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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.

JEL Classification: L1, L13, L4

Keywords: oligopoly, mergers, Asymmetric information, pooling, firm conduct, Pass-Through

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May 2022

Abstract

When reviewing mergers, antitrust agencies use models that assume complete information, static, simultaneous move Nash equilibrium behavior to balance anticompetitive incentives, resulting from market power, with procompetitive incentives, created by efficiencies. These models miss how there can be incentives to not pass through efficiencies when rivals would respond by lowering their prices. Using simple models where rivals lack complete information about either the costs or the incentives of the merged firm, we show that accounting for the profitability of pass-through could have substantial effects on predicted prices after both horizontal and vertical mergers.

JEL CODES: L1, L13, L4.

Keywords: oligopoly, horizontal mergers, vertical mergers, asymmetric information, pooling, firm conduct, pass-through.

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1 Introduction

Merger review usually involves weighing anticompetitive incentives, due to market power, against procompetitive incentives, arising from marginal cost reductions or the elimination of double marginalization (EDM). The pricing pressure and merger simulation calculations currently used for balancing assume that post-merger pricing will be determined as a complete information, static, simultaneous move Nash equilibrium (CISSNE). The CISSNE framework misses how passing through efficiencies lowers the merged firm's profits when it causes rivals to lower their prices. We show that this incentive could have substantial effects on the pass-through of large efficiencies in models where rivals are uncertain about the size of efficiencies or the merged firm's incentives, using stylized examples, and demand and cost estimates (Miller and Weinberg (2017), MW hereafter) previously used to understand efficiencies. We outline how merger review could be adjusted to account for the incentives that we identify.

The logic of our model is straightforward. After an exogenous merger, firms play a repeated price-setting game. Rivals are uncertain about some aspect of the merged firm's profit function. For example, suppose they are uncertain about the size of the realized cost efficiency. We consider a pooling Markov Perfect Bayesian equilibrium (MPBE) where, even when an efficiency is large, the merged firm sets prices consistent with a lower efficiency to prevent rivals from inferring its true cost and lowering their future prices. Rivals always best respond to the prices they expect the merged firm to set, so that behavior also differs from multi-firm collusion, or what agencies call "coordinated effects" (Ordover (2007)). We also consider models where any cost efficiency is known but there is some other uncertainty about the merged firm's incentives: for example, the extent to which a downstream price-setter's incentives have been adjusted to reflect EDM after a vertical merger.

We show that the incentive of a high efficiency firm to pool, and the effects of pooling, depend on how sensitive rivals' best response prices are to its prices. Sensitivity will typically depend on rivals' market power, so that, in our model, the size of efficiencies required to prevent price increases tends to rise with the concentration of the rest of the market. This feature contrasts with CISSNE models where the size of required efficiencies can depend on the market shares of the merging firms only (Nocke and Whinston (forthcoming), NW).

Current debates about merger enforcement have focused on efficiencies. For example, when withdrawing the 2020 Vertical Merger Guidelines (VMGs), the Democratic majority cited the "reliance on EDM ... [as] theoretically flawed because the economic model predicting EDM is limited to very specific factual scenarios" and empirical evidence suggesting "that we should be highly skeptical that EDM will even be realized—let alone passed on to end-users."[1] However, despite the 2010 Horizontal Merger Guidelines (HMGs) explicitly acknowledging that realized efficiencies are uncertain and "difficult to verify and quantify", agency and academic economists continue to assume that CISSNE models accurately predict pass-through (Shapiro and Hovenkamp (2021)).[2] Agency practitioners have even held that agencies should not present empirical evidence suggesting lower pass-through when challenging a merger (Froeb, Tschantz and Werden (2005)) nor require parties to provide additional evidence of pass-through (Yde and Vita (1995), YV).[3]

Whereas we suggest that CISSNE models may overstate the pass-through of large efficien-

[1] See `https://tinyurl.com/48autxs9` (accessed Feb 14, 2022).

[2] Bernile and Bauguess (2011) find that realized post-merger changes in operating performance are not explained by US public companies pre-merger estimates of synergies, controlling for observed firm characteristics.

[3] YV describe requiring additional evidence as "entirely at odds with the basic economic theory upon which modern antitrust law is based."

cies, Rose and Sallet (2019) suggest that agencies overestimate the efficiencies themselves. While agency expectations are not available and the retrospective productivity literature is small, single industry studies including Haynes and Thompson (1999), Bitzan and Wilson (2007), 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) have identified significant efficiencies, making it sensible to consider lower pass-through rates as an explanation of post-merger price increases (Ashenfelter, Hosken and Weinberg (2014), Kwoka (2014) and Asker and Nocke (2021)).[4] While our focus is not emprical, we discuss evidence of a change in cost pass-through after the 2008 MillerCoors joint venture (MCJV) that is potentially consistent with our model.[5]

A small literature considers oligopoly pricing with asymmetric information. One-shot models (Shapiro (1986), Vives (2011) and Amir, Diamantoudi and Xue (2009), who consider an uncertain merger synergy), do not capture the strategic incentive to raise rivals' future prices that drives our results. Sweeting, Tao and Yao (2022) consider a dynamic price-setting game where several oligopolists simultaneously use separating strategies to signal private information about their marginal costs, raising equilibrium margins. However, separating equilibria only exist when marginal costs are restricted to narrow ranges, so uncertainty about large efficiencies cannot be modeled. Lagerlöf and Heidhues (2005) consider a model of merger approval when the parties have private information about an efficiency. We treat the consummation of a merger as exogenous and focus on post-merger competition.

[4]However, Blonigen and Pierce (2016), using a cross-industry panel, suggest productivity does not increase on average.

[5]Ashenfelter et al. (1998) and Muehlegger and Sweeney (2019) both provide evidence of low rates of pass-through of firm-specific cost reductions outside of a merger setting. The broader theoretical literature on oligopoly pass-through also assumes CISSNE behavior (Weyl and Fabinger (2013)).

Harrington (2021), the closest paper to ours, provides a simple horizontal merger example where uncertainty about the timing of a cost efficiency can support a pooling equilibrium where the efficiency is not passed through. This logic is very similar to our Model 1 where we assume uncertainty about the size of the realized efficiency. We develop the model in several directions, emphasizing the possibility of quantitatively large effects after both horizontal and vertical mergers, and the sensitivity of pooling to concentration in the rest of the market.

2 Model of a Horizontal Merger

Before a horizontal merger, $F \geq 3$ firms sell $N \geq F$ differentiated, substitute products and set prices. $q_i(\mathbf{p})$ and c_i are the demand and marginal cost of product i, owned by $f(i)$, where $\mathbf{p}$ is the price vector. Prices are assumed to be observed perfectly. "Equilibrium best response" prices for a subset of firms are the prices that maximize the static profits of each subset firm, given the prices of the other subset firms, and specified prices for firms outside the subset.

Assumption 1 *There are unique CISSNE prices and unique equilibrium best response prices for all subsets of firms, all ownership structures and all marginal costs.*

Nocke and Schutz (2018) show Assumption 1 holds for multinomial logit (MNL) and CES demand systems with an outside good. As is typical, we will assume uniqueness for random coefficients logit demand.

Assumption 2 lets us compare pre-merger and post-merger prices.

Assumption 2 *There is CISSNE pricing before the merger.*

Post-Merger Game. A firm M is created by an exogenous one-off merger of firms 1 and 2, and M continues to sell their products. Demand and the marginal costs of the non-merging firms are unaffected, and they remain commonly known. We will allow some feature of M's payoff function to be private information.

We assume firms play a repeated pricing game, with no further mergers. To describe equilibria, we introduce some notation. M's discount factor is δ_M, which may reflect time preference and/or the probability each period that private information is publicly revealed. The price of an individual product is p_i, and $\mathbf{p}_j$ ($\mathbf{p}_{-j}$) are the prices of firm (firms other than) j. $\mathbf{p}^\dagger(\mathbf{c_M})$ denotes post-merger CISSNE prices given M's costs, as well as the unchanged costs of other firms. $\pi_M(\mathbf{c_M}, \mathbf{p}_M, \mathbf{p}_{-M})$ are M's profits, as a function of its costs, prices and rival prices. $\mathbf{p}_M^{BR}(\mathbf{c}_M, \mathbf{p}_{-M})$ maximize M's one period profits given costs and rival prices.

We consider two models with private information.

Model 1: Size of the Cost Efficiency is Private Information. 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.

We consider the existence of the following pooling MPBE (Toxvaerd (2008),Roddie (2012)). An MPBE specifies expected payoff-maximizing prices for each firm as a function of its type and, where relevant, its beliefs, which should be consistent with Bayesian updating on the equilibrium path. The Markovian restriction is that history matters only through beliefs, so CISSNE pricing would follow M's type being revealed.

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

As in Harrington (2021), if the post-merger game is infinitely repeated (e.g., a constant probability that private information is revealed), one can show

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

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

Proof. Non-merging firms' prices are optimal as they maximize one-period expected profits and do not affect future play. $\mathbf{p}_M^{\dagger}(\overline{\mathbf{c}})$ are static best responses for a $\mathbf{c}_M = \overline{\mathbf{c}}$-type M before a deviation, and $\mathbf{p}_M^{BR}(\mathbf{c}_M, \mathbf{p}_{-M}^{\dagger}(\underline{\mathbf{c}}))$ are optimal for both types following a deviation. Condition (1) is necessary and sufficient for a $\mathbf{c}_M = \underline{\mathbf{c}}$-type M to not deviate. ■

As rivals always set static best response prices, their patience does not affect existence. Existence for some $\delta_M < 1$ requires $\pi_M(\underline{\mathbf{c}}, \mathbf{p}_M^{\dagger}(\overline{\mathbf{c}}), \mathbf{p}_{-M}^{\dagger}(\overline{\mathbf{c}})) > \pi_M(\underline{\mathbf{c}}, \mathbf{p}_M^{\dagger}(\underline{\mathbf{c}}), \mathbf{p}_{-M}^{\dagger}(\underline{\mathbf{c}}))$. With suitable demand, this inequality will hold if differences between $\overline{\mathbf{c}}$ and $\underline{\mathbf{c}}$ are small enough.

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. See online Appendix A, applying the results in Nocke and Schutz (2018). ■

The intuition for existence is that around a $\mathbf{c}_M = \underline{\mathbf{c}}$-type M's best response prices, an increase in rivals' prices causes a first-order increase in M's profits, while the increase in M's own prices has a second-order effect.

When M's products are symmetric, there is an analytical formula for the maximum cost range supporting pooling with linear demand (Appendix D.1) and an MPBE with pooling on $\mathbf{p}^{\dagger}_M(\overline{\mathbf{c}})$ prices will also exist when M's realized costs can take any value between $\underline{\mathbf{c}}$ and $\overline{\mathbf{c}}$ when a pooling MPBE would exist for the two cost type model (Appendix D.2). Appendix D.3 provides an example where costs could have more dispersed values, and a partial pooling equilibrium exists. Appendix D.4 presents an example where it is uncertain how a merger has affected the fixed cost of improving product quality, and pooling involves a merged firm with low fixed cost not implementing the improvement.

Model 2: Known Synergy, But Uncertain Pricing Incentives. We also consider pooling MPBE when the magnitude of any cost synergy is commonly known, but there is some uncertainty about the incentives of M's managers when they set prices. For example, it may be uncertain how incentives have been adjusted to reflect EDM after a vertical merger. After a horizontal or a vertical merger, there may be uncertainty about the types of pricing strategies that the merged firm will adopt. In addition to an EDM example, we will consider pooling when, ex-ante, rivals attach some probability, $1-q$, to M being committed to act "as if" it has benefited from the synergy that maximizes its profits given best response pricing by rivals, effectively placing M in a position similar to a Stackelberg price leader in a complete information game (Amir and Stepanova (2006)).[6] We will label this case "as if" pricing.

[6] Framing the problem as M pricing acting as if it has a scalar synergy reduces the computational burden when we allow for multiple asymmetric products.

This allows us to consider pooling MPBE outcomes that would be most profitable for M given a known synergy. The analysis of this model provides a condition analagous to (1).

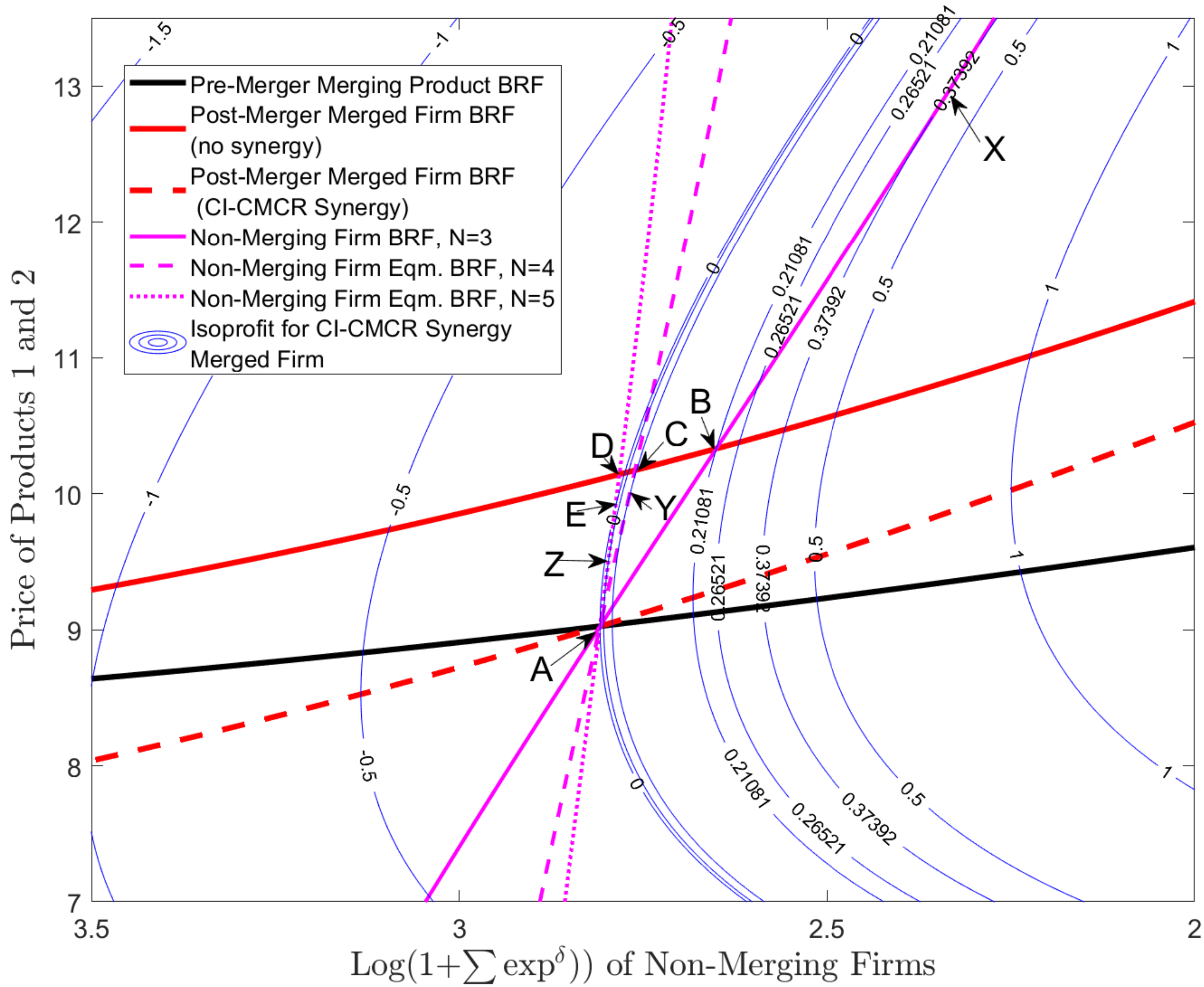
Multinomial Logit Example. We illustrate the logic of our results using a graphical example. Suppose that pre-merger there are $N = F = 3$ single-product firms with marginal costs of 4. There is MNL demand with consumer c's indirect utility for good i, with price p_i, $u_{ic} = a_i - 0.25p_i + \varepsilon_{ic} = \delta_i + \varepsilon_{ic}$, an i.i.d. logit draw. $a_1 = a_2 = 4$, $a_3 = 6$. $u_{0j} = \varepsilon_{0j}$ for the outside good.

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 best response pricing of firm 3. The pre-merger equilibrium is at A ($p_1^\dagger = p_2^\dagger = 9.03$, $p_3^\dagger = 13.01$).

Consider Model 1, with M's marginal costs equal to 4 (no synergy) or 2.27, which is the "compensating marginal cost reduction" (CI-CMCR) synergy that would keep CISSNE prices unchanged. The red solid and dashed lines show, respectively, the merged firm's CI best response functions, with CISSNE outcomes at B and A.

Our pooling MPBE involves repeated pricing at B given either level of synergy, including if q, the probability of the CI-CMCR synergy, is close to 1. $q > 0.5$ is especially relevant as merger review often asks whether consumer harm is "more likely than not", rather than assessing the expected harm, so a CISSNE analysis would suggest that the merger be allowed to proceed. Play at B, rather than at A, raises firm 3's profit by 0.68 (13%), and lowers CS by 0.89 per consumer.

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.



The blue isoprofit curves show the differences in a CI-CMCR-synergy M's profits 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). Deviation would cause subsequent play at A, and pooling can be sustained iff $\delta_M > \frac{0.26521-0.21081}{0.26521} = 0.21$. Pooling at B could also be sustained for much larger synergies than the CI-CMCRs: for example, if M's marginal costs are either 0 or 4, $\delta_M > 0.33$ supports pooling.

While these critical discount factors reflect the assumption that the pricing game may be infinitely repeated, pooling can also be sustained in the initial period(s) of a short, fixed length game with asymmetric information (Kreps et al. (1982)). This may be relevant if public disclosures will eliminate the asymmetry within several quarters, potentially consistent with our CISSNE pre-merger assumption. To illustrate, suppose that whether M's marginal costs are 2.27 or 4 will be revealed after two periods. If $\delta_M = 0.95$ and the probability of the large synergy is less than 0.8, then a pooling MPBE where firms set $\mathbf{p}^{\dagger}_M(\overline{\mathbf{c}})$ in the first period, and static Bayesian Nash (BNE) prices in the second period will exist if firm 3 interprets any first period deviation by the merged firm from the no synergy price as reflecting a low marginal cost.[7]

If we assume that M is known to have the CI-CMCR synergy but, following the merger, rivals perceive some probability that M is committed to price "as if" it has the marginal costs that would maximize M's profits given best responses by rivals, as in Model 2, then, in our $F = 3$ example, the pooling outcome would be at X. M prices as if its cost has increased to 7.29 (even though it has fallen to 2.27). Pooling could be sustained if $\delta_M \geq 0.5514$.

[7] As the probability that the synergy is high increases, final period BNE prices after pooling approach high synergy CISSNE prices, reducing the incentive to pool. We assume that **any** deviation in the first period is interpreted as reflecting a low cost so that a high cost M does not have an incentive to set a price above the CISSNE price to signal its type.

The figure also shows the reaction functions when we allow the merged firm to have two ($F = 4$) or three rivals ($F = 5$), adjusting rivals' marginal costs so that the pre-merger prices and shares of firms 1 and 2 are the same as when $F = 3$, with the outcome at A.[8] Consistent with NW, the CI-CMCRs are identical in each case, but, the changes in the slopes of rivals' equilibrium best response functions affect M's incentives to pool. Specifically, when rivals have less market power (smaller markups) their best response prices are less sensitive to M's prices, so that M has less to gain by setting prices above its own best responses. Pooling on no synergy CISSNE prices can only be sustained when $\delta_M > 0.70$ for $F = 4$, and for no $\delta_M \leq 1$ when $F = 5$ (CI-CMCR synergy-type M profits are lower at D than A). However, pooling, with an outcome at E, could be sustained for some $\delta_M < 1$, if the possible synergies were the CI-CMCRs and a marginal cost reduction of 0.375. For Model 2, the most profitable pooling outcomes for a CI-CMCR synergy M when $F = 4$ and $F = 5$ would be at Y and Z, with the merged firm's prices rising by 9.1% and 4.7% respectively.

NW use the fact that CI-CMCRs do not depend on the level of the post-merger HHI, conditional on the market shares of the merging firms, to suggest that the agencies' screens for anticompetitive mergers should not refer to levels. However, as our results illustrate, the profitability of passing through synergies, in a model where rivals' prices are not treated as fixed, will depend on the concentration of the rest of the market, rationalizing some consideration of broader concentration measures.[9]

[8] The x-axis shows the inclusive values of rivals, rather than their prices, so we can perform this exercise.

[9] The level of post-merger HHI may also correlate with the ability of firms to collude (Loertscher and Marx (2021)).

3 Numerical Example: Horizontal Mergers in the Beer Industry

We now investigate the existence and effects of pooling MPBEs for simulated mergers using MW's demand and marginal cost estimates. Caradonna, Miller and Sheu (2021) and NW use these estimates to calculate the efficiencies needed to prevent post-merger price increases, assuming that firms use CISSNE strategies.

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 wholesale price changes, so that retail prices can be modeled as being chosen by brewers. Before the 2008 MCJV, the firms are Anheuser-Busch (AB), Miller and Molson-Coors, together with two importers, Grupo Modelo (GM) and Heineken.

Our simulations, detailed in Appendix B, use observed prices and market shares from Q3 2007, immediately before the MCJV was announced, and MW's quarterly random coefficients nested logit demand (RCNL-2) estimates from their Table IV, column (iii). The estimates imply income heterogeneity in preferences over prices, calories and the included products. We use the CISSNE first-order conditions to infer product qualities and pre-merger marginal costs.

The first part of our analysis considers the local ("representative") market where firm market shares are closest to their national averages (Appendix B). For the ten possible firm-pair mergers, the left-hand columns of Table 1 report the implied change in HHI (based on pre-merger volume market shares for MW-sample products) and the share-weighted average

CI-CMCRs.

To consider the ability to support a Model 1 pooling MPBE, the next column reports the value of κ^*, defined as the **highest** value of a scalar parameter $\kappa \in [0,1]$ such that if the two possible synergies are the CI-CMCRs (for each merging product) multiplied by $(1-\kappa)$ (low synergy) or $(1+\kappa)$ (high synergy), the pooling MPBE would exist for $\delta_M = 0.9^{\frac{1}{4}}$ (annual discount 0.9) in an infinitely repeated game.[10] We center possible synergies around the CI-CMCRs, so that if $q \geq 0.5$, a CISSNE analysis would suggest not challenging the merger under either expected CS (Choné and Linnemer (2008)) or "more likely than not" standards.

As an example, consider the Coors/Miller merger, which would increase the HHI by 711 (out of 10,000) and, under a CISSNE analysis, require 9% marginal cost efficiencies to offset anticompetitive effects. The κ^* of 0.9 implies that, if the possible synergies are cost reductions of 1% and close to 16%, pooling could lead to large price increases (4.6% and 9.5% relative to pre-merger and CISSNE prices respectively) even if realized synergies are 90% greater than the CI-CMCRs.[11] With the large synergy, pooling lowers quarterly CS by \$47,600 and raise rivals' profits by \$33,200 (the definition of κ^* implies the increase in the merged firm's profits is small). These surplus effects sound small, but they are non-trivial given that MW's sample only covers retail sales of \$1.3 million in this market-quarter.

[10] We identify κ^* using a 0.01 grid of κ. For all mergers considered, if a pooling MPBE can be supported for some κ, it can also be supported for all smaller κs. For lower δ_M, consistent with some probability that the value of the synergy becomes publicly known, the κ^*s fall, but not dramatically. For example, for the Coors/Miller merger in the representative market, the κ^*s are 0.88 and 0.83 for $\delta_M = 0.95$ and $\delta_M = 0.9$, compared to 0.9 in the baseline. Therefore, it is possible to sustain pooling that has significant effects on prices even if the asymmetry of information is only likely to last a few years.

[11] Appendix Figure B.1 illustrates how raising rivals' prices affects the profitability of a price increase for Coors/Miller. Calculations also show that pooling on the lowest synergy prices would be an equilibrium if synergies, proportional to the CI-CMCRs, could take on any value between these extremes.

The next three columns consider what happens when the merged firm's marginal costs fall by exactly the CI-CMCRs but, as in our Model 2, rivals attach some probability to the merged firm being committed to price "as if" its marginal costs have fallen by the amount that would maximize its profits given rivals' best response behavior. We assume fictitious cost changes must be proportional to the CI-CMCRs. Coors/Miller's profits are maximized when firms set prices as if its marginal costs have fallen by (an average of) 0.7%, rather than 8.8%, causing its prices to rise by 4.4% after the merger.[12] Assuming deviation by the merged firm would be followed by CI-CMCR CISSNE pricing, this pooling MPBE exists if $\delta_M \geq 0.52$. For the Heineken/Coors and GM/Coors mergers, the most profitable outcomes involve the merged firm pricing "as if" the merger increases marginal costs. The final column reports how much the merged firm's marginal costs have to fall (assuming reductions are proportional to the CI-CMCRs) to prevent prices from rising if, after a merger, firms pool on the prices associated with the most profitable "as if" cost changes. For Coors/Miller, this would require a 24.5% average marginal cost reduction, which is 2.5 times larger than the CI-CMCRs and a level of marginal cost efficiency that would rarely be plausible. Consideration of the profitability of limiting pass-through could, therefore, have important effects on the decision to allow a merger.

We can perform similar analyses for all 390 possible firm-pair-market mergers, treating each market-merger as independent.[13] Figure 2 shows the (cross-market) ranges of the Model

[12] Pooling would lower CS by $24k per quarter, relative to CISSNE pricing, and raise the profits of Coors/Miller and the other firms by $1.6k and $17.2k respectively. Therefore, even though this is the outcome that is most desirable for the merged firm, the effect on the profits of rivals is greater.

[13] We have also calculated the κ^* that could support Model 1 pooling when the range of synergies (relative to the CI-CMCRs) is assumed identical in every market, and deviation in any market would lead to CISSNE pricing in all markets. The common κ^* is typically somewhat lower than the median market-specific κ^*s shown in Figure 2.

Table 1: Effects of Pooling in The Representative Market.

Merger	ΔHHI	$\overline{\text{CI-CMCR}}$ (\$)	$\overline{\text{CI-CMCR}}$ (%)	Model 1: Maximum Synergy Range κ^*	$\Delta\overline{p_M}$ (%)	$\Delta\overline{p_{-M}}$ (%)	ΔCS (\$000)	$\Delta\pi_{-M}$ (\$000)	Model 2: Most Profitable Pooling For CI-CMCR Synergy $\widehat{\text{Synergy}}$ (%)	$\Delta\overline{p_M}$ (%)	$\Delta\overline{p_{-M}}$ (%)	Pooling CMCR
AB/Coors	1,273	1.09	16.5%	0.19	1.91%	0.16%	-17.3	7.8	13.0%	1.33%	0.11%	22.4%
AB/GM	925	0.70	9.3%	0.28	1.91%	0.24%	-16.8	8.5	6.5%	1.28%	0.16%	14.3%
AB/Heineken	613	0.45	6.3%	0.30	1.34%	0.15%	-11.4	6.3	4.3%	0.95%	0.11%	9.8%
AB/Miller	2,103	1.97	31.1%	0.08	1.58%	0.06%	-12.4	4.2	28.3%	0.89%	0.03%	35.8%
Coors/Miller	711	0.58	8.8%	0.90	9.48%	1.54%	-47.6	33.2	0.7%	4.40%	0.72%	24.5%
GM/Coors	312	0.27	2.9%	1.00	3.99%	0.65%	-19.2	16.7	-0.4%	2.26%	0.36%	10.2%
GM/Heineken	150	0.29	2.4%	0.68	3.08%	0.40%	-9.9	9.1	0.8%	1.22%	0.16%	5.9%
GM/Miller	516	0.39	4.9%	0.98	6.00%	1.06%	-32.5	24.4	0.2%	2.91%	0.51%	14.5%
Heineken/Coors	207	0.19	2.2%	1.00	3.05%	0.39%	-12.0	11.0	-0.4%	1.77%	0.22%	7.5%
Heineken/Miller	342	0.26	3.5%	0.97	4.47%	0.64%	-20.2	16.1	0.1%	2.14%	0.31%	10.2%

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 Model 1 change measures compare outcomes in a pooling equilibrium when a high synergy merging firm (with marginal costs equal to pre-merger marginal costs less $\kappa^* \times$ the CI-CMCRs) sets the prices that would be CISSNE equilibria with a low synergy and outcomes in the CISSNE with high synergies. The Model 2 values report the synergy (relative to pre-merger marginal costs) which it is most profitable for the merged firm to price as if it has, when it actually has the CI-CMCR synergy, and the price increases (relative to pre-merger prices) that such behavior implies. The final column reports the marginal cost reduction that the merged firm would have to have to prevent consumer surplus from falling when the pooling equilibrium merged firm can choose the price according to the most profitable synergy.

1 κ^*s for each possible merger. For Coors/Miller, the κ^*s range from 0.03, a market where these firms have a combined market share above 75%, to 1, for 18 of the 39 markets, with a median close to 0.9. Summing CS effects across the 39 markets, pooling after a Coors/Miller merger, with market-specific κ^*s, would lower quarterly CS by $1.2 million, compared with total quarterly sample sales of $58.3 million. Given national off-premise beer sales in 2007 of $51.1 billion (i.e., over 850 times sales in one quarter of the MW sample), scaling our results would suggest that post-merger pooling could lower annual CS by hundreds of millions of dollars.[14]

Using MW's demand system, NW show that the CI-CMCRs are closely related to the market shares of the merging firms, but not the concentration of rivals (i.e., similar to the property that holds precisely with MNL demand). However, as in Section 2, when we allow for pooling, the incentive to pass-through efficiencies depends on the concentration of the rest of the market.

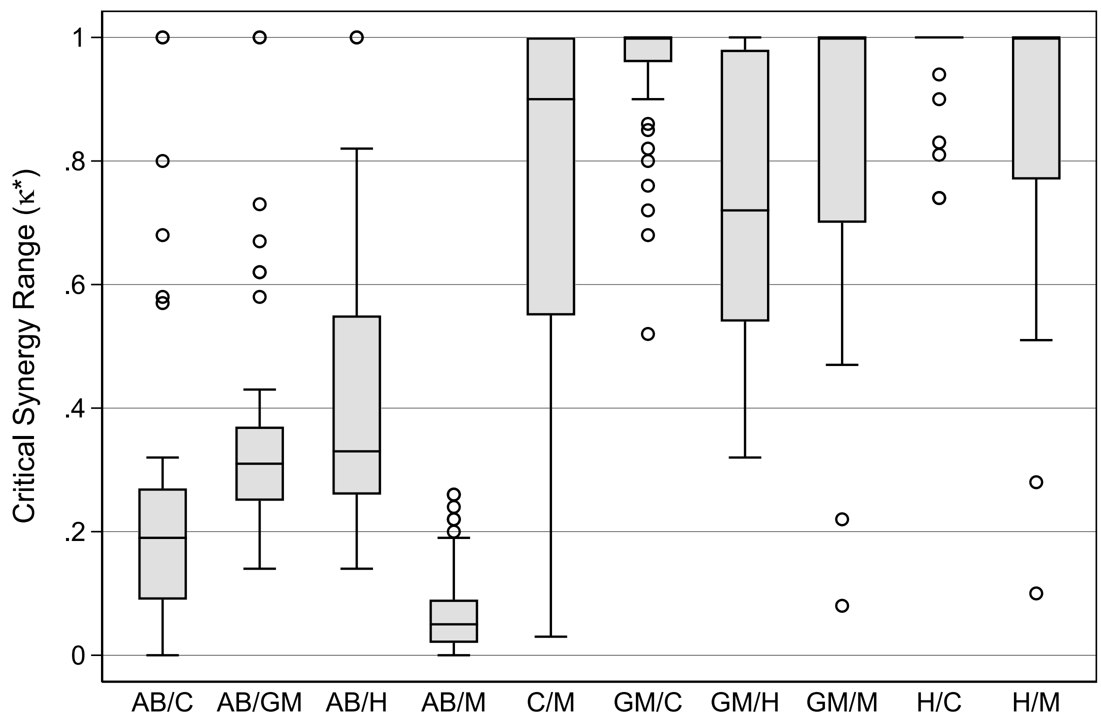
This can be seen when we compare across mergers, in both Table 1 and Figure 2.[15] For example, the existence of pooling for wide ranges of possible synergies (large κ^*s), the differences between pooling CMCRs and CI-CMCRs, and the welfare effects of pooling are all larger when AB, the largest brewer, is one of the rivals, rather than one of the merging firms.[16] This suggests that introducing new presumptions against mergers involving the

[14]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.

[15]Appendix B describes an additional exercise where we directly relate the κ^* for each market-merger to the slope of rivals' equilibrium best response function.

[16]It is also noticeable that the $\kappa^* s$ tend to be higher for mergers involving a domestic brewer and an importer. The demand system implies that domestic and imported products, which have more calories and sell at higher price points, are systematically differentiated. This tends to weaken unilateral effects in a CISSNE model, lowering the CI-CMCRs, but it may tend to increase the relative incentive to try to raise rivals' prices if this is made possible by the types of uncertainty created by a merger.

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.

largest firm in a market, as suggested by Rose and Shapiro (2022), might be inappropriate if it is the unprofitability of passing through efficiencies because of rivals' likely responses that has driven observed post-merger price increases.

We can further illustrate the sensitivity of pooling MPBE to the structure of the rest of the market by re-computing our results assuming that all non-merging products are owned by a single firm or by independent firms. The latter assumption implies smaller pre-merger markups and less sensitive rival prices.[17] The changes in our results are striking. With independent rival products, Model 1 pooling MPBEs exist for $\kappa = 0.001$ (a tiny range of synergies) for only 8 market-mergers, and, in the representative market, none of the Model 2 "pooling CMCRs" are more than 0.8 percentage points larger than the CI-CMCRs. In comparison, when rival products are assumed to be sold by a single firm, Model 1 pooling MPBEs exist for $\kappa = 1$, the largest κ considered, for 363 (out of 390) market-mergers, including 17 AB-Miller market-mergers and the pooling CMCRs are much larger. For example, the smallest pooling CMCR in Table 1, 5.9% for GM/Heineken, increases to 23.1% (almost 10 times larger than the CI-CMCRs).

Suggestive Evidence of Pooling in the Beer Context. Our choice of the beer example was primarily motivated by its previous use to consider the effects of mergers and efficiencies in the literature. On one level, we are similarly agnostic about whether pooling affects pricing after consummated beer mergers, viewing our counterfactuals as illustrating how asymmetric information *could* have large effects.

However, Sweeting, Tao and Yao (2022) (evidence also presented in Appendix C) show

[17]For example, for the representative market, average non-merging product margins are \$0.37 and \$0.90 when we assume they are owned by independent firms or a single firm respectively.

that cost pass-through changed after the consummated MCJV in a way that is potentially consistent with our model. Specifically, MC's pricing was consistent with a significant *reduction* in the per-mile efficiency of its distribution network, even while it benefited from shorter trucking distances to some markets. While rivals would observe changes in trucking distances, changes in a network's per-mile efficiency, which would depend on capacity utilization and management efficacy, might be more opaque. A fall in "per-mile efficiency" might be consistent with the worst possible efficiency outcome of the JV, which Model 1 would predict as determining post-merger pricing even if a better outcome is realized. Of course, one would need detailed cost data to understand whether per-mile efficiency actually decreased, in which case the change might be consistent with CISSNE pricing, or whether the changes in pricing reflect the incentives identified in this paper.[18]

4 Pass-Through of EDM

Since Spengler (1950), economists have viewed vertical mergers between two firms that charge positive margins as creating a procompetitive incentive for the firm to lower its downstream prices. However, the FTC withdrew the 2020 VMGs because they were skeptical that consumers benefited from EDM.

We present a stylized model where a vertical merger could lead to both EDM and anticompetitive effects due to changes in bargaining leverage. We illustrate how, relative to a complete information model, an asymmetry of information and pooling could lead to the

[18]We note that there is evidence, although of lower statistical significance, that AB's pricing changed in a way consistent with a decrease in the per-mile efficiency of its distribution network, with no change for importers. Changes for both domestic brewers would be consistent with the simultaneous signaling model presented in Sweeting, Tao and Yao (2022).

benefits of EDM not being fully passed through.[19] Our model, with a structure loosely based on Ho and Lee (2017), is motivated by the healthcare provider (upstream) and insurance (downstream) industries, where a number of vertical mergers have been proposed. For example, UnitedHealth Group (UHG) has been purchasing physician practice groups that supply both its insurance business and rival insurers. In 2019, UHG purchased the DaVita Medical Group and the FTC did not to challenge the acquisition in Colorado, based on the majority's view that EDM would outweigh anticompetitive effects, or balance so closely that the agency would not prevail in Court.[20]

Model and Parameterization. Initially there are two independent providers (U1 and U2) and insurers (D1 and D2), and a fully vertically integrated rival, VI3, which could represent Kaiser Permanente in an urban market. Di's network (N_{Di}) could contain one or both of U1 and U2. An enrollee c's indirect utilities are

$$u_{Di,c} = a_i + \log\left(\sum_{j \in N_{Di}} \exp(v_{Uj})\right) - \alpha p_{Di} + \theta_c + \varepsilon_{Di,c} \tag{2}$$

$$u_{VI3,c} = a_{VI3} - \alpha p_{VI3} + \theta_c + \varepsilon_{VI3,c},\ u_{0,c} = \varepsilon_{0,c}, \tag{3}$$

where the ps are downstream prices, $\theta_c \sim \mathcal{N}(0, \sigma^2)$ and the εs are logit payoff shocks. An enrollee will consume a unit of in-network care, with the provider chosen in another logit choice problem where v_{Uj} is the expected valuation of Uj, and the probability of using U1 when both providers are in-network is $\frac{\exp(v_{U1})}{\sum_{j=1,2}\exp(v_{Uj})}$. The upstream marginal costs are c_i and downstream retail costs are r_j.

The calculations below assume that all upstream marginal costs are 4, downstream retail

[19] Sweeting, Lecesse and Tao (2022) present a simpler example, with leverage changes, where the magnitude of EDM is private information to the merging parties.

[20] `https://tinyurl.com/yujpn68n`

costs are 0.1, $\sigma = 2$, and $\alpha = 0.3$. We set $a_{D1} = a_{D2} = 8$, $v_{U1} = v_{U2} = 0$ and $a_{VI3} = 8+\log(2)$, so that, when D1 and D2 contract with both providers, all downstream firms have symmetric demand. These parameters imply almost all consumers will buy from one insurer in the pre-merger equilibrium.

Bargaining and Pre-Merger Outcomes. We assume that pre-merger outcomes are determined by a static complete information game, where, first, provider-insurer pairs simultaneously engage in Nash-in-Nash bargaining over wholesale prices, where the outside option is that the provider is not in-network. We assume surplus is split equally. Second, insurers simultaneously set retail prices. Appendix E describes the equations that characterize the outcome, which is presented in column (1) of Table 2. Upstream and downstream margins are substantial, and VI3, benefiting from EDM, charges a significantly lower price.

Merger and Pass-Through. Suppose that U1 and D1 merge, forming U1D1, and that costs are unaffected. Consistent with the UHG example, we assume U1D1 continues to negotiate with U2 and D2. Column (2) of Table 2 shows the outcome when we resolve the complete information model. The EDM incentive leads U1D1 to reduce its downstream price. The merger also implies changes in bargaining leverage that increase $w_{U1,D2}$ and lower $w_{U2,D1}$. The merger is profitable, but its profitability is reduced by how EDM causes p_{VI3} to fall.

Suppose instead that the firms repeatedly play the bargaining-then-pricing game, and that, ex ante, rivals attach some probability, $1 - q > 0$, to the incentives of U1D1's retail price-setter continuing to reflect the pre-merger $w_{U1,D1}$ as the supply cost from U1, rather

Table 2: Alternative EDM Pass-Through in a Vertical Merger.

	(1)	(2)	(3)	(4)
			Post-Merger	
			Model 2	
	Pre-Merger Outcome	Prediction of Standard Model	No EDM Pass-Through	π^{U1D1}-maximizing EDM Pass-Through
$w_{U1,D1}$	7.98	-	-	-
$w_{U1,D2}$	7.98	9.99	10.41	10.18
$w_{U2,D1}$	7.98	6.31	7.34	6.61
$w_{U2,D2}$	7.98	8.04	8.44	8.19
Retail Prices				
p_{D1}	12.56	11.20	13.20	12.12
p_{D2}	12.56	13.22	13.79	13.47
p_{VI3}	10.48	10.25	10.93	10.56
Downstream Shares				
s_{D1}	0.256	0.345	0.259	0.303
s_{D2}	0.256	0.188	0.217	0.202
s_{VI3}	0.477	0.458	0.512	0.484
Profits Per Potential Consumer				
U1+D1	2.167	2.613	2.620	2.662
U2	1.019	0.778	0.915	0.820
D2	1.148	0.773	0.925	0.846
VI3	3.049	2.819	3.495	3.128
CS per Potential Consumer	20.958	21.327	20.282	20.835

Notes: authors calculations for the model described in the text.

than the true c_{U1}. The alternative possibility is that U1D1 accounts for EDM in the way normally assumed. We assume the incentives of the upstream negotiators are known to be adjusted to reflect the merger, and that they correctly predict equilibrium price-setting behavior.

Column (3) shows the outcome in a pooling equilibrium where U1D1 always prices as if EDM does not affect its retail pricing. All prices and profits increase relative to column (2), and CS falls. If lowering p_{U1D1} would lead rivals to believe that the merged firm has certainly recognized EDM, pooling will be an MPBE if $\delta_{U1D1} \geq 0.917$, even though pooling lowers the merged firm's market share by almost 30%. On the other hand, if p_{VI3} was assumed fixed at its pre-merger level then pooling could not be supported, for any δ_{U1D1}, as profits under complete information (2.714) would exceed profits without EDM (2.436).

Column (4) shows the pooling outcome when, instead of not recognizing EDM at all, other firms believe that there is some probability that U1D1 is committed to act as if its internal supply cost takes the value that is most profitable for it given the best response prices of rivals and bargaining behavior. This "as if" marginal cost is 6.07, which lies between the true cost of 4 and the pre-merger wholesale price of 7.98. Pooling can be sustained if $\delta_{U1D1} \geq 0.471$, with U1D1 and VI3 profits higher, and CS lower, than before the merger. If this outcome was expected to happen then, all else equal, the merger should be challenged.

5 Conclusion

While our results are in line with textbook presentations of strategic incentives in price-setting games (e.g., chapter 8 of Tirole (1988)), these incentives are currently ignored in merger review.[21] We now discuss a simple horizontal merger example to illustrate how, with limited additional assumptions, they might be included.

Suppose that, using pre-merger market share and margin data, agency economists calculate that marginal cost reductions of 8% (CI-CMCRs) would keep CISSNE prices from rising. Agency financial analysts estimate that a "likely" efficiencies range of 5-9% (Section 4D of Sweeting et al. (2020) provides an example with a range of likely efficiency estimates).[22] If all values within the range are viewed as equal likely, an agency might decide not to challenge the merger because, under CISSNE assumptions, it is sufficiently likely that efficiencies will be above or close enough to the CI-CMCRs that there will not be a substantial anticompetitive effect, even if a certain 5% efficiency would be viewed as insufficient.

To analyze the merger through the lens of our Model 1, the agency would establish a lower bound on the efficiency that rivals would expect, either using a survey of rivals or using their own 5% estimate by assumption. They would then use rivals' best response functions, which they already calculate to perform merger simulations, to test whether passing through efficiencies close to the CI-CMCRs, if realized, would be more profitable than passing through only the lower bound efficiency.[23] If pass-through would be profitable, then the standard evaluation of benefits and harms could be used, and otherwise the burden would shift to the parties to show not only that larger efficiencies are more likely, but also that their incentives would be to pass them through to customers.

[21] Incentives in quantity-setting games will be different, as the merged firm might strategically want to signal that it has benefited from a large efficiency.

[22] The likely range may be above than the efficiencies that an agency would accept as cognizable when challenging a merger in court.

[23] Model 2 incentives could be analyzed similarly.

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Online Appendices for "Should We Expect 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 (CISSNE) 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, simultaneous move Nash equilibrium (CISSNE) 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 CISSNE equilibrium for MNL and CES demand, and that CISSNE 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 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,

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

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 CISSNE pricing). ■

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

$$\delta_M \geq \frac{\pi_M(\underline{\mathbf{c}}, \mathbf{p}_M^{BR}(\underline{\mathbf{c}}, \mathbf{p}_{-M}^\dagger(\overline{\mathbf{c}})), \mathbf{p}_{-M}^\dagger(\overline{\mathbf{c}})) - \pi_M(\underline{\mathbf{c}}, \mathbf{p}_M^\dagger(\overline{\mathbf{c}}), \mathbf{p}_{-M}^\dagger(\overline{\mathbf{c}}))}{\pi_M(\underline{\mathbf{c}}, \mathbf{p}_M^{BR}(\underline{\mathbf{c}}, \mathbf{p}_{-M}^\dagger(\overline{\mathbf{c}})), \mathbf{p}_{-M}^\dagger(\overline{\mathbf{c}})) - \pi_M(\underline{\mathbf{c}}, \mathbf{p}_M^\dagger(\underline{\mathbf{c}}), \mathbf{p}_{-M}^\dagger(\underline{\mathbf{c}}))}, \tag{4}$$

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

For some $\delta_M < 1$, 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-2018, 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 CISSNE pricing. Denote consumer surplus (CS) with CISSNE prices $(\mathbf{p}_M^\dagger(\mathbf{c})), \mathbf{p}_{-M}^\dagger(\mathbf{c}))$ as $CS(\mathbf{c})$. By Proposition 6 of NS-2018, $CS(\underline{\mathbf{c}}) > CS(\overline{\mathbf{c}})$, i.e., CS at low synergy CISSNE prices is lower than at high synergy CISSNE 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 CISSNE 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 for Model 1. 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 CISSNE pre-merger pricing. This is done

for each market separately. For example,

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

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 CISSNE 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 CISSNE 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 $\mathbf{p}^{\dagger}(\underline{\mathbf{c}})$ and $\mathbf{p}^{\dagger}(\overline{\mathbf{c}})$.

   (b) calculate the profits of the merged firm with high synergy marginal costs ($\underline{\mathbf{c}}$) at both sets of CISSNE 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 $\underline{\mathbf{c}}$ 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.

$$\delta_M(\kappa) = \frac{\pi_M(\underline{\mathbf{c}}, \mathbf{p}_M^{BR}(\underline{\mathbf{c}}, \mathbf{p}_{-M}^{\dagger}(\overline{\mathbf{c}})), \mathbf{p}_{-M}^{\dagger}(\overline{\mathbf{c}})) - \pi_M(\underline{\mathbf{c}}, \mathbf{p}_M^{\dagger}(\overline{\mathbf{c}}), \mathbf{p}_{-M}^{\dagger}(\overline{\mathbf{c}}))}{\pi_M(\underline{\mathbf{c}}, \mathbf{p}_M^{BR}(\underline{\mathbf{c}}, \mathbf{p}_{-M}^{\dagger}(\overline{\mathbf{c}})), \mathbf{p}_{-M}^{\dagger}(\overline{\mathbf{c}})) - \pi_M(\underline{\mathbf{c}}, \mathbf{p}_M^{\dagger}(\underline{\mathbf{c}}), \mathbf{p}_{-M}^{\dagger}(\underline{\mathbf{c}}))}. \quad (5)$$

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 CISSNE prices, and we calculate the change in consumer surplus using the standard compensating variation formula for a random coefficients logit demand model.

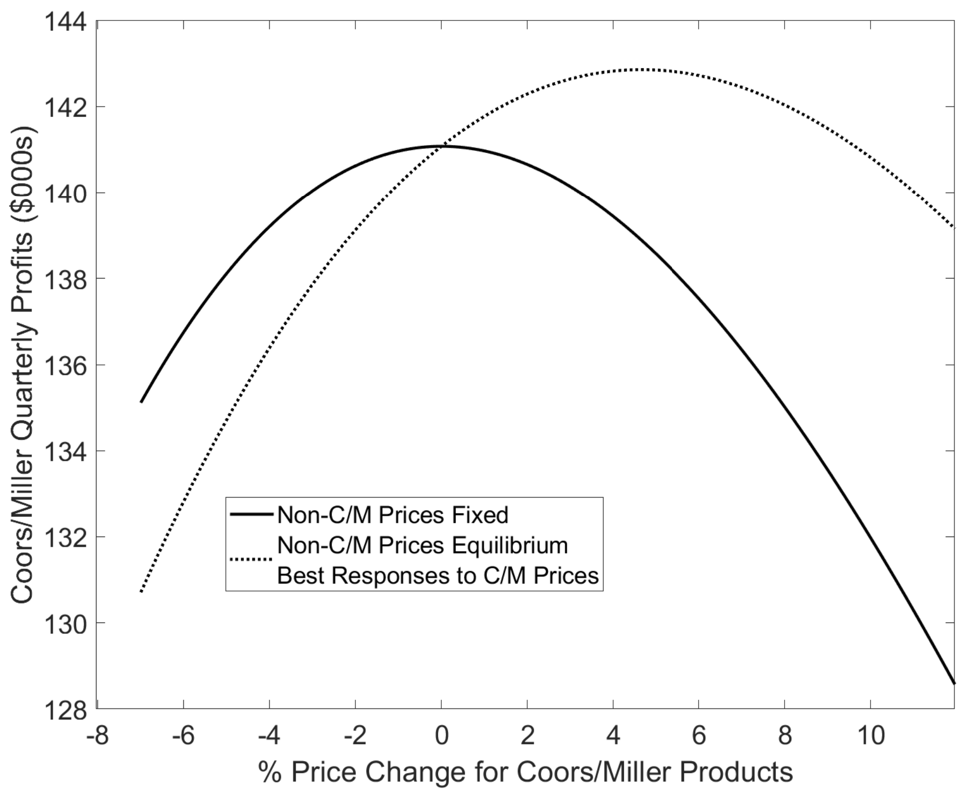
Analysis of "As If" Pricing (Model 2). Text Table 1 also reports results where we use our Model 2 specification, allowing the merged firm to potentially choose to price consistent with a cost type that will maximize its profits, even though rival firms know the true marginal cost efficiency realized after the merger. To calculate the profit-maximizing cost-type, we assume "as if" costs equal to $\mathbf{c}_M^{\hat{\text{PRE}}} - (1-\gamma)\textbf{CI-CMCR}_M$ where γ is a scalar. We consider steps of 0.001 for γ and allow it to range from 0 to 2. For each of these cost types, we find CISSNE equilibrium prices and calculate the profits of M when its marginal costs are actually $\mathbf{c}_M^{\hat{\text{PRE}}} - \textbf{CI-CMCR}_M$. We then report the results for the γ for which M's profits are maximized. We also calculate the marginal cost reduction that would lead CS unchanged with this type of profit-maximizing "as if" pricing, which involves repeating this analysis for different values of actual marginal costs, where, once again, we assume actual cost reductions are proportional to the CI-CMCRs and use a 0.001 grid.

Pooling Equilibrium When Synergies Can Lie on the Inside of the Interval. For the representative market, we also examine whether we could sustain a pooling equilibrium on the smallest possible synergy CISSNE 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 $\mathbf{c}_M^{\hat{\text{PRE}}} - (1+\kappa^*)\textbf{CI-CMCR}_M$ and $\mathbf{c}_M^{\hat{\text{PRE}}} - (1-\kappa^*)\textbf{CI-CMCR}_M$, 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 $\mathbf{p}^{\dagger}(\mathbf{c}_M^{\hat{\text{PRE}}} - (1-\kappa^*)\textbf{CI-CMCR}_M)$, as well as the one-period best response price and profit of the merged firm if it was to deviate from the low synergy CISSNE (pooling) prices and when it best responds to non-merging firms setting $\mathbf{p}^{\dagger}_{-M}(\mathbf{c}_M^{\hat{\text{PRE}}} - (1+\kappa^*)\textbf{CI-CMCR}_M)$ 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 D.2, non-merging firms believe that the merged firm has the lowest possible 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 $\mathbf{c}_M^{\hat{\text{PRE}}} - (1+\kappa^*)\textbf{CI-CMCR}_M$ and $\mathbf{c}_M^{\hat{\text{PRE}}} - (1-\kappa^*)\textbf{CI-CMCR}_M$ 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

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.



by the same percentage, holding the prices of non-merging products fixed. Of course, the optimal price increase for Coors/Miller might not involve changing its prices in exactly this way, but the figure is still informative about the firm's incentives. As pre-merger prices are post-merger CISSNE 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.

In text Table 1, the largest κ for which pooling can be supported involves a 9.4% price increase for Coors/Miller. Consistent with this, profits when rivals change their prices are slightly above the maximum of the solid line when Coors/Miller increases its prices by 9.4%.[24] On the other hand, the figure also shows that such a large price increase is somewhat costly for Coors/Miller given its large synergy, and the most profitable price increase would be just over 4%. For this reason, pooling is most profitable for the merged firm when it benefits from a large synergy and the alternative synergy is smaller but not too much smaller, or rivals' beliefs support the type of pooling considered in our Model 2.

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 $I = \log\left(1 + \sum_{j \in -M} \exp(\delta_j(\mathbf{p}_{-M}))\right)$

[24] Of course, the κ^* calculation assumes that the large synergy is larger than the CI-CMCR, so the correspondance between this figure and that calculation is only approximate.

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 NW 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 Evidence of a Change in Transportation Cost Pass-Through After the MillerCoors Joint Venture

In this Appendix, we reproduce the empirical analysis in Sweeting, Tao and Yao (2022) that suggests that the 2008 MillerCoors joint venture was followed by a change in how the merged firms' passed through transportation costs to retail prices. The maintained assumption is that there is no change in retail markups.

We note that Sweeting, Tao and Yao (2022) consider a different model to the one considered in this paper. In particular, that paper assumes that there is a component of the marginal costs of each domestic brewer that is private information. When it is assumed that it is the "per mile" efficiency of the firm's distribution network is privately known, the model predicts that, after the JV, each domestic brewer will pass-through transportation costs (e.g., reflecting driving distances and diesel prices) at a higher rate than before the JV. In contrast, the current paper assumes that there is private information about the merged firm, but that non-merging firms always set prices that are on their static, complete information best response functions. This implies that the pass-through of the merging parties may change, but that the pass-through of non-merging firms, such as Anheuser-Busch (AB), should not. As we will see there is evidence of a change in pass-through for AB, but it is not consistent whether this change is significantly different from zero across specifications. Therefore one can view the results as potentially consistent with either model.

We empirically estimate the rate of pass-through of transportation costs to retail prices. Our theory is the following: suppose that the distribution costs for a unit of output equal trucking distance multiplied by a "per mile" measure of distribution network efficiency, reflecting, for example, average capacity utilization in each truck. Transportation distances are likely observed (i.e., rivals know the brewery from which beer is sent to each market) but we suppose that per mile efficiency has a private information component. Assume that the merger may affect per mile efficiency, either positively or negatively, as well as changing trucking distances to some markets. Our Model 1 would predict that, even if efficiency increases after the merger, a merged firm may price as if it has become less efficient, because of the effect on rivals' prices. In fact, as shown by Miller and Weinberg (2017), the prices of both MC and AB increased after the JV.

Table C.1 reports price regressions that we use to measure changes in pass-through. The sample, which includes 13 brands made by domestic brewers and two importers, Grupo Modelo and Heineken, is the same as the one used in MW's Tables II and III, except that we include additional pack sizes (18- and 36-packs, which account for more than 20% of domestic brewer sales by volume) and we exclude the June 2008-May 2009 period, which MW exclude in their Table II, in all regressions. Observations are at the brand-size-market-month level and the dependent variable is the real price (in dollars) per 12-pack equivalent, and, for comparison purposes, it is useful to keep in mind that a variety of specifications suggests that the JV increased the real prices of the leading domestic products by 40 cents to one dollar per 12-pack. All specifications include date fixed effects, and various combinations of product and market fixed effects, but measure distances in different ways.

Column (1) estimates how the brewery-to-market trucking distance, measured in thousands of miles, affects retail prices before and after the JV, controlling for pre-/post-JV product (i.e., brand-size) fixed effects, market fixed effects and date fixed effects. We estimate distance (measured in thousands of miles) and a post-JV distance interaction coefficient for imported products and each domestic brewer. The coefficients show that domestic brewer prices were **more** sensitive to distance after the JV, while this is not the case for imported products. The coefficients are also quite large given that, for example, the average post-JV distance for Miller is 316 miles with standard deviation 269 miles, and a range of over 1,000 miles. The Coors and Miller coefficients are statistically significant, whereas the significance of the coefficient for AB is more marginal. As Sweeting, Tao and Yao (2022) shows little evidence of significant demand substitution to imported products, we view the imported brands as providing a comparison group whose pricing incentives may not have been changed by the JV, but would have been affected by common cost shocks. We interpret the Coors and Miller coefficients as being consistent with the JV pricing as if its distribution network has become less efficient.

In column (2), we use distance multiplied by the real price of diesel as the distance measure. Average real diesel prices in the two years before and after the JV were very similar. While the scale of the coefficients changes, the pattern remains the same. The

Table C.1: Distance Pass-Through Regressions: Real Price Per 12-Pack for all Pack Sizes

	(1)	(2)	(3)	(4)	(5)
Distance Measure	Own Distance	Own Dist. × Diesel	Own Distance	No distance Measure	Own Distance
Distance Measure (000 miles) ×					
AB	-0.319	-0.059			
	(0.180)	(0.068)			
Imports	0.470	0.109			
	(0.185)	(0.043)			
Coors	0.194	0.109			
	(0.067)	(0.021)			
Miller	-0.143	0.008			
	(0.102)	(0.038)			
Post-JV × Own Distance ×					
AB	0.629	0.197	0.569		0.290
	(0.314)	(0.102)	(0.313)		(0.304)
Imports	-0.198	-0.064	-0.132		-0.221
	(0.189)	(0.042)	(0.160)		(0.168)
Coors	0.560	0.156	0.718		0.611
	(0.144)	(0.047)	(0.134)		(0.133)
Miller	0.796	0.233	0.785		0.686
	(0.149)	(0.042)	(0.152)		(0.137)
Post-JV ×					
Reduction Coors Distance				-0.377	-0.443
				(0.201)	(0.196)
Mkt HHI Increase Due to JV				2.327	2.330
				(2.731)	(2.652)
Post-JV × Domestic ×					
Reduction Coors Distance				-0.078	0.126
				(0.133)	(0.137)
Mkt HHI Increase Due to JV				3.019	2.633
				(2.554)	(2.401)
Fixed Effects	Pre/Post× Product Market	Pre/Post× Product Market	Product× Market Pre/Post× Product	Product× Market Pre/Post× Product	Product× Market Pre/Post × Product
Observations	191,909	191,909	191,909	191,909	191,909
R-squared	0.927	0.926	0.957	0.957	0.957

Notes: standard errors, clustered on the market, in parentheses. See text for discussion of the sample. Date fixed effects in all specifications.

remaining columns use distance-only based measures, although the results are qualitatively similar using the distance×diesel price variable.

Column (3) includes product-market fixed effects, and the post-JV distance coefficients should be interpreted as reflecting how post-JV price increases vary with trucking distances.[25] Even though there are no distance changes for AB products after the JV, and for only a small number of markets for Miller products, the coefficients imply that the size of price increases are related to trucking distances for these firms, and not for imports.

MW estimate regressions where post-JV price increases depend on the JV-induced trucking distance reduction for Coors products and the increase in market HHI (measured between 0 and 1). The values of the HHI are higher in our analysis because we include additional pack sizes that are primarily sold by the domestic brewers. Specification (4) shows that a distance reduction is associated with lower prices of all products, with no significant difference domestic and imported products. Specifications (5) repeats specifications (3) including these additional controls. The Coors and Miller post-JV distance coefficients continue to be significant.

One might ask whether the increased sensitivity of pricing to own distance could also be explained by a model of tacit collusion, as well as our model. For instance, more collusive conduct might potentially change the rate of cost pass-through. We investigate this possibility by regressing the marginal costs implied by MW's supply-side model estimates (specifically their monthly RCNL-1 model in Table VI) for the same sample of products that they use and regressing them on post-JV distance measures for each brewer with brand-size-market, brand-size-post JV dummies and date fixed effects. The specification is therefore similar to our Table C.1 col. (3), except that the dependent variable is implied marginal costs (in dollars), rather than retail prices. If changes in conduct determined the change in distance pass-through then the distance coefficients should now be zero. Instead, the post-JV Miller, Coors and AB coefficients are 0.433 (s.e. 0.171), 1.414 (0.466) and 0.430 (0.394). Therefore, MW's estimated change in conduct does not explain the change in pass-through for the JV parties.

[25] In the MW data there are handful of small distance changes for markets before the JV, and the post-JV distance coefficients are unchanged if additional pre-JV distance coefficients are estimated.

D Examples and Extensions

D.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 CISSNE 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.

D.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

$$p_i = a_i - bq_i - \sigma \sum_{j \neq i} q_j = a_i - (b - \sigma)q_i - n\sigma\bar{q}, \tag{6}$$

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

$$q_i = \frac{1}{b-\sigma}\left[\frac{b+(F-2)\sigma}{b+(F-1)\sigma}(a_i - p_i) - \frac{\sigma}{b+(F-1)\sigma}\sum_{j \neq i}(a_j - p_j)\right] \tag{7}$$

$$= \frac{1}{b-\sigma}\left[a_i - p_i - \frac{F\sigma}{b+(F-1)\sigma}\overline{a-p}\right], \tag{8}$$

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 $c_M = \overline{c}$, where $\overline{c} > \underline{c}$. We assume that, for either level of synergy, the parameters are such that all products are produced at CISSNE prices, implying that CISSNEs 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 CISSNE prices with $c_M = \overline{c}$ irrespective of the realized value of c_M.

D.1.2 Existence Result

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

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

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

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

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 $\pi_M(\underline{c}, p^\dagger_M(\overline{c}), \mathbf{p}^\dagger_{-M}(\overline{c})) - \pi_M(\underline{c}, p^\dagger_M(\underline{c}), \mathbf{p}^\dagger_{-M}(\underline{c}))$ is then

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

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

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

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

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

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 $(B + (F-2)\sigma^2) > 0$. CISSNE behavior implies that $(p^\dagger_M(\underline{c}) - \underline{c}) > 0$. ■

D.1.3 Consumer Surplus

Proposition D.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 CISSNE equilibrium where $c_M = \overline{c}$ than in the equilibrium where $c_M = \underline{c}$.

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

$$p_M = c_M + \frac{1}{2}(a_M - c_M) - \frac{1}{2}\frac{(F-2)\sigma^2}{B}\left(\frac{1}{2}v_A + \frac{b + F\sigma - 2\sigma}{F\sigma - 2\sigma}v_B\right), \tag{9}$$

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 D.1).

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

$$p_i - c_i = \frac{b+(F-1)\sigma}{2(b+(F-2)\sigma)+\sigma}(a_i - c_i) - \frac{(b+(F-2)\sigma)\sigma}{(2(b+(F-2)\sigma)+\sigma)(2b+(F-1)\sigma)}v_B - 2\frac{\sigma}{2b+(F-1)\sigma}(a_M - p_M). \tag{10}$$

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 CISSNE prices are increasing in c_M and pooling reduces expected CS. ■

D.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 CISSNE prices associated with the highest marginal costs for all possible realizations of the synergy.

D.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.[26] 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 3 *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 D.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.

D.2.2 Existence Result.

Proposition D.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 D.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.

[26] The symmetry assumption ensures that we can consider a one-dimensional interval for the synergy and that, with lower synergies, the CISSNE 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

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

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

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

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

$$Q_M(p_M^{BR}(c', \mathbf{p}_{-M}^{\dagger}(\overline{c})), \mathbf{p}_{-M}^{\dagger}(\overline{c})) +$$
$$\frac{\delta}{1-\delta}Q_M(p_M^{BR}(c', p_{-M}^{\dagger}(\underline{c})), p_{-M}^{\dagger}(\underline{c})) -$$
$$\frac{Q_M(p_M^{\dagger}(\overline{c}), \mathbf{p}_{-M}^{\dagger}(\overline{c}))}{1-\delta} > 0, \tag{11}$$

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 (11) 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. ■

D.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 D.2 example consider pooling equilibria where all cost-types on the interval pool on the same CISSNE 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 D.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.*[27] *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.[28] 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.

[27] 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.

[28] 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.

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

			Rival Firm Sets Price Consistent With Quality Improvement	**Rival Firm** Sets Price Consistent With 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 D.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.

E Vertical Merger Model

In this Appendix, we summarize the equations that define the various forms of our vertical example.

E.1 Pre-Merger.

Solving for the pre-merger complete information equilibrium requires us to find the following.

- five sets of downstream (retail) prices: the retail prices when networks are complete, and retail prices where one of the four possible U-D bargains is not completed. This is a total of 15 (5 $\times$ 3) retail prices, for which there are 15 associated pricing first order conditions that treat the negotiated ws as given. For example, for downstream firm i, the first-order condition, when we normalize market size to 1, is

$$\frac{\partial s_{Di}}{\partial p_{Di}}(p_{Di} - \tilde{c}_i - r_i) + s_{Di} = 0$$

  where $\tilde{c}_i$ is Di's cost of a customer given its negotiated wholesale prices (or the upstream marginal cost of VI3).

- four wholesale prices. The Nash-in-Nash assumption implies there are determined as the solutions to maximization problems of the form

$$w_{Uj,Di} = \arg\max_{w_{Uj,Di}} \left(\pi_{Uj}(c_j, \mathbf{w}) - \pi_{Uj}(c_j, \mathbf{w}\backslash w_{Uj,Di})\right)^{\tau} \times \left(\pi_{Di}(\mathbf{w}) - \pi_{Di}(\mathbf{w}\backslash w_{Uj,Di})\right)^{1-\tau}$$

where $\pi_{Uj}(c_j, \mathbf{w})$ is the profit of Uj given patient flows when both providers are in both insurer networks and D1 and D2 set optimal retail prices given the ws. τ is the upstream share of bargaining surplus, assumed to be one-half in our example. $\pi_{Uj}(c_j, \mathbf{w}\backslash w_{Uj,Di})$ is the profit of Uj when it is not in the network of Di, but it is in the other insurer's network, the other bargained prices are held fixed, and the Ds set retail prices that reflect this incomplete network configuration. The associated first order conditions have the form:

$$\tau \left(\pi_{Di}(\mathbf{w}) - \pi_{Di}(\mathbf{w}\backslash w_{Uj,Di})\right) \frac{\partial \pi_{Uj}(\mathbf{w})}{\partial w_{Uj,Di}} + (1-\tau) \left(\left(\pi_{Uj}(c_j, \mathbf{w}) - \pi_{Uj}(c_j, \mathbf{w}\backslash w_{Uj,Di})\right) \frac{\partial \pi_{Di}(\mathbf{w})}{\partial w_{Uj,Di}} = 0$$

where the derivative terms reflect how the retail prices of all firms will change with the wholesale price $w_{Uj,Di}$, with the other wholesale prices held fixed.

E.2 Post-Merger.

E.2.1 Standard/Complete Information Model with EDM Pass-Through.

The standard model assumes that, after the merger,

- D1 will set its retail price recognizing that its marginal cost is $\frac{exp(v_{U1})}{\sum_{j=1,2} \exp\left(v_{Uj}\right)} \times c_1 + \frac{\exp(v_{U2})}{\sum_{j=1,2} \exp\left(v_{Uj}\right)} \times w_{U2,D1}$. The replacement of $w_{U1,D1}$ with c_1 is the effect of EDM.
- when U1 is bargaining with D2 it will recognize that, in the event of a failure to agree a deal, demand will switch from D2 to D1, and that this will imply some profits for U1D1. In bargaining, this will tend to increase the U1-D2 wholesale price, reflecting the merged firm's increased bargaining leverage (its profit when D2 does not have U1 in its network).

- when D1 is bargaining with U2 it will recognize that, in the event of a failure to agree a deal, D1's customers will use U1 and that the cost to D1 will be c_1 (lower than the wholesale price it had to pay prior to the merger). This will increase the bargaining leverage of D1, causing downwards pressure on the U2-D1 wholesale price. D1's leverage may also be increased by its greater incentive, when it benefits from EDM, to lower its retail price to increase its demand if a U2-D1 deal is not agreed.

The equations are the same as before the merger except that: (i) the bargaining first-order condition for $w_{U1,D1}$ is eliminated; (ii) the equation for $w_{U2,D1}$ reflects the profit that the merged U1D1 will make on patients who use U1, including when U2 is not in D1's network; (iii) the equation for $w_{U1,D2}$ will reflect the profit that the merged U1D1 will make on patients who use D1, including when U1 is not in D2's network; and, (iv) D1's marginal cost in its retail pricing equation reflects c_1 for the share of its customers who get care from U1.

E.2.2 A Pooling Equilibrium with No EDM Pass-Through.

The second scenario assumes that, after the merger, there is some non-zero probability that the downstream division of the merged firm will continue to set its retail price as if the cost of care for customers that use U1 for care, is the pre-merger $w_{U1,D1}$ (rather than c_1). For simplicity, we assume that the merged firm's bargaining incentives are adjusted, so that bargaining leverage considerations will affect prices even if EDM incentives do not affect the retail price.

The equations describing the pooling outcome are the same as for the standard model except that D1's marginal cost in its pricing equation equals the pre-merger $w_{U1,D1}$ for the share of its customers who get care from U1. We also solve for the profit-maximizing retail price of U1D1, holding the other retail prices and the negotiated wholesale prices fixed, if it chooses to deviate to a pricing in a way that recognizes EDM. We use these "deviation profits", U1D1 profits from the standard model, which we assume would describe equilibrium outcomes after a deviation, and U1D1 profits from the pooling outcome to calculate the critical discount factor (i.e., U1D1 patience) that would support pooling.

E.2.3 A Pooling Equilibrium with Profit-Maximizing EDM Pass-Through.

Given our assumed parameters the upstream margin is so large that it is quite expensive for the merged firm to not pass-through EDM at all, leading to a critical discount factor that is above 0.9. We therefore also calculate the pooling outcome, and the associated discount factor, when rivals believe that there is some possibility that the downstream division of the merged U1D1 may be committed to pricing as if it has the upstream marginal cost which is most profitable for it to have, given the best response and bargaining behavior of the other players. We find the most profitable effective upstream marginal cost by solving the model described above for different effective marginal costs (between c_1 and the pre-merger wholesale price) on a 0.01 grid. We then calculate the critical discount factor in a similar way to the no pass-through model.

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