustrates how the existence of a pooling MPBE depends on the slope of the equilibrium best response function of the non-merging firms. The function will steepen when rivals' prices are less sensitive to M's prices (for example, because rivals have less market power so that their pre-merger markups are smaller). The dashed and dot magenta lines are the equilibrium reaction functions of the rivals when there are 2 ($F = 4$) or 3 ($F = 5$) symmetric non-merging firms and we adjust (increase) their marginal costs so that the pre-merger equilibrium remains at A.[8] Assuming M realizes either no synergy or the CI-CMCR synergy, a pooling MPBE (at C) will exist when $F = 4$, for $\delta_M > 0.70$. There is no pooling MPBE for $F = 5$ for any δ_M, as a CI-CMCR synergy-type M has lower per-period profits at D than at A. However, a pooling equilibrium, with an outcome at E, would exist, for some $\delta_M < 1$, if the alternative synergies were the CI-CMCRs or a small marginal cost

[7] As the probability that the synergy is high increases, final period BNE prices after pooling approach high synergy CISNE prices, reducing the incentive to pool. Note that our assumption that any deviation from the pool is interpreted as coming from a low cost firm is important, as a low synergy (i.e., high cost) firm might otherwise want to set a price that is above the CISNE price in order to show its type.

[8] If we had presented the prices of non-merging rivals on the x-axis then increasing F would have changed the location of the merging firm's response function as well.

reduction of 0.375.

We have specified the marginal costs of the non-merging firms in our $F = 3$, $F = 4$ and $F = 5$ examples so that the pre-merger prices, margins and market shares of the merging firms are identical. As shown by Nocke and Whinston (forthcoming), with MNL demand, this implies that the values of the CI-CMCRs are the same in each case, as is the merger-induced change in the HHI (sum of squared market shares) index based on pre-merger market shares. Nocke and Whinston use the fact that CI-CMCRs do not depend on the shares or margins in the rest of the market to suggest it would be appropriate for the Horizontal Merger Guidelines to identify structural presumptions of harm based on the market shares of the merging firms alone. However, in our model, the concentration of the rest of the industry, as reflected by its responsiveness to the merged's firm prices, does affect whether a pooling equilibrium will exist and therefore whether a CI-CMCR, or larger, synergy will be passed through to consumers. This is the case even though our model remains a model of unilateral merger effects in the sense that other firms continue to use their static best response pricing functions.

3 Numerical Example: Horizontal Mergers in the Beer Industry

In this section, we consider what level of synergies will support pooling MPBEs for a range of simulated mergers using the demand and marginal cost estimates from Miller and Weinberg (2017) (MW). These estimates have previously been used to consider what types of efficiencies may offset anticompetitive harm under the assumption that firms use CISNE strategies (Caradonna, Miller and Sheu (2021) and Nocke and Whinston (forthcoming)).[9]

MW's sample, taken from the IRI Academic Dataset (Bronnenberg, Kruger and Mela (2008)), covers 5 beer manufacturers (brewers) with 13 brands (39 brand-size combinations) in 39 local markets. We follow MW by assuming that retailers perfectly pass through whole-

[9] Caradonna, Miller and Sheu (2021) and Nocke and Whinston (forthcoming) assume CISNE before and after mergers. MW assume CISNE before the creation of the Miller-Coors joint venture (MCJV), and estimate a degree of collusion, represented by a conduct parameter, between domestic brewers afterwards. Miller, Sheu and Weinberg (forthcoming) consider possible price leadership model before and after the joint venture and other possible mergers.

sale price changes, so that retail prices can be modeled as being chosen by brewers. Before the 2009 MCJV, the firms are Anheuser-Busch (AB), Miller and Molson-Coors, together with two importers, Grupo Modelo (GM) and Heineken.

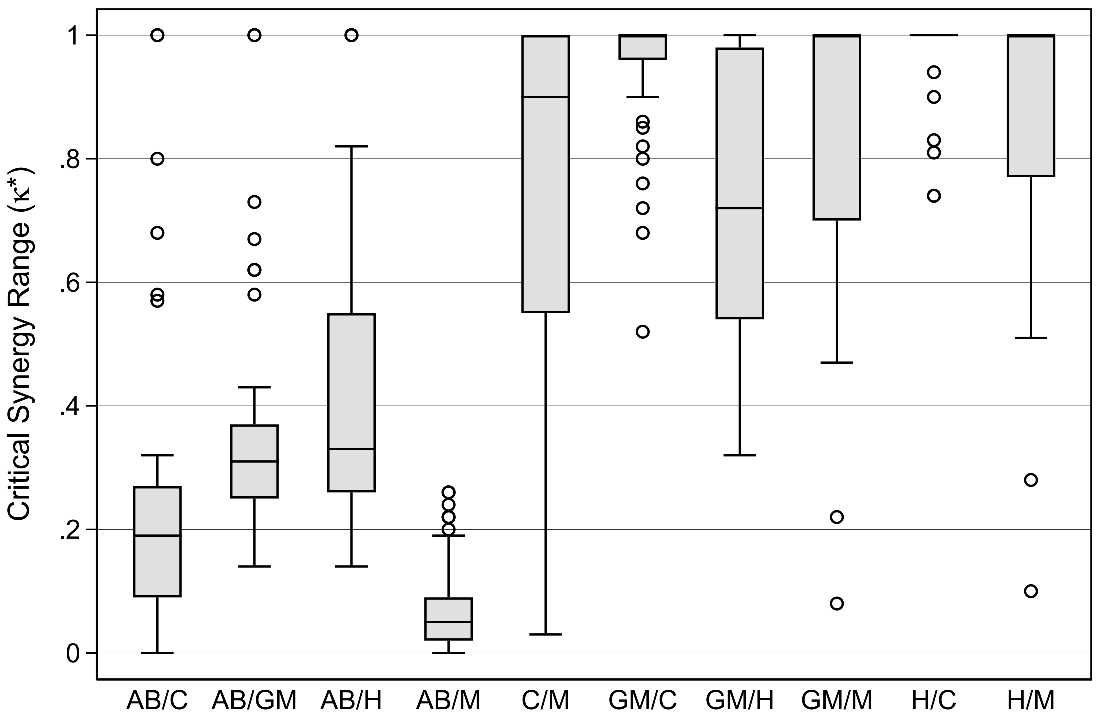
The starting point for our simulations, the mechanics of which are fully detailed in Appendix B, is MW's quarterly random coefficients nested logit demand (RCNL-2) estimates from their Table IV, column (iii). The demand model allows for income heterogeneity in preferences over prices, calories and the included products, as well as a nesting parameter capturing preferences for choosing any included product. We use observed prices and market shares from Q3 2007, immediately before the MCJV was announced, to infer pre-merger product qualities and marginal costs using the standard CISNE first-order conditions.

We simulate 390 market-mergers involving all firm-pair-local market combinations, treating each market independently.[10] We assume $\delta = 0.9^{\frac{1}{4}}$, consistent with a 0.9 annual discount factor. For each market-merger, we calculate the CI-CMCRs for each merging product and compute the **highest** value of a parameter $\kappa \in [0,1]$ (κ^*) such that if the two possible synergies are the CI-CMCRs multiplied by $(1-\kappa)$ (low synergy) or $(1+\kappa)$ (high synergy), a pooling MPBE of the type described in Section 2 will exist. The possible synergies are, therefore, always proportional to, and centered around, the CI-CMCRs. If $q \geq 0.5$ then, with CISNE pricing, expected CS will tend to increase slightly (Choné and Linnemer (2008)) so that mergers would be approved under either expected CS or "more likely than not" standards, but a merger should be blocked if firms are expected to play the pooling MPBE after a merger where the large synergy is realized. Note that when a merger can be supported for a specific κ, we also find that it can be supported for all smaller κs based on the 0.01 grid we use to find κ^*.

Figure 2 shows the (cross-market) ranges of κ^*s for each possible merger. Consider the simulated Coors/Miller merger, between the second and third largest brewers. The κ^*s range from 0.03, for a market where these firms have a combined market share above 75%, to 1 (for 18 of the 39 markets). The median is 0.92, implying that, for most markets, equilibrium prices in a pooling MPBE might rise almost as much as would be predicted if no synergies

[10]This ignores the possibility that prices that the merged firm sets in one market could be indicative of efficiencies in other markets.

Figure 2: Distribution (Across Markets) of the Largest κs that Support Pooling MPBEs for Each Merger.



Notes: mergers identified on the x-axis using the following abbreviations: AB=Anheuser-Busch, C=Coors, GM=Grupo Modelo, M=Miller, H=Heineken. For each merger, the black center line indicates the median value of κ^*, the limits of the grey box indicate the 25th to 75th percentiles, and the black whiskers indicate the adjacent values. The circles indicate values lying outside the range of the adjacent values.

were realized even if the merged firm's marginal costs fall by almost twice the CI-CMCRs. While there is heterogeneity across markets, the κ^*s are typically larger for mergers not involving AB, the largest national brewer, and for markets involving a domestic brewer and an importer.[11]

Table 1 reports the welfare implications of pooling by a merged firm whose marginal costs fall by $(1 + \kappa^*)\times$CI-CMCRs, using the example of the local market ("representative market") where brewer market shares are closest to their national averages (see Appendix B). The table also reports welfare effects when we sum across markets (with different κ^*s). We do not report the effect on the merging firm's profits as this is, by definition, close to zero for the κ^* synergy.

Pooling has the largest welfare effects for a Coors/Miller merger, which would increase the HHI by 711 (out of 10,000) based on pre-merger market shares. The CI-CMCRs imply that merging product marginal costs would need to drop by almost 9% to eliminate anti-competitive effects in a CISNE analysis. The κ^* of 0.9 implies that, if the possible synergies are cost reductions of 1% and close to 16%, pooling could lead to the benefits of a very large synergy hardly being passed through at all, with the merged firm's prices rising by 3.1%.[12] Pooling by a high synergy firm would reduce quarterly representative market CS by $47,600 and increase the profits of rivals by $33,200.

These magnitudes sound very small, but must be interpreted in light of MW's sample only capturing sales for all 13 brands of $1.3 million in the market-quarter being considered. Summing across MW's 39 markets, a Coors/Miller merger would lower quarterly CS by $1.2 million, compared with total quarterly sample sales of $58.3 million. This compares to national off-premise beer sales in 2007 of $51.1 billion in 2007, suggesting that, if pooling were to happen, welfare effects could be several hundred times larger than shown in the table.[13]

[11] The demand system implies that domestic and imported brands are systematically differentiated from each other, because they are sold at different price points and have different calorie counts. This tends to lead to smaller CI-CMCRs and, potentially, higher relative profitability of raising rivals' prices.

[12] Appendix Figure B.1 illustrates how raising rivals prices affects the profitability of a price increase for Coors/Miller.

[13] Value of total sales taken from Beverage Information Group (2021), p. 34 (as reported by `https://www.statista.com/statistics/483537/us-off-premise-beer-retail-dollar-sales/`), deflated to January 2010 dollars using the CPI-U to be consistent with the monetary values used by MW.

Table 1: Quarterly Welfare Effects of Pooling in a Representative Market

	Representative Market			Changes when a High-Synergy Firm Pools						
		$\overline{\text{CI-CMCR}}$				Representative Market			Total Across All Markets	
Merger	Δ HHI	($)	(%)	κ^*	$\overline{p_M}$ (%)	$\overline{p_{-M}}$ (%)	CS ($000)	π_{-M} ($000)	CS ($000)	π_{-M} ($000)
AB/Coors	1,273	1.09	16.5%	0.19	1.91%	0.24%	-17.3	7.8	-741.2	383.8
AB/GM	925	0.70	9.3%	0.28	1.34%	0.15%	-16.8	8.5	-1,016.0	596.2
AB/Heineken	613	0.45	6.3%	0.3	1.91%	0.16%	-11.4	6.3	-585.4	428.7
AB/Miller	2,103	1.97	31.1%	0.08	1.58%	0.06%	-12.4	4.2	-454.3	161.3
Coors/Miller	711	0.58	8.8%	0.9	3.08%	0.40%	-47.6	33.2	-1,647.8	1,170.7
GM/Coors	312	0.27	2.9%	1	3.99%	0.65%	-19.2	16.7	-978.2	824.0
GM/Heineken	150	0.29	2.4%	0.68	6.00%	1.06%	-9.9	9.1	-621.7	534.4
GM/Miller	516	0.39	4.9%	0.98	3.05%	0.39%	-32.5	24.4	-1252.0	972.4
Heineken/Coors	207	0.19	2.2%	1	4.47%	0.64%	-12.0	11.0	-447.0	439.2
Heineken/Miller	342	0.26	3.5%	0.97	9.48%	1.54%	-20.2	16.1	-591.3	520.6

Notes: the change in HHI (out of 10,000) based on market shares in Q3 2007 considering the 39 markets in the MW sample. The reported $\overline{\text{CI-CMCR}}$s are share-weighted averages across the merging firms' products. The % $\overline{\text{CI-CMCR}}$s are relative to pre-merger costs. The change measures compare the outcomes in a pooling equilibrium when a high synergy merging firm (with marginal costs equal to pre-merger marginal costs less κ^* times the CI-CMCRs) sets the prices that would be CISNE equilibria with a low synergy and outcomes in the CISNE with high synergies. The representative market is the local market with brewer market shares closest to national averages, and surplus and profits are computed using MW's assumed market size for the market in Q3 2007. The sums across markets add together CS and profit differences between the pooling and CISNE equilibria in the 39 markets in the MW data, using the market size for each of these markets.

A pooling equilibrium can be supported following a merger of the largest brewers, AB and Miller, for a much smaller range of synergies ($\kappa^* = 0.08$), and the welfare effects of pooling are smaller in this case. The intuition for why κ^* is small when the merging firms have high market shares (AB and Miller's combined share is close to 70%) is that the relative benefit to raising its rivals' prices tends to be small relative to the costs of setting a price that is too high given the firm's realized costs.

We now discuss two simple exercises that illustrate how, with richer demand, the existence of a pooling equilibrium remains sensitive to the market structure in the rest of the market.[14]

First, we consider how κ^* changes when we assume that non-merging products are owned by a single firm or independent firms. In the former case, the rival markups implied by observed prices and shares are much larger, and rivals' equilibrium best response prices are more sensitive to the prices of merging products.[15] The results are striking: pooling can be sustained for only 8 market-mergers even with $\kappa = 0.001$ (a tiny range of synergies) with independent rival products, whereas it can be sustained with $\kappa = 1$ for 363 (out of 390) market-mergers with monopolized rival products, including 17 AB-Miller market-mergers.

Second, for each market-merger, we compute a measure of the sensitivity of rivals' prices to the merged firm's prices by calculating the change in the inclusive value of rivals' products, based on the preferences of the average consumer in the market, when rivals' set equilibrium best response prices and the prices of the merged firm are increased by 1% (see Appendix B for details). We regress our calculated κ^*s on this statistic. Consistent with Figure 1, the estimated coefficient on this slope measure is negative and highly statistically significant (-6.241, s.e. 0.404) and the R^2 in this univariate regression is 0.48. The significance of the slope coefficient is robust to the inclusion of 39 market fixed effects and/or 10 merger fixed effects.

As mentioned in Section 2, one might interpret the discount factor (δ_M) as reflecting both time preference and an exogenous probability that M's realized synergy becomes known to the rest of the industry, after which CISNE pricing every period would be the only Markov

[14]Nocke and Whinston (forthcoming) show, using simulations, that the CI-CMCRs continue to depend almost entirely on the margins and market shares of the merging firms with this demand system.

[15]For example, for the representative market, average rival margins and the average slope of the equilibrium best response function of rivals, described below, are \$0.37 and -0.0052 when we assume rival products are owned by independent firms, and \$0.90 and -0.41 when we assume that they are owned by a monopoly.

Perfect equilibrium. This suggests that it may be appropriate to consider δ_M values lower than $0.9^{\frac{1}{4}}$. For the representative market, assuming $\delta_M = 0.95$ or $\delta_M = 0.9$ has little impact on the calculated κ^*s, and therefore on the per-period welfare implications of pooling as long as the asymmetry of information lasts.[16] Also, even if one believes that realized synergies must become known within a few years, our results are still relevant given that expected adverse price effects for only a few years may be sufficient to block a merger.

Are the Assumptions Plausible in this Context? We have chosen the beer example because it is a well-known setting with demand and cost parameters that have been used to think about the effects of mergers and cost efficiencies with alternative behavioral assumptions. On one level, we are similarly agnostic in this paper about whether merging brewers posess private information about their synergies. However, Sweeting, Tao and Yao (2022) show that after the MCJV, the JV's pricing was consistent with a significant *reduction* in the per-mile efficiency of its distribution network, even though it benefitted from shorter trucking distances to some markets.[17] While distances travelled are likely to be readily observed, per-mile efficiency, which would depend, for example, on how full trucks tend to be, is likely to be much more opaque, and the JV's pricing could therefore potentially be consistent with worst-possible efficiency outcome. One would need to use detailed cost data to determine whether the JV's efficiency actually decreased, or whether this pricing behavior reflects the type of strategic incentive identified in this paper.

4 Extensions

Many extensions to our model are possible. We briefly describe three that we detail in Appendices C.2-C.4, before presenting a vertical merger example.

A natural extension allows synergies to lie anywhere on an interval. Assuming merging products are symmetric, it is straightforward to show that if a pooling equilibrium exists in

[16] For example, the κ^*s for a Coors/Miller merger are 0.88 and 0.83 in these alternative cases, compared to 0.9 in the baseline.

[17] We also note that there is evidence, although of lower statistical significance, of a decrease in the per-mile efficiency of AB's distribution network. This is consistent with the simultaneous signaling model presented in Sweeting, Tao and Yao (2022). Notably, there is no change in pass-through for higher priced imported products.

a two-type game with high and low synergies, it will also exist, with pooling on the lowest possible synergy prices, when the synergy can lie anywhere in between. This follows from how the merged firm's incentive to deviate increases as its marginal cost falls. Numerical simulations show that pooling equilibria would exist in our beer mergers, where products are asymmetric, if we assume possible synergies are proportional to the CI-CMCRs.

A second extension allows for several discrete values of synergy, some of which are too large to support pooling on the smallest possible synergy prices. We provide an example of a partial pooling equilibrium outcome where firms with small and moderate synergies pool on the CISNE prices associated with the lowest possible synergy, and firms with large synergies pool together but on lower prices.

An alternative extension considers a game where the possible synergy is a reduction in the fixed cost of introducing a welfare-increasing product improvement, rather than a marginal cost reduction. In a CI environment, the firm will implement the improvement when it benefits from the synergy, even though, relative to the case where it is not implemented, the merged firm's profits are reduced because of how implementation affects rivals' prices. If the realization of the synergy is private information, there is pooling on no improvement being introduced, so that the merger lowers consumer surplus.

The Elimination of Double Marginalization (EDM). Since Spengler (1950), EDM has been viewed as a procompetitive incentive that may lead a vertically integrated firm to lower prices. While economists view the logic of EDM as broadly applicable (Shapiro and Hovenkamp (2021)), antitrust progressives have argued that, in practice, consumers may not benefit from EDM.

We present an example to illustrate how the likely reaction of downstream rivals may lead to EDM not being passed through when the magnitude of EDM is uncertain. For the sake of simplicity, vertical integration in our example can have no foreclosure effects.

Consider retail duopolists (D1 and D2) that simultaneously set prices. Di's inverse demand is $p_i = 30 - 2q_i + 1.5q_j$ and its marginal cost is the price (w_i) at which it buys units of input. Technology differences lead the Ds to buy from separate suppliers. Retail prices are chosen after wholesale prices are chosen and observed.

Before the merger, suppose that $w_1 = w_2 = 7.5$, and, initially assume that w_2 is known to be set competitively, whereas D1 is supplied by a monopolist U1. w_1 is the outcome of a bilateral generalized Nash bargain where, from the perspective of D2, U1's bargaining power is either $\tau_1 = 0$ (D1 makes it a take-it-or-leave-it offer), in which case U1's marginal cost is 7.5, or $\tau_1 = 0.5$, with U1 cost of 5.884, with the latter having probability q.[18] The possibility that rival firms may be uncertain about bargaining power is consistent with the heterogeneous estimates of bargaining power parameters in the empirical literature (e.g., Crawford and Yurukoglu (2012), Grennan (2013) and Grennan (2014)).

Now consider a vertical merger of U1 and D1. D1 will have access to the input at U1's marginal cost, and the transfer price will no longer be observed by D2. If pre-merger $\tau_1 = 0$, then there is no EDM. The black and magenta solid lines in Figure 3 show the downstream best response pricing functions, which are identical before and after the merger in this case, and they intersect at $p_1 = p_2 = 12$ (A).

Alternatively, if $\tau_1 = 0.5$, then there is EDM, and, under CI, D1's best response function would be the solid red line, with an equilibrium at B, with lower prices for both products.

The isoprofit curves show that U1D1 profits with a marginal cost of 5.884 are lower at B than at A. Suppose the merged D1 and D2 play the type of repeated downstream pricing game considered in Section 2. A pooling MPBE, where firms price as if there is no EDM for both values of τ will exist if $\delta_{U1D1} \geq 0.47$.

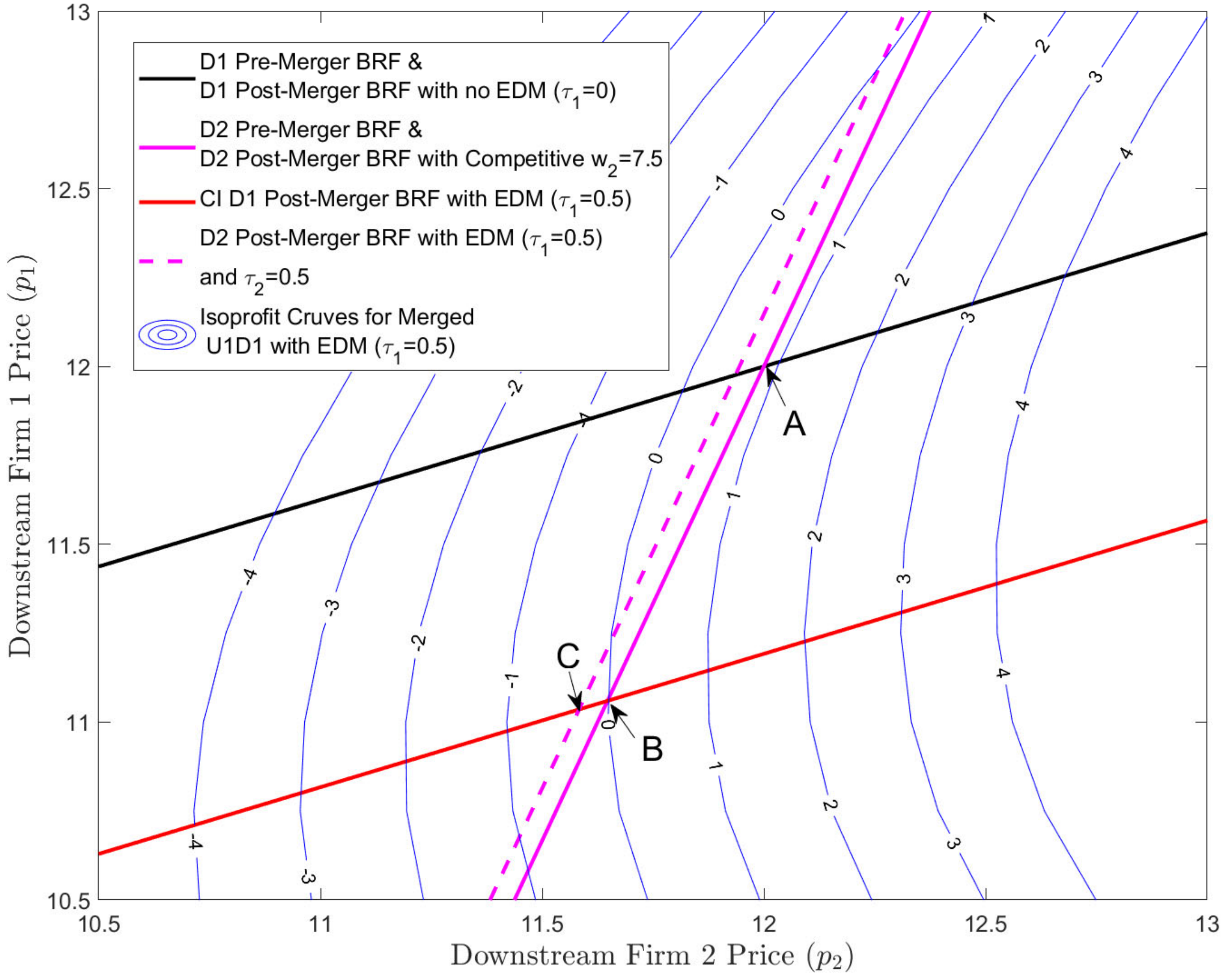
We can also relax the assumption that w_2 is set competitively. Suppose that, instead, it is known that a monopolist U2 and D2 engage in bargaining over w_2 each period before retail prices are set, with $\tau_2 = 0.5$. In this case, under CI about τ_1, D2's post-merger reaction function would be the dashed magenta line as the U1D1 merger would cause w_2 to fall. In this case, U1D1's incentive to maintain pricing at A will be stronger, as, if its benefit from EDM becomes known, equilibrium play would be at C. In this case, a pooling MPBE will exist if $\delta_{U1D1} \geq 0.40$.

[18]We assume firms recognize that wholesale prices affect downstream prices when bargaining. With generalized Nash bargaining, w_1 before a merger is determined by

$$\arg\max_{w_1} \left[(w_1 - c_1) q_1(p_1(w_1), p_2(w_1))\right]^{\tau_1} \left[(p_1 - w_1) q_1(p_1(w_1), p_2(w_1))\right]^{1-\tau_1}$$

as, in the event of no agreement, both U1 and D1 make zero profits.

Figure 3: Vertical Merger. Isoprofit curves for a merged U1-D1 with marginal cost of 5.884, with values showing differences in per-periods from profits at B.



5 Conclusion

We have explored games where rivals' uncertainty about the level of a horizontal or vertical merger efficiency provides a merged firm that realizes a large synergy with an incentive to act as if a smaller one has been realized. Rival firms benefit from this type of behavior, while customers are harmed. While the existence of this type of incentive is not surprising given the strategic complementarity of prices, agencies and academic analysis ignore how this incentive could combine with uncertainties about synergies to affect post-merger pricing, even though many agency practices are consistent with synergies being uncertain and unknown to rivals. We show that the incentive could lead to large synergies, which might be expected to offset anticompetitive effects from large mergers in concentrated industries, not being passed through to customers at all.

Of course, the assumptions that we make play a non-trivial role in our conclusions. For example, in a quantity-setting game, the merged firm would have an incentive to try to signal that it benefits from a large synergy as its rivals will tend to respond to an output expansion by reducing their outputs. This will lead to a situation where rivals will have incentives to prefer to not believe the signal that is being sent, and to test out the merged firm's determination to expand output. In contrast, in the price-setting game, rivals and the merged firm both benefit when a large synergy is not passed through.

Our model also highlights a need for empirical retrospectives that integrate analysis of price changes and productivity changes after mergers. If these analyses suggest that some types of synergy are passed through and others are not, then it will be natural to test whether observability or predictability explains these differences.

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Appendices for "Should We Expect Uncertain Merger Synergies To Be Passed Through to Consumers?"

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A Proof of Proposition 2

Proposition 2 states that (i) a Pooling MPBE (Definition 1) will exist when the differences in two possible synergies are small enough for some $\delta_M < 1$, for multinomial logit (MNL) and CES demand, assuming that there is an outside good, and that (ii) the pooling MPBE will lower expected consumer surplus relative to complete information static Nash equilibrium (CISNE) pricing. We provide a formal proof of these results here.

Notation. Consider a lower bound vector of marginal cost $\underline{\mathbf{c}}$ and *any* alternative cost vector $\mathbf{c}'$ where every element of $\mathbf{c}'$ is strictly more than the corresponding element of $\underline{\mathbf{c}}$. Define $\mathbf{c}(\lambda) = (1-\lambda)\underline{\mathbf{c}} + \lambda \mathbf{c}'$ where λ is a scalar between 0 and 1. $\pi_M(\underline{\mathbf{c}}, \mathbf{p}^\dagger_M(\lambda), \mathbf{p}^\dagger_{-M}(\lambda))$ are M's profits when it has marginal cost vector $\underline{\mathbf{c}}$, and both M and its rivals ($-M$) set prices that would be complete information static Nash equilibrium (CISNE) prices if M's costs were $\mathbf{c}' = (1-\lambda)\underline{\mathbf{c}} + \lambda \mathbf{c}'$.

We begin with a useful lemma.

Lemma A.1 *For multinomial logit or CES demand,* $\pi_M(\underline{\mathbf{c}}, \mathbf{p}^\dagger_M(\lambda), \mathbf{p}^\dagger_{-M}(\lambda)) > \pi_M(\underline{\mathbf{c}}, \mathbf{p}^\dagger_M(0), \mathbf{p}^\dagger_{-M}(0))$ *for* $\lambda > 0$ *small enough.*

Proof. Nocke and Schutz (2018) (NS-2018) show that there will be a unique CISNE equilibrium for MNL and CES demand, and that CISNE prices, markups and quantities, and therefore profits, are continuous in M's marginal costs. This implies that if $\left.\frac{d\pi_M(\underline{\mathbf{c}}, \mathbf{p}^\dagger_M(\lambda), \mathbf{p}^\dagger_{-M}(\lambda))}{d\lambda}\right|_{\lambda=0} > 0$, then the proposition in the lemma will hold.

We therefore calculate the derivative of $\pi_M(\underline{\mathbf{c}}, \mathbf{p}^\dagger_M(\lambda), \mathbf{p}^\dagger_{-M}(\lambda))$ with respect to λ.

$$\frac{d\pi_M(\underline{\mathbf{c}}, \mathbf{p}_M^\dagger(\lambda), \mathbf{p}_{-M}^\dagger(\lambda))}{d\lambda} = \sum_{i \in M} \frac{\partial \pi_M}{\partial p_i} \frac{\partial p_i^\dagger(\lambda)}{\partial \lambda} + \sum_{j \in -M} \frac{\partial \pi_M}{\partial p_j} \frac{\partial p_j^\dagger(\lambda)}{\partial \lambda}.$$

For $\lambda = 0$, $\frac{\partial \pi_M(\underline{\mathbf{c}}, \mathbf{p}_M^\dagger(\lambda), \mathbf{p}_{-M}^\dagger(\lambda))}{\partial p_i} = 0$ as $\mathbf{p}_M^\dagger(0)$ are M's profit-maximizing best response prices when its marginal costs are $\underline{\mathbf{c}}$, and other firms charge $\mathbf{p}_{-M}^\dagger(0)$. Therefore,

$$\begin{aligned} \left.\frac{d\pi_M(\underline{\mathbf{c}}, \mathbf{p}_M^\dagger(\lambda), \mathbf{p}_{-M}^\dagger(\lambda))}{d\lambda}\right|_{\lambda=0} &= \sum_{j \in -M} \left.\frac{\partial \pi_M(\underline{\mathbf{c}}, \mathbf{p}_M^\dagger(\lambda), \mathbf{p}_{-M}^\dagger(\lambda))}{\partial p_j} \frac{\partial p_j^\dagger(\lambda)}{\partial \lambda}\right|_{\lambda=0} \\ &= \sum_{j \in -M} \sum_{i \in M} (\mathbf{p}_i^\dagger(0) - c_i) \frac{\partial Q_i(\mathbf{p}_M^\dagger(0), \mathbf{p}_{-M}^\dagger(0))}{\partial p_j} \left.\frac{\partial p_j^\dagger(\lambda)}{\partial \lambda}\right|_{\lambda=0} > 0, \end{aligned}$$

as required, where the inequality follows from (i) $\frac{\partial p_j^\dagger(0)}{\partial \lambda} > 0$ (NS-2018 Proposition 6, recognizing that an increase in j's markup implies an increase in j's price when j's cost is constant), (ii) $\frac{\partial Q_i(p_M^\dagger(0), \mathbf{p}_{-M}^\dagger(0))}{\partial p_j} > 0$ (products are gross substitutes given assumed demand) and (iii) $\mathbf{p}_i^\dagger(0) - c_i > 0$ (all Nash equilibrium margins are strictly positive with CISNE pricing). ■

Existence for multinomial logit and CES demand. From Proposition 1, a pooling equilibrium will exist if and only if

$$\delta_M \geq \frac{\pi_M(\underline{\mathbf{c}}, \mathbf{p}_M^{BR}(\underline{\mathbf{c}}, \mathbf{p}_{-M}^\dagger(\overline{\mathbf{c}})), \mathbf{p}_{-M}^\dagger(\overline{\mathbf{c}})) - \pi_M(\underline{\mathbf{c}}, \mathbf{p}_M^\dagger(\overline{\mathbf{c}}), \mathbf{p}_{-M}^\dagger(\overline{\mathbf{c}}))}{\pi_M(\underline{\mathbf{c}}, \mathbf{p}_M^{BR}(\underline{\mathbf{c}}, \mathbf{p}_{-M}^\dagger(\overline{\mathbf{c}})), \mathbf{p}_{-M}^\dagger(\overline{\mathbf{c}})) - \pi_M(\underline{\mathbf{c}}, \mathbf{p}_M^\dagger(\underline{\mathbf{c}}), \mathbf{p}_{-M}^\dagger(\underline{\mathbf{c}}))}, \tag{2}$$

where $\overline{\mathbf{c}}$ is an alternative set of marginal costs where every element is strictly more than the corresponding element of $\underline{\mathbf{c}}$.

A necessary and sufficient condition for the proposition to hold is that

$$\pi_M(\underline{\mathbf{c}}, \mathbf{p}_M^{BR}(\underline{\mathbf{c}}, \mathbf{p}_{-M}^\dagger(\overline{\mathbf{c}})), \mathbf{p}_{-M}^\dagger(\overline{\mathbf{c}})) > \pi_M(\underline{\mathbf{c}}, \mathbf{p}_M^\dagger(\overline{\mathbf{c}}), \mathbf{p}_{-M}^\dagger(\overline{\mathbf{c}})) > \pi_M(\underline{\mathbf{c}}, \mathbf{p}_M^\dagger(\underline{\mathbf{c}}), \mathbf{p}_{-M}^\dagger(\underline{\mathbf{c}})).$$

The first strict inequality holds because (i) $\mathbf{p}_M^{BR}(\underline{\mathbf{c}}, \mathbf{p}_{-M}^\dagger(\overline{\mathbf{c}}))$ are, by definition, M's static profit-maximizing prices, (ii) $\mathbf{p}_M^\dagger(\overline{\mathbf{c}})$ is not equal to $\mathbf{p}_M^{BR}(\underline{\mathbf{c}}, \mathbf{p}_{-M}^\dagger(\overline{\mathbf{c}}))$ when $\underline{\mathbf{c}} \neq \overline{\mathbf{c}}$, and (iii)

M's static best response prices are unique given the assumed form of demand (this follows from NS-2008, Proposition 1).

Lemma A.1 implies that when the differences $\overline{\mathbf{c}} - \underline{\mathbf{c}}$ are small enough, the second inequality will also hold.

Proof that expected consumer surplus is lower in the pooling MPBE than with CISNE pricing. Denote consumer surplus (CS) with CISNE prices $(\mathbf{p}^{\dagger}_{M}(\mathbf{c})), \mathbf{p}^{\dagger}_{-M}(\mathbf{c}))$ as $CS(\mathbf{c})$. By Proposition 6 of NS-2018, $CS(\underline{\mathbf{c}}) > CS(\overline{\mathbf{c}})$, i.e., CS at low synergy CISNE prices is lower than at high synergy CISNE prices. Expected consumer surplus in a pooling MPBE is therefore $CS(\overline{\mathbf{c}}) < (1-q)CS(\overline{\mathbf{c}}) + qCS(\underline{\mathbf{c}})$, where the probability of a high synergy is q and $0 < q < 1$, and $(1-q)CS(\overline{\mathbf{c}}) + qCS(\underline{\mathbf{c}})$ is the expected CS at CISNE pricing.

B Numerical Simulations of Brewer Mergers

This Appendix details our numerical simulations of hypothetical horizontal mergers in the U.S. beer industry.

Our analyses of hypothetical horizontal mergers are based on the data, sample selection and analysis of Miller and Weinberg (2017) (MW). We briefly describe MW's data, before detailing our analysis.

Data. MW's data is taken from the IRI Academic Database (Bronnenberg, Kruger and Mela (2008)). This database contains revenues and unit sales at the UPC-week-store level for a sample of grocery stores between 2001 and 2011. We select and aggregate data in exactly the same way as MW to get observations at the brand-size-region-quarter level for 39 brand-size combinations (referred to as "products", e.g., "Bud Light 12 pack"). Considered pack sizes are 6 packs, 12 packs and an aggregation of 24 and 30 packs. There are 13 included brands produced by the following five brewers: Anheuser-Busch, SABMiller, Coors, Grupo Modelo and Heineken. MW use a sample of stores from 39 markets, where MW exclude IRI-sample markets where grocery stores sell only limited quantities or ranges of beer. Prices, defined as product revenues divided by units sold, are deflated, using the CPI-U series, to be in January 2010 dollars. MW define market size by inflating the highest volume sales that are observed in the geographic market, and purchases of brands that are not in MW's sample are included in the outside good. As noted in the text, the percentage of off-premise national sales included in MW's sample is small, partly because convenience stores and alcohol stores are not included.

For some of our analysis, we focus on a single "representative" geographic market. We identify this market as the market where, in Q3 2007, brewer (volume) market shares are closest to their national averages. For the 39 products in the data, we aggregate volume market shares to the firm-market level. We then calculate the difference between the firm shares and their national averages using the sum of squared differences in shares or the sum of absolute differences in shares. For Q3 2007 we identify the same market as representative using both of these measures, whether or not we include the outside good. However, in some other quarters these measures would identify different markets.

Demand. Our analysis uses the same demand specifications as MW. Our hypothetical merger simulations uses MW's quarterly "RCNL-2" specification (column (iii) of MW's Table IV). This model allows for a nesting parameter over the included brands, and preferences over the included brands, price and calorie content that vary with household income, as well as brand-size and quarter fixed effects.

Hypothetical Merger Simulations. We find the largest range of possible synergies, symmetric around the complete information compensating marginal cost reductions (CI-CMCRs) that can support a pooling MPBE as an equilibrium, assuming a discount factor of $\delta_M = 0.9^{\frac{1}{4}}$, consistent with an annual discount factor of 0.9 and quarterly price-setting.

We proceed using the following steps:

1. Given MW's demand system estimates, and observed Q3 2007 prices and market shares, we calculate implied unobserved product qualities and the marginal costs of each product using the first-order conditions implied by CISNE pre-merger pricing. This is done for each market separately. For example,

$$\mathbf{c}^{\hat{\mathrm{PRE}}} = \mathbf{p} + (\Omega(\mathbf{p}))^{-1}\,\mathbf{s}$$

where $\mathbf{c}$, $\mathbf{p}$ and $\mathbf{s}$ are the marginal cost and observed price and market share vectors, and Ω is the dot product of an indicator ownership matrix (element $\{i,j\}$=1 if and only if products i and j have the same owner) and the matrix of demand derivatives (element $\{i,j\} = \frac{\partial s_i}{\partial p_j}$).

2. For a given merger, calculate the CI-CMCRs for each product,

$$\textbf{CI-CMCR} = \left((\Omega(\mathbf{p}))^{-1} - (\Omega'(\mathbf{p}))^{-1} \right) \mathbf{s}.$$

   These are the marginal cost reductions that would keep CISNE prices at exactly their observed levels after a merger that transforms the ownership matrix from Ω to Ω'. The CI-CMCR elements for all of the non-merging products will be zero and the elements for the merging products will be positive. Denote the subvector of the pre-merger marginal cost vector for the merging firms' products as $\mathbf{c}_M^{\hat{\text{PRE}}}$ and the subvector of CI-CMCRs as $\textbf{CI-CMCR}_M$.

3. Find the largest scalar κ, which we will denote κ^*, on a 0.01 step grid between 0.01 and 1 that will support a pooling MPBE, when we define the merged firm's possible marginal costs as $\overline{\mathbf{c}} = \mathbf{c}_M^{\hat{\text{PRE}}} - (1-\kappa)\textbf{CI-CMCR}_M$ and $\underline{\mathbf{c}} = \mathbf{c}_M^{\hat{\text{PRE}}} - (1+\kappa)\textbf{CI-CMCR}_M$. If $\kappa = 1$ then marginal costs are either equal to pre-merger marginal costs, or they are equal to pre-merger marginal costs less *twice* the CI-CMCRs. The test for whether a pooling MPBE can be supported for given κ proceeds in the following four steps.

   (a) compute CISNE prices (by solving the standard first-order conditions) when the merged firm's costs are either $\underline{\mathbf{c}}$ or $\overline{\mathbf{c}}$, and other firms' products have the marginal costs calculated in step 1. Denote these prices $\mathbf{p}(\underline{\mathbf{c}})$ and $\mathbf{p}(\overline{\mathbf{c}})$.

   (b) calculate the profits of the merged firm with high synergy marginal costs ($\underline{\mathbf{c}}$) at both sets of CISNE prices. Denote these profits, $\pi_M(\underline{\mathbf{c}}, \mathbf{p}_M^\dagger(\underline{\mathbf{c}}), \mathbf{p}_{-M}^\dagger(\underline{\mathbf{c}}))$ and $\pi_M(\underline{\mathbf{c}}, \mathbf{p}_M^\dagger(\overline{\mathbf{c}}), \mathbf{p}_{-M}^\dagger(\overline{\mathbf{c}}))$.

   (c) compute the static profit-maximizing best response prices and profits of the merged firm with marginal costs $\underline{\mathbf{c}_M}$ when non-merging firms are setting prices $\mathbf{p}_{-M}^\dagger(\overline{\mathbf{c}})$. Denote these prices $\mathbf{p}_M^{BR}(\underline{\mathbf{c}}, \mathbf{p}_{-M}^\dagger(\overline{\mathbf{c}}))$ and the profits $\pi_M(\underline{\mathbf{c}}, \mathbf{p}_M^{BR}(\underline{\mathbf{c}}, \mathbf{p}_{-M}^\dagger(\overline{\mathbf{c}}))$.

(d) calculate the critical discount factor ($\delta_M(\kappa)$) that would support a pooling MPBE given the calculated profits.

$$\delta_M(\kappa) = \frac{\pi_M(\underline{\mathbf{c}}, \mathbf{p}^{BR}_M(\underline{\mathbf{c}}, \mathbf{p}^{\dagger}_{-M}(\overline{\mathbf{c}})), \mathbf{p}^{\dagger}_{-M}(\overline{\mathbf{c}})) - \pi_M(\underline{\mathbf{c}}, \mathbf{p}^{\dagger}_M(\overline{\mathbf{c}}), \mathbf{p}^{\dagger}_{-M}(\overline{\mathbf{c}}))}{\pi_M(\underline{\mathbf{c}}, \mathbf{p}^{BR}_M(\underline{\mathbf{c}}, \mathbf{p}^{\dagger}_{-M}(\overline{\mathbf{c}})), \mathbf{p}^{\dagger}_{-M}(\overline{\mathbf{c}})) - \pi_M(\underline{\mathbf{c}}, \mathbf{p}^{\dagger}_M(\underline{\mathbf{c}}), \mathbf{p}^{\dagger}_{-M}(\underline{\mathbf{c}}))}. \tag{3}$$

If $\delta_M(\kappa)$ is less than the assumed $\delta_M = 0.9^{\frac{1}{4}}$ then a pooling equilibrium can be supported.

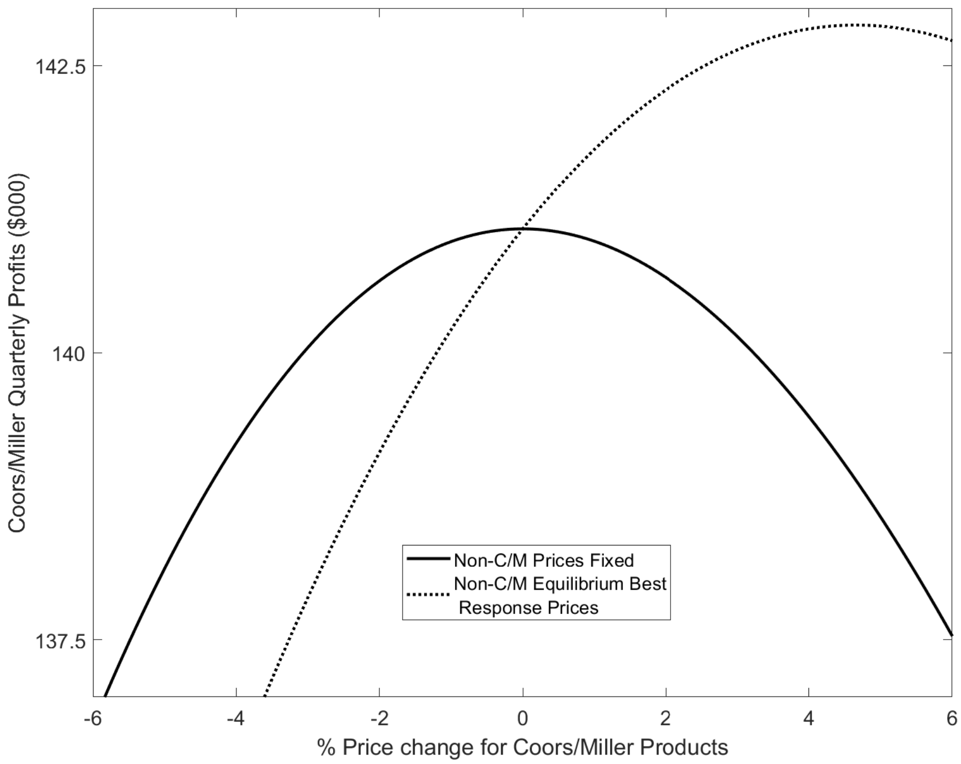
We follow the same steps to find the largest κ that can support pooling for alternative discount factors. When we vary the assumed ownership structure of non-merging rival products, we follow the same procedure but only consider whether pooling can be supported for κ values of 0.001 and 1.

Having identified the highest value that supports pooling (κ^*) for a given market-merger, we calculate the profits of all firms at the low and high synergy CISNE prices, and we calculate the change in consumer surplus using the standard compensating variation formula for a random coefficients demand model.

Pooling Equilibrium When Synergies Lie on an Interval. For the representative market, we also examine whether we could sustain a pooling equilibrium on the smallest possible synergy CISNE prices when the merged firm's realized synergy can have any value on an interval. Specifically, we consider the case where marginal costs can take on value between $\mathbf{c}_M^{\hat{\text{PRE}}} - (1+\kappa^*)\mathbf{CI\text{-}CMCR}_M$ and $\mathbf{c}_M^{\hat{\text{PRE}}} - (1-\kappa^*)\mathbf{CI\text{-}CMCR}_M$, where κ^* is the value identified in the two-type exercise described above. By doing so, we are assuming that a change in the realized synergy moves the marginal costs of every product owned by the merging firms in the same way relative to the CI-CMCR marginal costs.

Taking 0.01 steps of κ, we find the merged firm's profits at $\mathbf{p}^{\dagger}(\mathbf{c}_M^{\hat{\text{PRE}}} - (1-\kappa^*)\mathbf{CI\text{-}CMCR}_M)$, as well as the one-period best response price and profit of the merged firm if it was to deviate from the low synergy CISNE (pooling) prices and when it best responds to non-merging firms setting $\mathbf{p}^{\dagger}_{-M}(\mathbf{c}_M^{\hat{\text{PRE}}} - (1+\kappa^*)\mathbf{CI\text{-}CMCR}_M)$ prices. We use these profits to test whether the merged firm would want to deviate from the pooling equilibrium, under the assumption that, as in Appendix C.2, non-merging firms believe that the merged firm has the lowest possi-

Figure B.1: Profits of Coors/Miller In the Representative Market When All of Its Prices Change By the Same Percentage and It Benefits from the CI-CMCR Synergies.



ble marginal costs after a deviation, even if, after the off-the-equilibrium path deviation, the merged firm sets prices that are inconsistent with this assumption. For all ten mergers and all of the gridpoints that we consider, we find that the critical discount factor for merged firms with marginal costs between $\mathbf{c}_M^{\hat{\mathrm{PRE}}} - (1+\kappa^*)\mathbf{CI\text{-}CMCR}_M$ and $\mathbf{c}_M^{\hat{\mathrm{PRE}}} - (1-\kappa^*)\mathbf{CI\text{-}CMCR}_M$ are less than our assumed $0.9^{\frac{1}{4}}$, implying that pooling can be sustained.

Profit Effects for a Coors/Miller Merger in the Representative Market In our game, the merged firm's private information about the realized synergy allows it to choose between two locations on its rivals' equilibrium best response pricing functions. To illustrate the difference in profits, we plot two profit functions for a merged Coors/Miller in the representative market in Figure B.1, assuming that the merged firm benefits from the CI-CMCR synergy. The black solid line shows the merged firm's per-period variable profits, assuming a CI-CMCR synergy, when we increase or decrease all of its pre-merger prices by the same percentage, holding the prices of non-merging products fixed. As pre-merger prices are post-merger CISNE prices given the assumed synergy, the black line peaks when there is no price change. The dotted line shows the merged firm's profits when non-merging firms prices are equilibrium best responses to the prices that the merged firm sets. In this case, a significant price increase for the merged firm becomes profitable. The 4.7% price increase that maximizes this measure of per-period profits is larger than the 3.1% price increase associated with the calculated $\kappa^* = 0.9$ for this merger (see Table 1), because, as rivals' prices rise, the incentive of the high synergy merged firm to deviate from the proposed equilibrium also increases.

The Slope of Rivals' Equilibrium Best Response Function. As part of our analysis, we also calculate the "slope of the equilibrium reaction function of the non-merging firms". To parallel our discussion in Section 2 this is defined by the change in the implied inclusive values of the non-merging firms when they best respond to each other in response to a change in the merging firm's prices. These inclusive values can be interpreted as the competitiveness of the product and price offerings by all of the non-merging firms. While the slope of the equilibrium reaction function is defined unambiguously in the context of the Section 2 example where we have multinomial logit demand and merging firms' products are symmetric, this is not true in the empirical example where the merging firms' products are asymmetric and different consumers value prices and other product characteristics differently. We detail the calculation that we perform here.

1. at the observed (Q3 2007) prices and market shares, we compute $I = \log\left(1 + \sum_{j \in -M} \exp(\delta_j(\mathbf{p}_{-M}))\right)$ for the "average" consumers in the market, i.e., the δs are equal to those found using the "BLP" (Berry, Levinsohn and Pakes (1995)) contraction mapping evaluated for the mean income of consumers in the market.

2. compute equilibrium prices ($\mathbf{p}'_{-M}$) among the non-merging firms when all of the prices of merging products increase by 1%.

3. use these prices to compute $I' = \log\left(1 + \sum_{j \in -M} \exp(\delta_j(\mathbf{p}'_{-M}))\right)$

4. compute the slope as $\frac{I'-I}{0.01}$. The slope therefore has the interpretation of the percentage change in $1 + \sum_{j \in -M} \log(\delta_j)$ given a small percentage change in merging firm prices (i.e., an elasticity).

Note that, because price increases reduce the expected utility provided by rival products, the sign of the slope will be negative.

Once we have computed this slope for each of the 390 market-mergers in the sample, we regress the computed value of κ^* (described above) for the two-type model on the slope and either a constant, market fixed effects (for the 39 markets) or market and merger fixed effects (recall there are 10 potential firm mergers). For the ten market-mergers where pooling cannot be supported even when $\kappa = 0.01$, we use $\kappa^* = 0$ as the dependent variable. We expect that the fixed effects may explain a significant proportion of the variation in κ^* because they will capture how the profitability of the merged firm depends on the equilibrium mean utilities of rivals.

Table B.1: Regressions of Computed κ^* for Simulated Beer Mergers on the Slope of the Equilibrium Reaction Function of Rivals

	(1)	(2)	(3)
Slope of Equilibrium RF of Rivals	-6.241	-6.787	-4.288
	(0.404)	(0.369)	(0.623)
Market Fixed Effects	No	Yes	Yes
Merger Fixed Effects	No	No	Yes
Observations	390	390	390
R^2	0.481	0.523	0.810

Notes: An observation is a simulated market-merger. Robust standard errors in parentheses.

In each of the specifications, the estimated slope coefficient implies that when the competitiveness of rivals' offerings are more sensitive to the prices set by the merging firm, it is possible to support pooling for a wider range of possible synergies. This is consistent with the logic of the Section 2 example, and implies that even though the size of the CI-CMCRs are almost exactly determined by the market shares and markups of the merging parties (as Nocke and Whinston (forthcoming) conclude for the same set of hypothetical mergers using

MW's demand system), rivals' market power can have non-trivial effects on whether realized synergies are passed through to customers when synergies are uncertain.

C Examples and Extensions

C.1 Linear Demand Example

Assuming linear demand and symmetric merging products, we show that a post-merger pooling MPBE, that lowers consumer surplus relative to CISNE pricing, will exist in the two-type synergy model, deriving an explicit expression for the largest difference in marginal costs for which pooling can be supported.

C.1.1 Specification

Before the merger, there are $3 \leq F < \infty$ single-product firms. The marginal cost of product i is c_i. The inverse demand of each product i is

$$p_i = a_i - bq_i - \sigma \sum_{j \neq i} q_j = a_i - (b - \sigma)q_i - n\sigma\bar{q}, \tag{4}$$

where $b > \sigma > 0$. $\bar{q} = \frac{1}{F}\sum_j q_j$ is the average firm-level sales quantity (including firm i). The implied direct demand is

$$q_i = \frac{1}{b - \sigma}\left[\frac{b + (F-2)\sigma}{b + (F-1)\sigma}(a_i - p_i) - \frac{\sigma}{b + (F-1)\sigma}\sum_{j \neq i}(a_j - p_j)\right] \tag{5}$$

$$= \frac{1}{b - \sigma}\left[a_i - p_i - \frac{F\sigma}{b + (F-1)\sigma}\overline{a - p}\right], \tag{6}$$

where $\overline{a - p} = \frac{1}{F}\sum_j (a_j - p_j)$.

Consider an exogenous merger where two symmetric firms, labeled 1 and 2 (i.e., $a_1 = a_2 = a_M$, $c_1 = c_2 = c_M$). The firms merge to form a single firm, M. M continues to sell both products. Symmetry simplifies the algebra, although it is straightforward to derive similar formula when the merging products have different inverse demand intercepts. The merger synergy is such that $c_M = \underline{c}$ (a scalar) with probability q or $c_M = \bar{c}$, where $\bar{c} > \underline{c}$.

We assume that, for either level of synergy, the parameters are such that all products are produced at CISNE prices, implying that CISNEs are unique (Cumbul and Virág (2018)).

As in Section 2, we assume that firms play an infinite horizon pricing game with no changes to demand or costs, and no subsequent mergers. M's discount factor is δ_M. The pooling equilibrium involves firms setting prices equal to the unique CISNE prices with $c_M = \overline{c}$ irrespective of the realized value of c_M.

C.1.2 Existence Result

Proposition C.1 *A Pooling MPBE exists for some $\delta_M < 1$ if and only if $\overline{c} < \underline{c} + \Delta$, where*

$$\Delta = \frac{4B(F-2)\sigma^2}{B^2 - (F-2)^2\sigma^4}(p_M^\dagger(\underline{c}) - \underline{c})$$

where $B = 2b^2 + F^2\sigma^2 + 5\sigma^2 + 3Fb\sigma - 7b\sigma - 5F\sigma^2$. $F \geq 3$ and $b > \sigma$ imply that $\Delta > 0$ (i.e., a pooling MPBE will exist for a narrow enough range of possible synergies).

Proof. Proposition 1 implies that a pooling equilibria will exist for some $\delta_M < 1$ if and only if $\pi_M(\underline{c}, p_M^\dagger(\overline{c}), \mathbf{p}_{-M}^\dagger(\overline{c})) > \pi_M(\underline{c}, p_M^\dagger(\underline{c}), \mathbf{p}_{-M}^\dagger(\underline{c}))$. Algebra shows that

$$\pi_M(\underline{c}, p_M^\dagger(\overline{c}), \mathbf{p}_{-M}^\dagger(\overline{c})) = [(a_M + \overline{c}) - 2\underline{c} - 2f(\overline{v_A})]\, q_M(\overline{v_A}, \overline{c})$$
$$\pi_M(\underline{c}, p_M^\dagger(\underline{c}), \mathbf{p}_{-M}^\dagger(\underline{c})) = [(a_M - \underline{c}) - 2f(v_A)]\, q_M(v_A, \underline{c})$$

where $\overline{v_A} = 2(a_M - \overline{c})$ and $v_A = 2(a_M - \underline{c})$,

$$f(x) = \frac{(F-2)\sigma^2}{2B}\left(\frac{1}{2}x + \frac{b + F\sigma - 2\sigma}{F\sigma - 2\sigma}v_B\right)$$

where $v_B = \sum_{j=3,..,F}(a_j - c_j)$, and

$$\begin{aligned} q_M(v_A, c_M) &= \frac{b + (F-3)\sigma}{(b-\sigma)(b+(F-1)\sigma)}(p_M - c_M) \\ &= \frac{b + (F-3)\sigma}{(b-\sigma)(b+(F-1)\sigma)}\left[\frac{1}{2}(a_M - c_M) - \frac{1}{2}\frac{(F-2)\sigma^2}{B}\left(\frac{1}{2}(a_M - c_M) + \frac{b + F\sigma - 2\sigma}{F\sigma - 2\sigma}v_B\right)\right] \end{aligned}$$

The difference $\pi_M(\underline{c}, p_M^\dagger(\overline{c}), \mathbf{p}_{-M}^\dagger(\overline{c})) - \pi_M(\underline{c}, p_M^\dagger(\underline{c}), \mathbf{p}_{-M}^\dagger(\underline{c}))$ is then

$$\left\{ \begin{array}{c} \left[(a_M - \overline{c}) - \frac{(F-2)\sigma^2}{B}\left(\frac{1}{2}\overline{v}_A + \frac{b+(F-2)\sigma}{(F-2)\sigma} v_B\right)\right] \times ... \\ \left[\frac{1}{2}(a_M - \overline{c}) + \overline{c} - \underline{c} - \frac{(F-2)\sigma^2}{2B}\left(\frac{1}{2}\overline{v}_A + \frac{b+(F-2)\sigma}{(F-2)\sigma} v_B\right)\right] \end{array} \right\}$$
$$- 2(p_M^\dagger(\underline{c}) - \underline{c})^2$$

Writing $\Delta' = \overline{c} - \underline{c} > 0$, the profit difference simplifies to

$$\left(\frac{(F-2)\sigma^2}{B}\Delta'\right)^2 - \frac{1}{2}(\Delta')^2 + \frac{2(F-2)\sigma^2}{B}\Delta'(p_M^\dagger(\underline{c}) - \underline{c}).$$

Finding the Δ' for which this difference is equal to zero (Δ) gives

$$\Delta = \frac{4B(F-2)\sigma^2}{(B + (F-2)\sigma^2)(B - (F-2)\sigma^2)}(p_M^\dagger(\underline{c}) - \underline{c}).$$

It remains to check that this expression is strictly positive.

$$\begin{aligned} B - (F-2)\sigma^2 &= 2b^2 + F^2\sigma^2 + 5\sigma^2 + 3Fb\sigma - 7b\sigma - 5F\sigma^2 - (F-2)\sigma^2 \\ &= 2b^2 + (3F-7)b\sigma - 2\sigma^2 + (F-3)^2\sigma^2, \end{aligned}$$

which is positive if $b > \sigma > 0$ and $F \geq 3$, which also implies that $B > 0$, and $4B(F-2)\sigma^2$ and $(B + (F-2)\sigma^2) > 0$. CISNE behavior implies that $(p_M^\dagger(\underline{c}) - \underline{c}) > 0$. ■

C.1.3 Consumer Surplus

Proposition C.2 *For our linear demand example, expected consumer surplus in a pooling MPBE is lower than if firms set static Nash prices under complete information.*

Proof. A sufficient condition for CS to be lower in the pooling equilibrium is that all prices are higher in the CISNE equilibrium where $c_M = \overline{c}$ than in the equilibrium where $c_M = \underline{c}$.

In our example model, the CISNE price of firm M when it has marginal cost c_M is

$$p_M = c_M + \frac{1}{2}(a_M - c_M) - \frac{1}{2}\frac{(F-2)\sigma^2}{B}\left(\frac{1}{2}v_A + \frac{b + F\sigma - 2\sigma}{F\sigma - 2\sigma}v_B\right), \tag{7}$$

where $v_A = 2(a_M - c_M), v_B = \sum_{j=3,..,F}(a_j - c_j)$. Therefore,

$$\frac{dp_M}{dc_M} = \frac{1}{2} + \frac{1}{2}\frac{(F-2)\sigma^2}{B} > 0$$

where the inequality follows from $\sigma > 0$, $F \geq 3$ and $B > 0$ (see the proof to Proposition C.1).

The non-merging firms' CISNE prices will be on their equilibrium best response function. The markup of a non-merging product i will be

$$p_i - c_i = \frac{b+(F-1)\sigma}{2(b+(F-2)\sigma)+\sigma}(a_i - c_i) - \frac{(b+(F-2)\sigma)\sigma}{(2(b+(F-2)\sigma)+\sigma)(2b+(F-1)\sigma)}v_B - 2\frac{\sigma}{2b+(F-1)\sigma}(a_M - p_M). \tag{8}$$

where $v_B = \sum_{j=3,..,F}(a_j - c_j)$. Therefore,

$$\frac{dp_i}{dp_M} = 2\frac{\sigma}{2b+(F-1)\sigma} > 0$$

so, as $\frac{dp_M}{dc_M} > 0$, $\frac{dp_i}{dc_M} > 0\ \forall i$.

Therefore all CISNE prices are increasing in c_M and pooling reduces expected CS. ■

C.2 Synergies Taking Any Value on An Interval

Our baseline model assumes that a merged firm's costs can take on two possible values, associated with a high or low synergy. Here we consider a model where the realized synergy can take on any value on an interval and we show that if, for given δ_M, a pooling MPBE would exist in the two-type game where costs can take on the values at the extremes of the interval then there will exist a pooling equilibrium in the continuous outcome game where firms will set the CISNE prices associated with the highest marginal costs for all possible realizations of the synergy.

C.2.1 Specification.

Suppose that the merged firm has symmetric products (i.e., symmetric demand and identical marginal costs) and is restricted to set the same price, p_M, for each of its products.[19] The realized marginal cost, c_M, lies on an interval $[\underline{c}, \overline{c}]$, with density $f(c_M)$. The merged firm's discount factor is δ_M. The total demand for the merged firm products is $Q_M(p_M, \mathbf{p}_{-M})$.

Assumption 2 *We assume that:*

1. $Q_M(p_M, \mathbf{p}_{-M})$ *is decreasing in* p_M*,*

2. $p_M^{BR}(c_M, \mathbf{p}_{-M})$ *is increasing in* c_M*.*

Definition C.1 ***Pooling MPBE with Synergies on an Interval.*** *Firm M sets prices* $p_M^\dagger(\overline{c})$ *for its products in the first period and when it has done so in each previous period, and otherwise it sets prices* $p_M^{BR}(c_M, \mathbf{p}_{-M}^\dagger(\underline{c}))$*. All other firms believe that realized* c_M *has pdf* $f(c_M)$ *and set prices* $p_{-M}^\dagger(\overline{c})$ *in the first period and when M has set prices* $p_M^\dagger(\overline{c})$ *in every period, and otherwise believe that* $c_M = \underline{c}$ *with probability 1 and set prices* $p_{-M}^\dagger(\underline{c})$*.*

Note that this definition assumes that, after a deviation, rivals permanently assume that the merging firm has the lowest possible marginal cost even if its initial deviation and/or its subsequent pricing are consistent with a higher cost.

C.2.2 Existence Result.

Proposition C.3 *If, for given* δ_M*, a Pooling MPBE (Definition 1) exists in the two-type game where post-merger marginal costs are* $\underline{c}$ *and* $\overline{c}$ *then a Pooling MPBE (Definition C.1) will exist in a game where the post-merger marginal cost can take on any value on the interval* $[\underline{c}, \overline{c}]$*.*

Proof. Suppose the proposition is not true. Then there exists a c' type, $\overline{c} > c' > \underline{c}$, which has an incentive to deviate in the interval type game, but a type $\underline{c}$ would not want to deviate in the two-type game. We show that this is not possible.

[19] The symmetry assumption ensures that we can consider a one-dimensional interval for the synergy and that, with lower synergies, the CISNE quantities sold of each product will decrease.

First, note that the incentive to deviate of a type $\underline{c}$ in the interval type game is the same as the incentive to deviate of a type $\underline{c}$ in the two-type game, i.e., the lowest cost type would want to deviate unless

$$\begin{aligned} &(p_M^{BR}(\underline{c}, \mathbf{p}_{-M}^{\dagger}(\overline{c})) - \underline{c}) Q_M(p_M^{BR}(\underline{c}, \mathbf{p}_{-M}^{\dagger}(\overline{c})), \mathbf{p}_{-M}^{\dagger}(\overline{c})) + \\ &\frac{\delta}{1-\delta}(p_M^{BR}(\underline{c}, p_{-M}^{\dagger}(\underline{c})) - \underline{c}) Q_M(p_M^{BR}(\underline{c}, p_{-M}^{\dagger}(\underline{c})), p_{-M}^{\dagger}(\underline{c})) - \\ &\qquad \frac{(p_M^{\dagger}(\overline{c}) - \underline{c}) Q_M(p_M^{\dagger}(\overline{c}), \mathbf{p}_{-M}^{\dagger}(\overline{c}))}{1-\delta} \leq 0. \end{aligned}$$

i.e., the net payoff to deviating must be negative.

If the proposition is not true, then there is a type $c' > \underline{c}$ such that

$$\begin{aligned} &(p_M^{BR}(c', \mathbf{p}_{-M}^{\dagger}(\overline{c})) - \underline{c}) Q_M(p_M^{BR}(c', \mathbf{p}_{-M}^{\dagger}(\overline{c})), \mathbf{p}_{-M}^{\dagger}(\overline{c})) + \\ &\frac{\delta}{1-\delta}(p_M^{BR}(c', p_{-M}^{\dagger}(\underline{c})) - \underline{c}) Q_M(p_M^{BR}(c', p_{-M}^{\dagger}(\underline{c})), p_{-M}^{\dagger}(\underline{c})) - \\ &\qquad \frac{(p_M^{\dagger}(\overline{c}) - c') Q_M(p_M^{\dagger}(\overline{c}), \mathbf{p}_{-M}^{\dagger}(\overline{c}))}{1-\delta} > 0. \end{aligned}$$

The assumptions on price setting imply that $p_M^{\dagger}(\overline{c}) > p_M^{BR}(c', \mathbf{p}_{-M}^{\dagger}(\overline{c}))$ and $p_M^{\dagger}(\overline{c}) > p_M^{BR}(c', p_{-M}^{\dagger}(\underline{c}))$, so that a necessary condition for c' to deviate is that

$$\begin{aligned} &Q_M(p_M^{BR}(c', \mathbf{p}_{-M}^{\dagger}(\overline{c})), \mathbf{p}_{-M}^{\dagger}(\overline{c})) + \\ &\frac{\delta}{1-\delta} Q_M(p_M^{BR}(c', p_{-M}^{\dagger}(\underline{c})), p_{-M}^{\dagger}(\underline{c})) - \\ &\qquad \frac{Q_M(p_M^{\dagger}(\overline{c}), \mathbf{p}_{-M}^{\dagger}(\overline{c}))}{1-\delta} > 0, \end{aligned} \tag{9}$$

i.e., deviation increases the discounted total volume of M's sales.

A **lower** bound on the extra incentive that a type $\underline{c}$ has to deviate compared to a type

c' is

$$\begin{aligned}(c'-\underline{c})Q_M(p_M^{BR}(c',\mathbf{p}^{\dagger}_{-M}(\overline{c})),\mathbf{p}^{\dagger}_{-M}(\overline{c}))+\\ \frac{\delta}{1-\delta}(c'-\underline{c})Q_M(p_M^{BR}(c',p^{\dagger}_{-M}(\underline{c})),p^{\dagger}_{-M}(\underline{c}))-\\ \frac{(c'-c')Q_M(p^{\dagger}_M(\overline{c}),\mathbf{p}^{\dagger}_{-M}(\overline{c}))}{1-\delta}\end{aligned}$$

where the bounding follows from the fact that the formula is written assuming that a type $\underline{c}$ would deviate using the same strategies as a type c', whereas it could have a more profitable deviation strategy. This simplifies to

$$= (c'-\underline{c})\times\left(Q_M(p_M^{BR}(c',\mathbf{p}^{\dagger}_{-M}(\overline{c})),\mathbf{p}^{\dagger}_{-M}(\overline{c}))+\frac{\delta}{1-\delta}Q_M(p_M^{BR}(c',p^{\dagger}_{-M}(\underline{c})),p^{\dagger}_{-M}(\underline{c}))-\frac{Q_M(p^{\dagger}_M(\overline{c}),\mathbf{p}^{\dagger}_{-M}(\overline{c}))}{1-\delta}\right).$$

The inequality (9) and $(c'-\underline{c})>0$ imply that this expression is stirctly greater than zero. But, this implies that a type $\underline{c}$ has a strictly greater incentive to deviate than a type c', contradicting the presumption above. ■

C.3 Synergies Can Take Multiple Discrete Levels, Some of Them Too Large to Support Pooling on Lowest Synergy Prices

The two-type examples and the Appendix C.2 example consider pooling equilibria where all cost-types on the interval pool on the same CISNE prices. Existence therefore depends on the type with the largest possible synergy being willing to set the price of a firm that has the lowest possible synergy, which, as we have discussed, requires the range of possible synergies to be "not too large". However, one can also consider equilibria where types with similar synergies pool with each other, but groups of types with quite different levels of synergies pool on different prices.

As an illustration, consider the multinomial logit demand example from Section 2 where pre-merger $N=4$ and $\delta=0.8$. When firms 1 and 2 merge, their post-merger marginal costs (c_M) can be 0, 1, 2, 3 and 4 (no synergy), with each probability $q(c_M)>0$. If possible marginal cost values were 0 and 4 then a pooling equilibrium could not be supported in the two-type model considered in Section 2. However, now allow for these five possible marginal costs values and suppose that in the first period after the merger, the merged firm gets to set its price first, and the non-merging firms then simultaneously respond. In subsequent periods, all firms set prices simultaneously. The following is a MPBE, where merged firm types that realize large synergies pool on one price, and types that realize smaller synergies pool on a different price.

Definition C.2 ***Hybrid Pooling MPBE.*** *If M has marginal costs of 2, 3 or 4 it sets prices of 9.5782 in the first period, and prices of 8.8495 in the following periods as long as it has not deviated. If M has marginal costs of 0 or 1 it sets prices of 7.2954 in the first period, and prices of 6.4063 in the following periods as long as it has not deviated.*[20] *The non-merging firms set equilibrium best response prices to M's chosen price in the first period. If M sets a price of 9.5782 in the first period and prices of 8.8495 in the following periods, the non-merging firms believe that its marginal costs are 2, 3 or 4 with probabilities consistent with Bayesian updating given $q(c_M)$, and set prices that are equilibrium best responses to M's prices of 8.8495 in subsequent periods. On the other hand, if M sets a price of 7.2954 in the first period and prices of 6.4063 in the following periods, the non-merging firms believe M's marginal costs are 0 or 1 with probabilities consistent with Bayesian updating given $q(c_M)$, and set prices that are equilibrium best responses to merged firm prices of 6.4063 in subsequent periods. If M sets prices that are inconsistent with these strategies, then the non-merging firms believe that M's marginal costs are 0 with probability 1, and set prices $\mathbf{p}^{\dagger}_{-M}(0)$.*

In this equilibrium, a merged firm that benefits from synergies that reduce its marginal costs by 1 or 2 prices in the same way as a merged firm that has no synergy, and a merged firm that benefits from a synergy that reduces its marginal costs by 4 prices in the same way as a merged firm with a synergy that reduces its marginal costs by 3.[21] Even though there is some pass-through of the very largest synergies, the level of expected pass-through can be substantially less than would be expected in a complete information model.

[20] If it has deviated from this strategy, it sets prices $\mathbf{p}^{BR}_M(c_M, \mathbf{p}^{\dagger}_{-M}(0))$ for all subsequent periods.

[21] This example does not have a clean solution, at least without introducing additional changes to the model, if synergies are continuous. In the continuous case, a firm with a synergy that is slightly larger than the largest level that would be willing to pool with the no synergy firm from the second period onwards may still be willing to pool in the initial period in order to make its deviation in the second period more profitable.

C.4 Synergies Associated With A Product Improvement

While antitrust analysis often focuses on possible marginal cost synergies, there are cases where merging parties suggest synergies that will facilitate the introduction of products of higher quality. Exactly the same logic considered above can also apply to synergies of this type.

Consider the multinomial logit model from Section 2 where there are $N = 3$ single-product firms before the merger, consumer j's indirect utility for good i, with price p_i, is $u_{ij} = a_i - 0.25p_i + \varepsilon_{ij} = \delta_i + \varepsilon_{ij}$ with $a_1 = a_2 = 4$ and $a_3 = 6$. The marginal cost of each product is 4.

As before, firms 1 and 2 engage in a merger. But now, with probability $0 < q < 1$, the merged firm will have the ability to increase its product quality to 5 by investing a per-period fixed cost of 1.4 (recall market size equals 1). With probability $1 - q$ the merged firm does not have the ability to increase its quality (equivalently, we could suppose that the fixed cost is prohibitively large). The decision to increase quality is taken simultaneously with setting prices, and the merged firm and the non-merging firm choose prices simultaneously.

Table C.1: Per-Period Profits of the Merged Firm in the Product Improvement Example.

			Rival Firm Sets Price Consistent With	
			Quality Improvement	No Quality Improvement
Merged Firm	Improve Quality	Yes	3.4125-1.4	4.0856-1.4
		No	1.8537	2.3307

Notes: the merged firm's payoffs are shown as a function of whether it implements the product improvement and where the non-merging rival sets the price that are its complete information Nash equilibrium price when the improvement is implemented (first column) or not implemented (second column). The merged firm sets the best response given its chosen quality and the strategy of the non-merging rival.

If it is known that the firm has the ability to implement the quality improvement, then the merged firm's stage game profits are given in Table C.1. Under CI, there is a unique

Nash equilibrium in the stage game where the merged firm implements the improvement and non-merging rival sets a price of 12.21, and the merged firm realizes a profit of 2.01 ($= 3.4125 - 1.4$). On the other hand, if the merged firm is known to be unable to implement the improvement then the non-merging rival will set a price of 13.69, and the merged firm realizes a profit of 2.33.

With asymmetric information and an infinitely repeated game, a pooling equilibrium will exist where a merged firm with the ability to implement the improvement chooses not to implement it in order not to reveal its type to the non-merging rival (i.e., pools with a merged firm that cannot implement the improvement) as long as $\delta > 0.38$. The logic is exactly the same as in the cost example: when the merged firm implements the improvement, this reduces the price set by rivals enough that the profit gain that would result from the synergy, holding the prices of the rivals fixed, is dissipated.

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