The Welfare Consequences of Mergers with Endogenous Product Choice∗

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Abstract

Merger simulations focus on the price changes that may occur once previously independent competitors set prices jointly and other market participants respond. This paper considers an additional effect - the possibility that market participants change the products they choose to offer after a merger. Using a model that endogenizes both product choice and pricing, we conduct equilibrium market simulations for mergers including the potential for product offering changes in a variety of scenarios. We find that allowing for changes in product offering can have effects on profitability and consumer welfare above and beyond those generated by traditional price responses alone, particularly in cases where the merging parties offered relatively similar products prior to the merger. Cost synergies may also affect product offering decisions, potentially leading to increases in consumer welfare if more products are introduced. The results suggest that analysts carefully consider the impacts of product choice, along with prices, when simulating potential welfare changes associated with mergers.

Keywords: product positioning decisions, market structure, merger analysis

JEL Classification: L10, L40, L80

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1 Introduction

Over the past several decades, advances in industrial organization economics have had an increasing impact on the analysis of horizontal mergers. In particular, new econometric techniques have been developed to estimate equilibrium models of demand and pricing. Using data from the industry of the proposed merger, an analyst can assess the relationship between market concentration and price changes and predict how prices would adjust following the merger of two industry participants. This approach – empirical demand elasticity and marginal cost estimation followed by merger simulation (i.e., simulated with the proposed ownership change and the estimated parameters) – has been used as suggestive evidence of the likely effects of a merger on prices charged to consumers.

This paper addresses one shortcoming of this approach. While prices are explicitly included as choice variables of the industry participants, their product offerings – which products they choose to bring to market – are treated as fixed. In effect, it is assumed that they cannot be adjusted by the industry participants after the merger. This abstraction has consequences for the accuracy of merger simulations to the extent that merged firms may cull duplicate products or competitors may increase their product portfolios post-merger. We develop an empirically motivated model that endogenizes both prices and product selection decisions; subsequent merger simulations are not bound by the constraint that products offered by market participants are identical pre- and post-merger.

In this paper, we present a detailed examination of the implications of relaxing this constraint based on an example motivated by an empirical case. In our setting, competing firms have created a menu of horizontally differentiated product offerings from which they choose a subset to offer in a given period. Permitting firms to make product offering decisions, and to reconsider them after a merger, generates more complex incentives for firm behavior, with corresponding effects on consumer surplus. In some cases, for example, the merged firm may choose not to offer those products that are close substitutes in product space. Alternatively, industry participants (both the merged parties and others) may choose to expand their product offerings given a new ownership structure. Impacts on consumer welfare associated with price increases may be reduced if consumers value characteristics of products that are increasingly made available after a merger. Our simulations allow us to tease apart

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1 Budzinski and Ruhmer (2010) provide a recent survey of the use of merger simulation in competition policy.

2 It is worth noting that authors who have proposed the use of product differentiated demand models for merger simulation are well aware of the abstraction from post-merger product selection inherent in their approach. For example, Nevo (2000) states, “this approach is not consistent with firms changing their strategies in other (than price) dimensions that may influence demand... this implies that characteristics, observed and unobserved,... are assumed to stay the same pre- and post-merger.”
these potentially offsetting effects, identify the range of parameter values - and thus stylized empirical settings - for which ignoring product choice would affect significantly the assessment of merger effects, and describe the consequences.

Our approach builds on existing theoretical and empirical work that explores the effects of endogenous entry and product choice decisions on merger evaluations. Analyses by Werden and Froeb (1998), Cabral (2003), and Spector (2003) explore whether the presence of sunk entry costs may dissuade a potential entrant (that would counter market power effects were it to enter) from joining the industry after a merger. Gowrisankaran (1999) and Marino and Zabojnik (2006) expand to a more dynamic analysis that examines the effects of mergers on entry and exit over time. These papers focus on the subsequent effect on price that entry may or may not mitigate.

On the theory side, our paper is closest to Gandhi et al. (2008). Like ours, their paper analyses the behavior of a fixed number of market participants that can change their product choices after a merger. Specifically, they propose a Hotelling (1929) set-up in which single outlet firms (stores) can optimally change their product space location (along with price) after a merger. For a wide range of utility and cost parameterizations, merging parties that previously offered similar products move further away from each other in product space, as it is more profitable to avoid cannibalization. The remaining industry participants also alter their product space locations. The authors conclude that “the merged firm’s product repositioning both mitigates the reduction in consumer welfare the merger otherwise would produce and allows the merged firm to capture a much larger portion of the profits the merger generates.” This ‘repositioning’ approach contrasts with our model, where the industry participants have products at various product space locations which they endogenously choose to offer or not per- and post-merger. Either approach to endogenizing product selection may be relevant, depending on the conditions in the industry in question.

A similar contrast can be found in recent empirical work on endogenous product choice in merger analysis. Fan (2013)’s study of the newspaper industry includes a fully developed equilibrium model of demand, firms’ joint pricing (here, subscription and advertising rates) and product characteristic choices, such as news quality. Like Gandhi et al. (2008), these product characteristics are measured as continuous indices (though they are vertical characteristics rather than horizontal). Fan (2013) uses the estimated demand, marginal cost of circulation and advertising acquisition, and marginal cost of improving news quality, to

Such considerations may be quite important in merger evaluation, especially when parties argue that entry behavior by other market participants (e.g., US vs. Oracle) or product introduction decisions by more efficient competitors (e.g., FTC vs. H.J. Heinz Co.) can mitigate the effects of market power. Section 6.1 of the 2010 revision of the Horizontal Merger Guidelines indicates that the DOJ and FTC consider product offering decisions when evaluating potential merger effects.
simulate the adjustment in news quality and prices in response to consolidation between two competing newspapers. The simulation exercise suggests that the effect of ignoring product characteristic adjustments to higher concentration can be significant; both in a proposed and ultimately blocked merger and in hypothetical mergers between local competitors, firms reduce news quality, generating consumer surplus losses beyond those due to higher prices alone. The set-up in Wollmann (2016) is more similar to ours – market participants in the truck manufacturing industry can choose from a menu of options that vary in a smaller number of horizontal characteristics (e.g., size, cab design). Using data on which market participants offer what products, the sunk costs of offering a particular product from each firm’s menu can be inferred. These sunk cost parameters are then used to simulate new market structure patterns after a change due, for example, to a merger.

Following this introduction, we outline our modeling approach, which generalizes the work of Draganska et al. (2009). Firms play a two-stage game: optimally choosing whether to offer products from their available menu in the first stage and then competing on price with those choices in the second stage. To ground the merger simulations that follow in a reasonable empirical setting, we estimate a differentiated products demand system using data from the ice cream market to generate parameter estimates for preferences and marginal costs. By additionally modeling the product offering decision, we can also derive estimates for the costs associated with offering a particular product variety. As such, the approach endogenizes both price and product offering decisions, allowing both to update as a result of a changed industry structure in the context of a merger simulation.

We then use these estimates to carry out a series of merger simulations, allowing for both price and product offering changes post-merger. We extend our simulations beyond the initial empirical setting by varying our preference parameters across a range of empirical relevance (including the values that we estimate) to demonstrate the sensitivity of outcomes to various industry primitives. Finally, we highlight alternative mechanisms that may cause industry participants to make these changes and tease out their effects on welfare after the merger.

The results from our simulations confirm that the number of products offered, the extent of differentiation, and the consumer welfare effect may be substantially different from “price only” merger simulations. This is particularly true given parameter values that represent merging parties that are relatively undifferentiated. In analyzing various incentives for firms to change offerings post-merger, our simulations demonstrate offsetting effects: higher prices post-merger induce firms to offer more varieties but the merged firm can save on costs by not offering duplicate products with similar characteristics. For most preference parameters we study, the latter incentive dominates: the merged firms reduce the number of products
offered. This reduction induces a significant consumer welfare loss, as consumers’ options are diminished and prices increase due to both the decrease in available products and the commonly highlighted channel of joint pricing by the merged firm. This result contrasts with the findings in Gandhi et al. (2008) who find that by endogenizing product locations – but holding the number of offered products fixed – estimates of welfare loss induced by a horizontal merger are not as large as would be predicted by merger simulations that allow only price, but not product locations, to adjust post merger.

2 A Model of Endogenous Product Choice

We begin by proposing a model of competition among firms offering differentiated products, within which we can analyze the product offering decision in the context of merger simulation. While the model is restricted to three firms for simplicity of exposition, it can be readily expanded to include any number of firms.

Consider an industry with three firms identified by $i \in \{A, B, C\} \equiv I$. Each firm has an established portfolio of products with predefined characteristics. $J_i$ represents the set of products for firm $i$ and $j$ represents one of these products. The game has two stages: in the first stage firms simultaneously choose which products to offer from their portfolio and incur an entry fee for each product. This entry fee may be product specific and can be considered as a fixed cost of carrying the product, as a sunk cost of offering the product or as a combination of both. In the second stage, after observing which products are offered, firms choose simultaneously prices for each of their offered products.

An equilibrium is a vector of offering choices and of prices, $(x^\star, p^\star)$. In this context, $x^\star$ is the entry decisions for each firm: $x^\star \equiv (x^\star_A, x^\star_B, x^\star_C)$ where $x_A = (x_{1A}, x_{2A}, ..., x_{jA})'$ and $x_{1A}$ is one if the product is offered and zero if it is not. The price vector $p^\star \equiv (p^\star_A, p^\star_B, p^\star_C)$ consist of the prices that arise given $x^\star$ is the set of offered products. If a product is not offered, let its price be defined as $\emptyset$. This definition of an equilibrium implies we focus only on pure strategy equilibria.

We characterize the equilibrium by solving the game through backward induction. For a given offering choice $x$ we find the equilibrium prices of the subgame and calculate the

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4 We believe that products with predefined characteristics represent a useful characterization of post-merger activity in many industries in which industry participants can easily add or subtract existing products in response to a merger but in which designing new products optimally may be a longer-term prospect: e.g. retail, transportation, etc.

5 This is a model in which firms choose to offer products whose location is fixed. In contrast, Gandhi et al. (2008) study a model in which firms choose the product space location of a fixed number of products. Our current model can approximate a setting in which firms choose location by discretizing all possible locations into a finite set and endowing firms with products at each location.
subsequent profits and consumer surplus. Using these profits we then model the entry game and characterize its equilibrium. We give more detail on the profit functions and the fixed costs in the next subsections.

2.1 The Pricing Game

The offering choices are given by \( x \) and are taken as fixed in this subsection. Here we characterize the pricing game given the offering \( x \). We define \( K_i \) to be the set of active products of firm \( i \), so that \( K_i \subseteq J_i \) and \( K \) are all the products offered in the market: \( K \equiv \cup_{i \in I} K_i \).

We model the pricing game assuming discrete choice consumer demand functions. A consumer \( s \) has a particular preference for each product, yielding utility given by

\[
    u_{js} = \theta_{js} - \alpha p_j + \epsilon_{js}
\]

and that of not purchasing is given by \( u_{0s} = \epsilon_{0s} \). Here, \( \alpha \) is the consumer’s price coefficient (his utility of income) and \((\theta_{js}, \epsilon_{js})\) are two idiosyncratic taste shocks. The distinction between the two is that \( \epsilon_{js} \) is drawn from a Type 1 Extreme Value distribution with scale parameter \( \sigma \), while \( \theta_{js} \) is drawn from an arbitrary distribution that allows for correlated shocks across products and non-zero means: \( \theta_s \equiv (\theta_{1s}, \theta_{2s}, ..., \theta_{Js})' \sim F(\theta|\mu_F, \Sigma_F) \). In most applied work, \( \theta_{js} \) is a linear function of observed covariates and random taste shocks: \( x_j \beta_s + \zeta_{js} \) where \((\beta_s, \zeta_{js})\) are random variables distributed according to some parameterized distribution. Here we have simply summarized such linear index into \( F(\theta) \). The scale parameter \( \sigma \) defines how important price and the correlations across products are relative to other unobserved characteristics.

Let \( M \) be the total number of consumers. The additivity and independence assumptions between the two idiosyncratic shocks allows us to integrate the probability of purchase in two steps, where the demand for good \( j \) is given by

\[
    s_j(p) = M \int \frac{e^{\frac{1}{\sigma}(\theta_{js} - \alpha p_j)}}{1 + \sum_{n \in K} e^{\frac{1}{\sigma}(\theta_{ns} - \alpha p_n)}} dF(\theta_s|\mu_F, \Sigma_F)
\]

The scale parameter \( \sigma \) controls how “smooth” the integrand in Equation 2 is. One interpretation of the idiosyncratic shock \( \epsilon \) is thus a convenience tool that is used to form a Kernel to approximate the outer integral over the random coefficients, \( \theta_{js} \), with \( \sigma \) controlling the bandwidth of this Kernel.

Assuming a product-specific constant marginal cost \( c_j \), profits in the pricing game are
then given by
\[ \pi^i(p) = \sum_{j \in K_i} s_j(p) (p_j - c_j) \quad \text{(3)} \]
and the equilibrium prices are defined as the solution to
\[ \frac{\partial \pi^i(p)}{\partial p_j} = 0 \quad \forall j \in K_i \quad i = \{A, B, C\} \quad \text{(4)} \]
Conditions for existence and uniqueness of equilibrium are given in Nevo (2000).

Let \( p_x \) define the equilibrium prices when the offering choice is \( x \) and let \( \pi_x \) denote the associated equilibrium variable profit. Before moving on to the entry game, we present the calculations for consumer surplus and price elasticities. Given the current setup, for an offering vector \( x \), consumer surplus can be defined as
\[ CS_x = \int M \sigma \ln \left[ 1 + \sum_{n \in K} e^{\frac{1}{\sigma} (\theta_{ns} - \alpha p_n, x)} \right] dF(\theta_s | \mu_F, \Sigma_F) \quad \text{(5)} \]
which is a measurement of the equivalent variation as in McFadden (1973), modified to account for the random coefficients. Price elasticities are given as
\[ \xi_{ij}(p_x, x) = \frac{p_j}{s_i(p_x)} \frac{ds_i(p_x)}{dp_j} \quad \{i, j\} \in K \quad \text{(6)} \]

2.2 The Entry Game

We model a simultaneous move entry game. For this game, we take the vector of profits \( \pi_x \) as the subgame outcomes of the entry game and assume no discounting. Firms incur a cost \( g_{ji} \) of offering product \( j \), which we group together in the vector \( g_i \equiv (g_{1i}, g_{2i}, ..., g_{ Ji})' \). In summary, the ex-post net profits for firm \( i \) of offering products \( x_i \) are
\[ \Pi_i(x_i, x_{-i}) = \pi(x_i, x_{-i}) - g_i' \cdot x_i \]

We model a complete information game: all players know \( \Pi_i(x_i, x_{-i}) \). In section 4.5, we extend the model to incomplete information in which rivals know \( \pi_x \) but not rivals’ costs: \( g_{ji} \). Hence, a firm chooses an optimal offering given rival players’ offerings and their own fixed costs:
\[ x^*_i(g_i, x_{-i}) = \arg \max_{x_i} \Pi_i(x_i, x_{-i}) \quad \text{(7)} \]
An equilibrium is defined by an optimal offering decision for each firm given rival firms’ optimal offering decisions: \( x^*_i(g_i, x_{-i}^*) \quad \forall i \); firm \( i \) offers the set of products that, given its
rivals’ product offerings, maximizes its profit net of fixed product offering costs.

As there may be more than one such solution, resulting in a multiplicity of equilibria, we employ an equilibrium selection rule to choose a single solution. Let \( \hat{x}(g) \) be the equilibrium offering decision given cost realizations \( g \) and the equilibrium selection rule. In the simulations below we analyze the sensitivity of our results to the presence of multiple equilibria.

### 2.2.1 Expected Market Outcomes

To understand how a change in, say, ownership (e.g. mergers) or market conditions (e.g. price sensitivity) affects equilibrium market outcomes (e.g. consumer surplus, prices, products offered, etc.), one needs to determine which fixed product offering cost value \( g \) gave rise to the initial market outcome. Then, holding cost fixed at the implied \( g \), new equilibrium product offering decisions and prices under the changed economic environment can be predicted. A challenge is that there are many fixed offering cost realizations of \( g \) that give rise to the same initial equilibrium offering, but might give rise to different market outcomes following a change in economic conditions. Rather than arbitrarily choosing one particular cost realization consistent with the initial equilibrium offering, we instead determine the likelihood of each such cost value and analyze expected changes in market outcomes given their likelihood.

Let \( G_i(\cdot) \) be the cdf with which \( g_i \) is distributed and \( G = G_1 \times \ldots \times G_I \). Expected market offerings, consumer surplus, and producer surplus are calculated as

\[
\bar{x}_i = \int \hat{x}_i(g) \, dG(g) \quad CS = \int CS_\hat{x} \, dG(g) \quad PS_i = \int \Pi_i(\bar{x}_i, \hat{x}_{-i}) \, dG(g) \quad (8)
\]

### 2.3 Merger Analysis

When two firms merge, there are several mechanisms that could potentially generate incentives for industry participants to change their product offerings. We provide intuitions for the most important mechanisms here and present corresponding merger simulations to illustrate the impact of each.\(^6\)

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\(^6\)Gandhi et al. (2008) also isolate the impact of individual mechanisms on the overall change in product offering decisions. Their analysis focuses on location choice given a fixed number of offered products, so their individual mechanisms relate to how the benefits of joint pricing and the elimination of business stealing incentives affect optimal product location. In contrast, we examine how these two mechanisms (and others) affect the product offering decisions.
**Increasing Prices**  A first, straightforward mechanism may occur as a consequence of post-merger price changes. Holding product offerings constant, merged firms increase their prices. Since competition is in strategic complements, other industry participants would also raise price. The net effect is that, holding product offerings fixed, average prices rise following a merger. The post-merger price increases may induce more entry, as the firms may now find it profitable to offer a product that wouldn’t have been profitable under the lower pre-merger prices. This increase in entry may subsequently reduce the initial price effect as new products generate additional price competition.

**Saving on Fixed Costs**  A second potential effect arises from the merging firms internalizing the business stealing effects that their entry decisions (rather than their pricing decisions) have on each others’ profitability. Even when holding prices fixed at pre-merger values, the merged firm may want to cut back on the number of products it offers, decreasing the cannibalization of their own products and saving on the fixed costs of the products being eliminated. Such considerations have been cited in grocery store mergers, such as the 2009 merger between Whole Foods and Wild Oats where the government’s expert testimony argued that this effect would be likely. In response to such a reduction in offerings, other industry participants may increase their product offerings. The net effect would be a reduction in total product offerings, following the same rationale behind competition in strategic substitutes.

**Cost Efficiencies**  Mergers may furthermore generate cost efficiencies for merging parties. Such efficiencies may be in the form of reductions in the fixed costs of offering a product, or in the marginal cost of producing and stocking a product. Depending on the size of this reduction, entry may increase post merger potentially offsetting negative effects on consumer welfare.

**Coordinating on Favorable Equilibrium**  A last mechanism involves the merging firms’ abilities to coordinate on a more favorable equilibrium. Since they now jointly determine the offering decisions for more products, the merging firms have effectively increased the set of actions they can choose among. They may utilize these actions to coordinate on a more favorable equilibrium, one that possibly excludes a rival from entry.

For example, consider a hypothetical setting in which the market can support only one of three products and any one of the products being offered could be an equilibrium: when in the market on their own, each of them would make positive profit, but would no longer break

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7See Kevin Murphy’s expert report (Murphy (2007)).
even when a second product was being offered as well. When firms $A$ and $B$ merge, they can now choose among the two possible equilibria that involve offering either of their products the one that yields more profit; the previous equilibrium in which the least profitable of the two products would be offered is no longer an equilibrium. Formally, the merger eliminates some equilibria that existed pre-merger, in particular all non-coalition-proof equilibria involving a coalition between the merging parties.

To illustrate how such coordination can effectively exclude a rival from the market, consider a linear city, in which $A$ is located in the middle, $B$ and $C$ are located at the ends, and consumers are mostly concentrated towards the middle. In such settings, profits may be such that $A$ enters if either $B$ or $C$ enter, but not both. $B$ and $C$ enter only if $A$ does not. This game has two equilibria in pure strategies, one in which only $A$ enters and one in which $B$ and $C$ enter. A merger between firms $A$ and $B$ would eliminate this last equilibrium whenever $A$’s profits in the presence of $C$ are larger than $B$’s profits in the presence of $C$. In its unsuccessful attempt at blocking the 2003 Oracle-PeopleSoft merger in court, the Department of Justice argued - unsuccessfully - that rivals would not adjust their offerings after the merger, thereby leaving anticompetitive price increases by the merging parties unconstrained. This example suggests that merging parties may be able to exclude the non-merging firm from the market even without changes in pricing.

The effect discussed here, while it results in excluding non-merging parties from the market, is not preemption in the formal sense. Preemption involves committed investments prior to the rivals’ investment decisions. In effect, preemption would require a sequential entry game with committed entry decisions, which we do not analyze in this paper.

We illustrate the significance of each of these forces in a set of simulations involving three firms with one product each. The next section provides detail on the empirical context we use to inform the preferences and cost structures we employ in these simulations.

3 Motivating Example: Premium Ice Cream

The model described above could potentially apply to a wide range of settings represented by a variety of preference parameterizations and cost distributions, so to ground our analysis and illustrate the strength of each of the above incentives, we estimate the above model using real data. Based on prior related work [Draganska et al. (2009)], we use data from the US ice cream industry (focusing on the premium vanilla category), which can be characterized

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8If $C$ enters, $AB$’s best response is to enter with only $A$, in which case $C$’s best response is to not enter, and $AB$’s best response is to continue entering with $A$ alone.

9See McAfee et al. (2007) for a detailed overview of the alleged anticompetitive effects of this merger.
by the proposed model in several important ways. There are two leading national suppliers – Breyers and Dreyers – and various regional players that operate across markets that we collapse into a “composite” firm. Our proposed merger simulations, then, could be thought of as a hypothetical merger between Breyers and Dreyers. As in Gandhi et al. (2008), we also simulate situations in which the merging parties choose prices as a joint firm but entry decisions as independent organizations, and vice-versa, jointly determining entry decisions, but pricing as independent organizations. These simulations allow us to dissect how important each of the above incentives are individually.

Consistent with the model described in section 2, we parameterize demand for each brand and flavor of vanilla ice cream. Specifically, we allow demand to vary with price scaled by a price coefficient, \( \alpha \), with brand, assuming a brand-specific mean-utility shock \( \theta_{js} \) that is normally distributed with mean \( \mu_F \) and variance-covariance \( \Sigma_F \), and with idiosyncratic tastes, captured with a T1EV shock with scale parameter \( \sigma \). The variance matrix on the random utility assumes products are ‘horizontally’ equidistant, with travel parameter \( \rho \):

\[
\Sigma_F = \begin{bmatrix}
1 & \rho & \rho \\
\rho & 1 & \rho \\
\rho & \rho & 1
\end{bmatrix}
\]

(9)

Marginal cost is characterized by a brand-specific, constant, variable cost \( c \). Lastly, we parameterize entry costs by a brand-specific censored normal distribution with mean parameter \( \gamma_G \), variance parameter \( \nu_G \), lower censoring at 0, and no upper censoring. It is these parameters, \((\alpha, \mu_F, \rho, \sigma, c, \gamma_G, \nu_G)\), that we calibrate using our US ice cream data.

Ice Cream Data We observe monthly sales (quantity and revenue) of ice-cream in 63 US geographic markets from July 2003 to June 2005. \(^{10}\) We focus on the premium vanilla ice cream category sold in 3.5 and 4 pint containers. Between the two nationwide manufacturers and the composite third brand, there are a total of 14 premium vanilla flavors in the data. We use the monthly sales of each flavor in each market, together with the assumption that the potential premium vanilla ice cream market is defined by the monthly per-capita consumption of all premium ice cream flavors (i.e. vanilla and non-vanilla flavors) estimated in the trade press, scaled by each market’s population, to estimate a random coefficients demand model. This estimated demand model is used to obtain estimates of price elasticities, which are then in turn used to calibrate the above parameters.

\(^{10}\)For an in-depth description, see Draganska et al. (2009)
Estimating Demand for Premium Vanilla Ice Cream In estimating a random-coefficients demand system, we allow the utility of each product (a brand-flavor pair) to vary with price, brand, flavor, and demographic variables that capture overall demand for vanilla ice cream. We specify heterogeneous preferences for price, brand, and flavors. We assume that price responsiveness is distributed normal, with mean and variance parameters. Preferences over brands are assumed to be distributed joint-normal, with distinct mean values for each of the three brands and with a completely flexible variance-covariance matrix that captures correlations in heterogeneous preferences across brands. Preferences for each flavors are assumed normal, with a flavor-specific mean value and a variance parameter common to all flavors. More details are given in the appendix. After estimating the demand model, we calculate brand-specific price elasticities for each market and each month. These elasticities, along with observed shares, are used to calibrate the demand parameters (i.e. \((\alpha, \mu_F, \rho, \sigma)\)), as described below.

Calibrating Demand Parameters While it would be computationally feasible to simulate merger effects for the full set of empirically offered flavors, we focus our simulations on the case where each of the three brands offers a hypothetical single flavor only. This both greatly simplifies the exposition that follows and allows a clear focus on the main trade-offs and effects of a merger between two of the brands. We therefore use the estimated demand system to calibrate preferences that are consistent with the overall patterns in the data but assume that all of the brands’ sales derive from a single flavor only. Specifically, we calculate mean observed market shares per brand relative to the potential market and mean observed prices, where we average across all markets and months.\(^{11}\) We also calculate an average price elasticity, by averaging the brand-specific price elasticities (estimated through the demand estimation detailed above) across all markets and months that shared a common portfolio of flavors. We use the most frequently observed portfolio of flavors across markets and months.\(^{12}\) These average shares, prices, and elasticities are:

\(^{11}\)Breyers and Dreyers do not employ flavor-specific prices, charging the same price for each flavor, which we employ here. For the composite third brand, we use a sales-weighted average price of all flavors offered in the given market-month.

\(^{12}\)As the flavors offered differ across markets and time, elasticities differ due to entry and exit in addition to the estimated preferences for flavors. By only considering market-months with the same flavor offerings, the average elasticities are not affected by differences in entry/exit. To calculate the average elasticity over the most market-months possible, we chose the product portfolio that was most commonly offered across market-months, the modal product portfolio.
\[s_B = 5.6\% \quad p_B = $3.75\]
\[s_D = 3.4\% \quad p_D = $3.47\]
\[s_C = 3.1\% \quad p_C = $3.57\]

\[
\xi = \begin{bmatrix}
B & D & C \\
-3.05 & 0.10 & 0.09 \\
0.18 & -2.89 & 0.09 \\
0.18 & 0.10 & -2.99
\end{bmatrix}
\]

Using the nine elasticities, together with observed mean prices and shares, we calibrate the price coefficient \((\alpha)\), mean utilities \((\mu_F)\), and the covariance parameter \(\rho\) in \(\Sigma_F\) so that predicted shares and elasticities implied by the model in Equations 2 and 6 match those implied by the data in Equation 10. As there are only five parameters but twelve equations, we calibrate the parameters by minimizing a weighted sum of squared differences between the predicted values and the observed values. The T1EV scale parameter \(\sigma\) is set to 1/8.

The calibrated mean utilities are, for Breyers, Dreyers and the composite firm, respectively, \(-0.24\), \(-0.42\), and \(-0.40\). The difference between Breyers’ calibrated mean brand preference and others’ reflects the much larger market share that Breyers has relative to others, despite having a higher price. In contrast, Dreyers’ and the composite firm’s calibrated mean brand preferences are similar, as differences in market shares between the two are justified by differences in prices, and hence need not be justified by differences in mean preferences. The price coefficient \(\alpha\) is calibrated at \(-0.39\) and the correlation parameter \(\rho\) is 0.17. The low correlation parameter reflects the small cross-price elasticities observed in Equation 10, which are about 4% of the own-price elasticities. That is, consumers are much more likely to buy the outside option of non-vanilla flavored ice cream than to switch brands if firms were to increase prices, and a small \(\rho\) captures this.

In what follows below, we frequently summarize the degree of differentiation between brands, estimated via \(\rho\), using diversion ratios. We derive a diversion ratio from a particular product \(A\) to another product \(B\) as \(-\frac{\partial s_B}{\partial p_A} / \frac{\partial s_A}{\partial p_A}\), evaluating the market share responses at equilibrium prices. For the calibrated model, with a value of \(\rho\) of 0.17, diversion ratios are relatively low, driven by the low cross-price elasticities between brands. For example, when all three brands offer their flavor, the largest diversion ratio is from the composite firm to Breyers, with a value of five percent. The diversion ratio from Breyers to Dreyers is four percent.

13 The three share equations are given three times the weight of the nine elasticity equations such that half of the identifying variation arises from elasticities and the other half from mean market shares.

14 We also tried calibrating the T1EV scale parameter along with the other parameters. However, the calibrated scale value \((\sigma)\) resulted in large values. As a goal of the simulations below is investigating the role of bringing products closer or farther apart, a large \(\sigma\) limits how much closer products can be from each other. Hence we preferred to fix \(\sigma\) at a low value and calibrate the remaining parameters.
Calibrating Marginal Cost Parameters  

Optimal brand pricing implies the Lerner index must be inversely proportional to own-price elasticities. Hence, using observed prices and estimated elasticities, we calculate marginal cost as $c_i = p_i (1 + 1/\xi_{ii})$. These calibrated costs imply markups of approximately 50 percent. As own price elasticities are approximately the same across the three brands, differences in calibrated costs are proportional to differences in prices, where Breyers’ calibrated cost is $2.52$, Dreyers’ is $2.27$, and the composite firm’s is $2.37$.

Calibrating Entry Cost Parameters  

In an equilibrium of our product offering game in Section 2, a firm offers its product if $\pi_i \geq g_i$ given the offering decisions of its rivals. While we assume $g_i$ to be known by all players, a range of fixed offering costs are consistent with the observed outcomes in the data. The observed offering frequencies across markets are informative of the range of fixed costs that are consistent with offering a given product and, together with an assumption on the distribution of such fixed costs, allow us to calibrate the parameters of said distribution. We assume that $G$ follows a censored normal distribution with lower censoring at 0 and no upper bound. The probability of observing a firm offering a product in equilibrium, abstracting for simplicity from multiple equilibria, is then given by $G(\pi_i | \gamma_G, \nu_G)^{15}$ We calibrate $\gamma_G$ and $\nu_G$, by matching $G(\pi_i)$ to observed data patterns, separately for each brand. To do so, we need two key values: predicted profits when offering a flavor ($\pi_i$) and the frequency of product offering. In addition, we need information on how differences in predicted profits correlate with differences in frequencies of product offering.

To obtain frequencies of product offering, for each brand we work with one “optional” flavor – the particular vanilla flavor that had the most variation in how often it was offered across markets and months, treating all flavors of the fringe brands as though they were controlled by the single composite firm.\(^{16}\) For each brand, we segment all market-months into four categories depending on rivals’ offerings of their optional flavors: both rivals offer it, neither offers it, rival 1 does but not rival 2, and vice-versa. For each category and brand, we calculate the percentage of times the brand offers its optional flavor. To obtain the predicted profits of offering a flavor, we rely on the calibrated demand model and calibrated variable costs to calculate the profits that a single-product firm would have obtained by offering its product, according to the model and the configuration of rivals’ offerings. As the model predicts different profits depending on rivals’ product offering, we calculate

\(^{15}\)In the presence of multiple equilibria, this simplified way of integrating over the distribution of fixed cost would yield probabilities that sum to more than one. As we illustrate below, however, the incidence of multiple equilibria at the calibrated covariance between brand tastes is extremely low.

\(^{16}\)For Breyers, that is Homemade Vanilla, offered in 87 percent of all market-months; for Dreyers, it is Vanilla Custard at 44 percent; and for the Composite brand, it is Natural Vanilla at 25 percent.
four distinct profit values for each brand, according to rival offering. These four predicted profits can be associated with the four offering frequencies; observing multiple predicted profit and offering frequencies allows to calibrate not only the mean, but also the variance of the fixed offering cost distribution.

For each brand, we use the four variable profits and offering percentages to calculate average values ($\bar{p}_i$, $\bar{\pi}_i$) and standard deviations ($\sigma^p_i$, $\sigma^\pi_i$), in which we use the total number of market-months in each category as weights. These six value pairs, two for each brand, are then used together with our assumption of a censored normal distribution for $G$, to calibrate $\gamma_G$ and $\nu_G$ by inverting:

$$p_i = G(\pi_i | \gamma_G, \nu_G) \quad (11)$$
$$\bar{p}_i - \sigma^p_i = G(\bar{\pi}_i - \sigma^\pi_i | \gamma_G, \nu_G) \quad (12)$$

While restrictions such as the ones in Equations 11 and 12 are not typical characterizations of an entry game, we impose them so that the fixed cost distributions, $G$, can be grounded in observed empirical regularities. Equation 11 centers the distribution such that average predicted variable profits induce the average offering incidence observed in the data. Equation 12 scales the distribution such that the variation in predicted profits corresponds to the variation in the offering incidence. We could have used any of a number of alternative restrictions, as well as alternative measures of central tendency and variation, such as the median value and range, and we would not expect the resulting calibrated distributions to be qualitatively different.

Calibrating the fixed cost distributions under these restrictions has two significant advantages over a traditional static entry game estimation where each set of offering decisions in a given market-month is treated as an independent outcome of the game. First, it is much easier to implement. Second, it guarantees monotonicity between $\pi$ and $G(\pi)$ (i.e. $\pi_1 > \pi_2 \iff G(\pi_1) \geq G(\pi_2)$). If this monotonicity were violated – as it is, on average, in the observed data where predicted profits are higher in market-months in which a flavor is not offered than in those in which it is – the static entry game approach would yield a calibrated distribution that is much more spread out with variable profits being relatively uninformative of entry decisions. Table 1 shows the entry probabilities from the observed data, predicted by the calibrated values, and predicted by parameters obtained from a static entry game estimation (detailed in the appendix, presented for reference). As the table shows, the static entry game significantly overpredicts Breyers’ entry decision and underpredicts Dreyers’, driven by extreme distributions: low cost, low variance for Breyers, large variance for Dreyers. By construction, the calibrated values from inverting Equation 11 most closely...
Table 1: Product Offering Probabilities, by Rivals’ Actions

<table>
<thead>
<tr>
<th>Rivals’ Actions</th>
<th>Observed</th>
<th>Calibrated</th>
<th>Estimated</th>
</tr>
</thead>
<tbody>
<tr>
<td>(∅)</td>
<td>607</td>
<td>0.80</td>
<td>0.88</td>
</tr>
<tr>
<td>(D)</td>
<td>490</td>
<td>0.91</td>
<td>0.86</td>
</tr>
<tr>
<td>(C)</td>
<td>198</td>
<td>0.90</td>
<td>0.86</td>
</tr>
<tr>
<td>(D,C)</td>
<td>154</td>
<td>0.96</td>
<td>0.85</td>
</tr>
<tr>
<td>(∅)</td>
<td>168</td>
<td>0.26</td>
<td>0.47</td>
</tr>
<tr>
<td>(B)</td>
<td>929</td>
<td>0.48</td>
<td>0.45</td>
</tr>
<tr>
<td>(C)</td>
<td>26</td>
<td>0.27</td>
<td>0.45</td>
</tr>
<tr>
<td>(B,C)</td>
<td>326</td>
<td>0.45</td>
<td>0.43</td>
</tr>
<tr>
<td>(∅)</td>
<td>143</td>
<td>0.13</td>
<td>0.26</td>
</tr>
<tr>
<td>(B)</td>
<td>662</td>
<td>0.27</td>
<td>0.25</td>
</tr>
<tr>
<td>(D)</td>
<td>51</td>
<td>0.14</td>
<td>0.25</td>
</tr>
<tr>
<td>(B,D)</td>
<td>593</td>
<td>0.25</td>
<td>0.24</td>
</tr>
</tbody>
</table>

In column (2), we denote as (∅) instances where neither of the two rivals of the firm in each column offers its optional flavor, as (A) cases where only rival A offers its optional flavor, and as (A,B) cases where both rivals A and B offer their optional flavors.

In calculating predictions, we estimate mean parameters and standard deviation parameters of a censored normal distribution. The data are divided into segments: 0.80, 0.88, 1.00 for Breyers; 0.26, 0.47, 0.17 for Dreyers; and 0.13, 0.26, 0.25 for the composite firm. The calibrated mean of the censored normal distribution are -0.006, -0.012, and -0.020 for Breyers, Dreyers, and the composite firm, respectively. As in calculating predicted profits, market size is normalized to ‘1’, these fixed cost parameters are calibrated relative to a dollars per unit of market size. The calibrated standard deviations are 0.040, 0.087, and 0.158, respectively. As the distributions are censored at zero, negative mean parameters imply the densities of the distributions are decreasing everywhere: costs are distributed according to a right tail of a normal distribution. Breyers has a higher calibrated mean parameter than the other two brands but a much lower standard deviation parameter, reflecting the empirically observed much higher frequency of offering its product, which is justified in the calibration by lower offering costs. Breyers’ average cost is just 0.030, compared to an average cost of 0.065 for Dreyers and of 0.119 for the composite firm. Breyers’ lower standard deviation is driven by the fact that Breyers’ predicted profits are affected more by rivals’ entry than vice versa and Breyers’ variance in offering incidence not being very large.

Varying the Degree of Differentiation  The demand calibration process just described fixes the ‘distance’ between products. As discussed above, we calibrate ρ to 0.17, a value at which products are relatively far from each other. Although this is driven by the low
estimated cross-price elasticities (see Equation 10), one may be interested in how the effects of a merger vary with the degree of product substitutability. To analyze mergers in settings with varying degrees of differentiation, in the simulations that follow we vary $\rho$ between 0 and 1\textsuperscript{17} where large values of $\rho$ imply products are close substitutes to each other while low values of $\rho$ imply products are further apart. As we vary $\rho$, we describe the degree of differentiation using diversion ratios instead of values of $\rho$, as we believe them to be easier to understand and apply than a primitive of the underlying demand model. We thus divide the range of $\rho$ values from 0 to 1 into a 200 point grid, where grid points are spaced at a decreasing rate such that the resulting grid of diversion ratios implied by each value of $\rho$ is equally spaced.

**Multiplicity of Equilibria** The entry game described in section 2 may have a multiplicity of equilibria: for example, both firm A offering its product and not firm B, or B offering its product and not A may be equilibria, depending on relative payoffs and market sizes. In such instances, we impose an equilibrium selection rule to select among multiple equilibria; we use the equilibrium that yields highest industry profits.

The degree to which merger effects may be sensitive to the choice of such an equilibrium selection rule depends in part on the frequency with which multiplicity of equilibria occur. We explore the incidence of multiplicity of equilibria in the above calibrated model by noting how often we observe scenarios in which a particular brand offers its product in one or more equilibria but does not offer its product in alternative equilibria. For these cases, we quantify the frequency with which the selection rule choosing the most profitable industry equilibrium would yield an equilibrium in which the brand indeed offers its product. Table 2 shows these values for three levels of the product differentiation parameter $\rho$, expressed as the implied diversion ratios from Breyers to Dreyers, based on 100,000 simulated triplets of product offering fixed costs drawn from the calibrated distribution of $G$\textsuperscript{18}.

As is apparent from the table, multiple equilibria are not very common. At the calibrated degree of product differentiation $\rho$, which implies a diversion ratio of 4 percent from Breyers to Dreyers, the incidence of multiple equilibria is less than 0.07 percent of the 100,000 simulation draws. In addition, the equilibrium selection rule chooses the equilibrium in which each brand offers its product at least 60 percent of the time. This implies, for example, that

\textsuperscript{17}Although $\rho$ could span from $-0.5$ to 1 and $\Sigma_F$ would still retain positive definiteness, at $\rho = 0$ products are already poor substitutes to each other. Lowering $\rho$ further would hardly separate products further, resulting in no additional effects of interest.

\textsuperscript{18}The levels of $\rho$ that we choose correspond to the calibrated, low value of $\rho$, an intermediate value, and a high value corresponding to a diversion ratio of 30%. The presence in the demand model of the individual specific idiosyncratic preference shifter $\epsilon$, with its T1EV distribution with assumed scale parameter of $\sigma = 0.18$, caps diversion ratios at approximately 35% for a value of $\rho$ of 1.
Table 2: Multiplicity of Equilibria under Alternative Degrees of Product Differentiation

<table>
<thead>
<tr>
<th>Incidence of multiple equilibria (%)</th>
<th>Diversion Ratio, Breyers to Dreyers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall</td>
<td>4%</td>
</tr>
<tr>
<td></td>
<td>0.07</td>
</tr>
<tr>
<td><strong>With Changed Offerings for Brand:</strong></td>
<td></td>
</tr>
<tr>
<td>Breyers</td>
<td>0.05</td>
</tr>
<tr>
<td></td>
<td>( 59% )</td>
</tr>
<tr>
<td>Dreyers</td>
<td>0.05</td>
</tr>
<tr>
<td></td>
<td>( 65% )</td>
</tr>
<tr>
<td>Composite</td>
<td>0.03</td>
</tr>
<tr>
<td></td>
<td>( 94% )</td>
</tr>
</tbody>
</table>

This table summarizes the incidence of multiple equilibria at the calibrated mean brand preference and price sensitivity parameters and three alternative brand preference covariances, $\rho$, expressed as diversion ratios from Breyers to Dreyers when all products are offered. $N = 100,000$ draws from the calibrated fixed cost distribution $G$. In addition to the overall incidence of multiple equilibria, we display the percentage of simulation draws with multiple equilibria where the row brand offers the product in one equilibrium, but not another, together with, in parentheses, the percent of draws with such multiple equilibria such that the industry-wide most profitable equilibrium is one where the brand offers its product.

if we changed the equilibrium selection rule to one where we always selected the equilibrium in which Breyers offers its product when a second equilibrium exists in which it does not, market outcomes would change in only 41 percent of the 0.05 percent of cases that involve such multiple equilibria, or 0.02 percent of cases.

At higher diversion ratios, multiple equilibria are more common, as products compete more closely against each other and, as a result, it becomes common that the market can support only one of these closer substitutes. However, even at a diversion ratios of 30 percent, corresponding to a product differentiation parameter $\rho$ of 0.97, the incidence of multiple equilibria remains limited at below 7 percent of fixed cost draws, and the instances where the equilibrium selection rule substantively changes outcomes are even fewer. Again, using Breyers as an example, if in cases of multiple equilibria where Breyers sometimes, but not always, offers its product, we always selected an equilibrium where Breyers offered its product instead of choosing the industry-wide most profitable equilibrium, market outcomes would change in at most 3.2 percent of cases.

4 Merger Simulations

Having calibrated parameters using data from the ice cream industry, we turn to simulations of the changes in market outcomes induced by a hypothetical merger between two market
participants. The simulations represent a detailed examination of an example motivated by the empirical ice cream case, but abstract from this setting in a number of ways. We focus on a single, rather than the full set of, flavors for each of the three competitors, which we refer to generically as A, B, and C. We connect to the example by representing preferences for brand A’s product and the costs associated with offering its product using the calibrated preference and cost parameters for Breyers, demand and costs for B’s product is described by calibrated preferences and costs for Dreyers, and for C from the Composite brand.

We begin our first set of simulations by analyzing the effects of a merger between A and B on a number of outcomes including price, consumer surplus (CS) and firm profit (π), capturing the combined effect of the various mechanisms described in Section 2.3. We compare expected outcomes, integrating over the product offering fixed cost distribution, under a market structure with three independent profit maximizing firms to the same expected outcomes under a market structure where two of the competitors maximize profit jointly in making both of the firms’ strategic decisions: choosing which products to offer in the market place, and – given the chosen product set – how to set prices. As the analysis averages welfare changes across possible market outcomes induced by possible fixed cost values, it is the relevant comparison for policy makers looking to develop general merger guidelines. An alternative comparison relates pre-merger outcomes given an observed market structure to expected post-merger outcomes; this is useful in analyzing specific merger cases. In a subsequent figure, we show this comparison, conditioning on the specific product offerings predicted to exist prior to the merger.

Figure 1 shows the difference in key market outcome measures between a setting in which all three firms are independent (O-subscript) and one in which A and B have merged (M-subscript). The figure is constructed as follows. We simulate 100,000 draws from each of the three products’ fixed offering cost distributions and hold those draws fixed for the simulation exercise. For a given value of the product differentiation parameter ρ and associated diversion ratio from A to B and for a given ownership structure (A and B operating independently or operating as a merged firm), we calculate the equilibrium of the two stage product offering and pricing game for each triplet of product fixed costs. We also record market outcomes under the resulting equilibrium, including the product offering decision for each product, equilibrium prices, market shares, consumer surplus and firm profits. We then average across the simulated fixed cost draws to obtain expected market outcomes. We repeat this exercise for different values of ρ. Figure 1 depicts the expected product offering frequencies for each of the three flavors under the two ownership structures, together with the change in the remaining expected market outcomes expressed as percentage differences in moving to firms A and B operating jointly from operating independently. To focus attention on outcomes
Figure 1: Net Effect of a Merger as a Function of the Degree of Product Differentiation: Three Equi-Distant Products

Product differentiation, on the x-axis, is the diversion ratio from $A$ to $B$, derived from the underlying value of $\rho$. See text for details.
likely to occur from proposed mergers, we censor fixed-cost draws such that the merger is always profitable for the merging parties when calculating expected values. That is, we only retain fixed-cost draws for which, if given the option to merge, firms $A$ and $B$ would gladly accept, or at least be indifferent to continuing standalone operations. This censoring does not materially affect our results as a merger rarely results in the firms earning less profit than when operating alone. In contrast to the setup considered by theoretical merger analyses, firms here incur a fixed cost of offering a product, but not a sunk cost of introducing it. When costs are sunk, as in Cabral (2003), a merger that reduces pricing pressure can induce entry, resulting in losses for the merging party. In our setting, firms can always choose not to offer the product themselves. In doing so, firms mitigate, and in many cases avoid altogether, the losses due to rival entry induced by the post-merger reduction in pricing pressure.

The figure is a double-axis plot. The left axis measures the percentage difference in expected consumer surplus, expected market price averaged across firms, and expected profits between the two scenarios for the merged (combined) and remaining firms. The right axis measures the product offering frequency for each product in the two scenarios.

The x-axis measures how close products are to each other. Instead of plotting the value of $\rho$, we show the diversion ratios between two products, as a measure of product closeness. In Figure 1, as in the following figures, we show the diversion ratio from product $A$ to $B$ on the x-axis. A green line marks the diversion ratio corresponding to a $\rho$ value of 0.17, the calibrated value from the ice cream data. At the extreme left of the plot, products are ‘almost’ local monopolies ($\rho \to 0$) and diversion ratios are close to zero. At the extreme right of the plot products are ‘almost’ perfect substitutes ($\rho \to 1$), with diversion ratios above 35 percent. A diversion ratio of 50 percent indicates perfect substitutes, as one half of $A$’s lost sales following a price increase would go to $B$ and one half to $C$.

The size of the effects shown in Figure 1 varies substantially with the degree of substi-

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19We find that this censoring removes less than one percent of fixed cost draws across across all differentiation values ($\rho$). Such a profit reduction could occur if the decrease in pricing pressure due to joint pricing post-merger would induce entry by firm $C$, and such entry would significantly decrease firm profits. However, such events are rare as they require $A$ and $B$ being sufficiently close substitutes that pricing pressure is significantly reduced with the merger, but not so close that both products would not both be offered without the merger, and $C$ being a sufficiently close substitute to $A$ and $B$ that entry is not profitable without the merger but profitable with the merger.

20Since diversion ratios depend not only on the covariance in brand preferences $\rho$, but also vertical and price differences between products, the diversion ratio from $A$ to $B$ does not necessarily equal the diversion ratio from $A$ to $C$, say, even though preferences for $A$ and $B$ covary identically to preferences for $A$ and $C$ through the common $\rho$ and the products are thus equi-distant from each other in terms of horizontal product differentiation.

21We say products are ‘almost’ local monopolies or ‘almost’ perfect substitutes because the type one extreme value distribution for consumers’ idiosyncratic product preferences induces some minimal degree of differentiation between products.
tution. For intermediate values of product differentiation – diversion ratios of around 20 percent – the effects of a merger are largest: due to the merger, consumer welfare falls by up to 13 percent on average; profits increase by 5 percent and by up to 3 percent for the non-merging party. The effects of the merger on consumer and producer surplus are largest at such intermediate diversion ratios because at the extremes, the merger does not confer additional market power: with very low diversion ratios, products are almost local monopolies; each product has full market power in their ‘local market’ prior to the merger. With extremely high diversion ratios, products are so substitutable to each other that the market can support at most one product. As a result, transferring ownership of potential products does not change outcomes significantly as the market continues to support only one product.

Figure 1 also highlights how product offering decisions differ across the two ownership scenarios. For each firm, the heavy dashed line shows how frequently its product is offered in the independent market structure and the lighter dashed line in the scenario where A and B have merged. For A and B, the merger results in products being offered less frequently. In particular B’s product is culled frequently. Due to its weaker demand (exhibited through lower mean preferences), the gain in variable profit from offering A rather than B exceeds the difference in expected fixed product offering cost, conditional on such costs being less than variable profit of A rather than B. These conditional expected costs are determined by the mean and standard deviation parameters discussed above; given brand A (Breyers)’s distribution has a higher mean but lower standard deviation than brand B (Dreyers)’s, it is not clear ex-ante that one brand would have, on average, higher conditional expected costs than the other brand.

For firm C, the merger increases product offering frequencies marginally. The offering frequencies under the two alternative market structures mask various offsetting effects that drive product offering decisions – incentives to add products due to less intense price competition, in particular for the non-merging firms and to cull products through the internalization of business stealing for the merging parties. We explore these in greater in Sections 4.1 through 4.4.

A merger simulation that only accounts for price changes and omits the possibility of changes in product offering can significantly mis-represent expected changes in market outcomes. However, the mis-representation is severe only if the merger would induce large changes in product offering. In Figure 2 we show the changes in expected market outcomes that a ‘price-only’ merger simulation would predict. For these simulations we first calculate product offering decisions assuming firms A and B price independently and choose product

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22 If two competing products were to be offered they would be priced at marginal cost and would not recoup their fixed costs; a second noncompeting product would fully cannibalize sales of the first.
Figure 2: Net Effect of a Merger Holding Product Offering Constant
(i.e. ‘Price Only’ merger)

Product differentiation, on the x-axis, is the diversion ratio from $A$ to $B$, derived from the underlying value of $\rho$. See text for details.

offering decisions independently. We then calculate prices under this setting (independent pricing; $O$-subscript) and under a setting in which firms $A$ and $B$ price jointly ($M$-subscript), holding the product offering decisions fixed.

The effect of a merger on producer and consumer surplus differ across figures 1 and 2, indicating that using a ‘price-only’ merger simulation to assess potential merger effects when firms can easily re-optimize their product offerings would mis-represent the effects of such a merger. Specifically, the expected changes in consumer surplus and producer surplus are underestimated with a ‘price-only’ merger simulation, as merging firms are likely to cull products resulting in higher profit gains and higher consumer surplus losses. As evidenced in Figure 1, these effects are strongest when products have intermediate diversion ratios; we investigate the role of the diversion ratio on the individual trade-offs that drive equilibrium offering decisions most merger in greater detail below.

In Figure 1 we compare expected effects across all possible product offering outcomes induced by potential variation in fixed costs. Therefore, we necessarily include market out-
comes in calculating expected merger effects in which the pre-merger product set included none of the merging firms’ products. In the case of a 20 percent diversion ratio, for example, neither firm A nor B offer their two potential products in five percent of fixed cost realizations; by construction there is no change in outcomes post-merger. Including such cases may mask the expected merger effects.

Consequently, the next figures, Figures 3 and 4, focus separately on merger effects for each of the pre-merger product configurations that could arise when the three firms independently maximize profits. In a setting where the three firms can offer one product each, there are eight possible product configurations to consider, each of which is depicted in one of the eight panels in the two figures. Comparing across the panels, we see that there is little to no impact associated with A and B jointly maximizing profits in most of the possible baseline product configurations. A merger between A and B has the greatest potential impact in the baseline product configurations in which both A and B offered their products. Focusing attention on the panel for this (1,1,0) case, first note that we have removed the lines for the baseline product offering frequencies, which are fixed by construction to one for each A and B and zero for C. We have also removed the percent change in profit for C. The remaining effects are larger than in Figure 1 where we average over all eight baseline product configurations.

The figures also highlight the role of ownership structure in affecting post-merger product offering choices. A comparison of, for example, the (0,1,1) baseline graph relative to the (1,0,1) baseline graph suggests the joint firm benefits more with the merger if the pre-merger market structure is (0,1,1) than if it is (1,0,1). This occurs because A’s demand and cost structures differ from B’s, such that joint-pricing reduces price pressure for A more than it does for B, inducing the firm to offer both products more often in settings where pre-merger only B was offered relative to setting in which pre-merger only A was offered.

In the rest of this section, we look separately at the individual mechanisms underlying the overall changes to market structure show in Figure 1. We also focus on the particularly

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23 We summarize each product configuration with a triplet of offering indicator variables that are equal to one if the firm chooses to offer its product and zero when it does not. For example, the ordered triplet (1,0,1) describes a product configuration in which firms A and C offer their products, but firm B does not. 24 We construct each panel by identifying that pre-merger set of fixed costs realizations that give rise to the product configuration under consideration and integrate over that subset of G to derive expected merger effects in the particular scenario. 25 The decline in B’s offering incidence in the (0,1,1) panel is driven by the merged firm coordinating on a more favorable equilibrium that excludes firm C. Due to A’s dominant demand position, there are settings in which there are two equilibria: (0,1,1) and (1,0,0), and in which the former generates higher industry profits than the latter. Given the equilibrium selection rule assumed, the former is the equilibrium that arises prior to the merger. However, the merger allows the merging party to eliminate such equilibrium by offering A instead of B, increasing the joint-firms profits and inducing C to not offer its product.
relevant pre-merger product configurations when we highlight the individual mechanisms below.

4.1 Increasing Prices

The first mechanism we illustrate is how allowing firms A and B to set prices for their products jointly may induce them to also increase their product offering. To isolate this mechanism from the others, we model the merger as one in which both firms make independent product offering decisions – that is, they do not internalize the effect entry has on the other’s profit – but allow the firms to price jointly after the entry stage of the game has been played. Anticipating higher prices and profits by reducing price competition, each firm may choose to offer a product that it previously found unprofitable to offer. By artificially separating the product offering from the pricing stage, we abstract from the incentive to reduce product offerings to save on fixed costs and to coordinate on favorable equilibria.

This particular mechanism is only relevant in certain baseline product configuration scenarios, specifically in cases where at least one product is offered by A and B pre-merger. In cases where neither A nor B offers its product under independent pricing, joint pricing cannot induce additional offerings; adding just one product would not produce the benefit of joint pricing. Figure 5 thus has four panels, focusing on the baseline product configurations of (0,1,0), (0,1,1), (1,1,0), and (1,1,1). The analogous cases of (1,0,0) and (1,0,1) are presented in an Appendix.

To begin, focus on the (0,1,1) panel as the pre-merger product configuration, where B and C offer their products, but not A. In this scenario there are some (higher) values of the diversion ratio for which the higher prices from joint pricing induce the merged firm to offer product A when it would have not otherwise. The additional entry of A can induce firm C not to offer its product, resulting in higher profits for the merged firm, an increase in average market price, and a decrease in consumer surplus. In the absence of C in panel (0,1,0), these effects do not occur and the merger has no impact. This occurs because when determining whether to offer product A, the merging firm is trading off earning monopoly profits from A’s new sales (total sales minus sales cannibalized by B) with A’s fixed costs. However, A’s fixed cost must be large, as A was not present pre-merger: A’s fixed cost is larger than the competitive-profits A would have made on all sales.

When the baseline cases are (1,1,0) or (1,1,1), joint pricing allows prices to increase significantly, increasing A, B and C’s profits and hurting consumer surplus. However, C’s presence (baseline (1,1,1)) mitigates these price hikes and drop consumer surplus loss. Of interest is that we do not observe C entering in the (1,1,0) baseline, as would have been
Each panel corresponds to a specific baseline product offering set. Product differentiation, on the x-axis, is
the diversion ratio from A to B were all products offered, derived from the underlying value of \( \rho \). The left
axis corresponds to the solid lines, showing percentage change in consumer surplus, average market price,
and profits. The right axis corresponds to the dotted lines, corresponding to the frequency with which each
products is offered whenever A and B are merged. See text for details.
Each panel corresponds to a specific baseline product offering set. Product differentiation, on the x-axis, is the diversion ratio from $A$ to $B$ were all three products offered, derived from the underlying value of $\rho$. The left axis corresponds to the solid lines, showing percentage change in consumer surplus, average market price, and profits. The right axis corresponds to the dotted lines, corresponding to the frequency with which each products is offered whenever $A$ and $B$ are merged. See text for details.
Each panel corresponds to a specific baseline product offering set. Only relevant panels shown. Product differentiation, on the x-axis, is the diversion ratio from A to B were all three products offered, derived from the underlying value of ρ. The left axis corresponds to the solid lines, showing percentage change in consumer surplus, average market price, and profits. The right axis corresponds to the dotted lines, corresponding to the frequency with which each product is offered whenever A and B are merged. See text for details.
Each panel corresponds to a specific baseline product offering set. Only relevant panels shown. Product differentiation, on the x-axis, is the diversion ratio from $A$ to $B$, were all three products offered, derived from the underlying value of $\rho$. The left axis corresponds to the solid lines, showing percentage change in consumer surplus, average market price, and profits. The right axis corresponds to the dotted lines, corresponding to the frequency with which each products is offered whenever $A$ and $B$ are merged. See text for details.

predicted by some theoretical literature (e.g. Cabral (2003)). There are two reasons why this is so: first, the merger must be profitable for the merging parties for it to be considered. If $C$ were to enter resulting in lower overall profits for the merging firms, we would not observe such merger in the above figures. Second, the absence of $C$ in the baseline case is likely caused by high fixed costs. As the merger does not change these costs, $C$ is likely to remain unprofitable even under diminished pricing pressure.

### 4.2 Saving on Fixed Costs

Firms that are maximizing profit jointly may choose not to offer a product to save on fixed cost of offering it, so long as its remaining product serves a large enough fraction of the market that the culled products had served. To illustrate this mechanism, we focus only on those baseline industry structure scenarios in which both $A$ and $B$ choose to offer products – (1,1,0) and (1,1,1). To focus solely on the culling effect, we assume that firms continue to price independently, as if they had not merged, and that they know they price as such when making initial offering decisions. Nevertheless, they make the offering decision jointly, internalizing the business stealing effects of product introductions.

Figure 6 shows the outcomes of such a merger – the first panel for the (1,1,0) baseline industry structure and the second panel for the (1,1,1) baseline. In both panels, we observe a
substantial decrease in the frequency with which firms A and B offer their products when they jointly optimize their offering decisions. The culling is more pronounced when the diversion ratio between A and B is higher because of the larger business stealing effects as products are more similar – the gain in variable profit is less frequently able to offset the additional fixed cost associated with offering both products. Saving the fixed product offering costs improves profits substantially, while lower product availability and the associated higher prices reduce consumer surplus. Note that the presence of firm C’s offering mitigates these effects; they are more pronounced in the (1,1,0) baseline panel than in the (1,1,1) panel. In the former case, C offers its product slightly more often in response to the merging firms’ culling (not observable in the figure due to scale), but this only has a small offsetting effect on aggregate profits and consumer surplus.

4.3 Product Offering Cost Synergies

4.3.1 Fixed Cost Synergies

In the context of mergers, it is natural to ask how large any cost efficiencies induced by a merger have to be for the merger to be beneficial to consumers? Farrell and Shapiro (1990) take a first stance at this question, calculating the size of the cost efficiencies in a symmetric Cournot setting. In our simulations, we could potentially have more frequent product offerings (and higher consumer surplus), if the merger, for example, induced increased economies of scope associated with offering products. To investigate this possibility, we simulated market outcomes when economies of scope accompany the merger. Specifically, we allow the merging firms’ fixed product offering costs to decrease by 20 percent whenever they offer both products. As firms are endowed with a single product each, these economies of scope are achieved solely through merger activity. Figure 7 shows the outcomes of such a merger, where the setting is the same as that of Figure 1 incorporating all mechanisms and averaging over all baseline product configurations.

The product offering cost synergies have the largest impact when products are far substitutes of each other – at low levels of the diversion ratio, the merging firms offer both product A and product B more often as a result of the reduction in the offering costs post-merger, compared to the firms’ pre-merger offering frequency. As a consequence, up to a diversion ratio of about 10 percent, the availability of additional products creates sufficient value to consumers to offset the merger’s higher prices. Note that there is a range of diversion ratios...
Product differentiation, on the x-axis, is the diversion ratio from $A$ to $B$, derived from the underlying value of $\rho$. See text for details.
tios, between 10 and approximately 18 percent, where the greater product availability is not sufficient to offset the negative impact that the merger’s higher prices has on consumer surplus. Even with economies of scope, the culling effect is still in play; as above, as the diversion ratio increases and business stealing effects grow, the cost savings from the merger synergies are swamped by the benefit of avoiding one product’s fixed costs altogether. Once products A and B are sufficiently close substitutes, their product frequency offering once again becomes lower when A and B jointly optimize. This results in lower consumer surplus at higher diversion ratios – even when there is an offering cost synergy.

4.3.2 Variable Cost Synergies

Economies of scope may affect not only fixed costs but also variable costs, due to, e.g., reduced shipping and handling costs from using centralized distribution facilities in our motivating empirical setting. As with the previous example, we explore how outcomes change with a merger in which the merging firms’ variable costs are reduced by some percentage when both products are offered. Here, we abstract from fixed cost synergies, but to make the simulations comparable to the previous ones, we calculate for each value of the differentiation parameter $\rho$ the percent reduction in marginal cost that implies the same expected total cost savings in the two scenarios – deriving in the above exercise from fixed cost savings, here from variable cost savings – holding fixed the product offering decisions at the ones taken under fixed cost synergies. Said differently, if firms behaved as if they were given fixed cost synergies of 20 percent and had such synergies unexpectedly been replaced by variable cost synergies and the opportunity to re-optimize prices but not offerings, we choose percent marginal cost reductions so the merging firms’ profits would not have changed. On average, across different diversion ratios, these marginal cost reductions amount to 5 percent. That variable cost savings are a quarter of the fixed cost subsidies is consistent with fixed costs being a quarter of variable profits, on average.\(^28\)

Figure 8 shows the results from such simulations. The general patterns are similar to those resulting from fixed cost synergies: the merging firms offer their products more often at high levels of differentiation and this benefits consumers and negatively affects the non-merging firm. As differentiation decreases, market price increases due to joint pricing and the incentive to cull products increases. At very high diversion ratios, the culling incentive swamps all benefits from economies of scope and the merging parties offer their products less frequently than they would have without a merger. Such a reduction in offering frequencies\(^31\)

\(^{28}\) Marginal cost efficiencies are larger (e.g., 6 percent) at low diversion ratios and smaller (e.g., 3 percent) at higher diversion ratios, consistent with the fact that a decrease in marginal costs increases profits more when products are closer substitutes than when they are far substitutes.
Figure 8: Net Effect of Merger With Economies of Scope: Reduction in Marginal Cost When Offering Multiple Products

Product differentiation, on the x-axis, is the diversion ratio from A to B, derived from the underlying value of $\rho$. See text for details.
benefits the non-merging firm.

There are important differences, however, when comparing variable cost synergies to fixed cost synergies: market price is lower and consumer surplus is higher under variable cost synergies than under fixed cost synergies. This is driven by two factors. First, some of the reduction in variable costs is passed through to lower prices for the merging parties, and this price reduction induces the non-merging firm to also decrease price; overall average price decreases. Second, variable cost synergies cause $A$ and $B$ to jointly offer their products in situations where absent cost synergies, the offering would have been $A$ and $C$, or $B$ and $C$. Because of $C$’s induced price response, cost synergies decrease $C$’s profits, incentivizing the merged firm to offer both products in order to discourage firm $C$ from offering its.

Accounting for synergies, $A$ and $B$’s variable costs are, on average, $2.40$ and $2.20$, lower than $C$’s cost of $2.40$, the product of configuration of $A$ and $B$ results in lower market prices, which translate to higher consumer surplus.

### 4.4 Coordinating on Favorable Equilibrium

We conclude our analysis of the different mechanisms behind the patterns displayed in Figure 1 by turning to what we have called a coordination effect above: the ability of the merging firms to choose the most profitable equilibrium for itself in instances where there are multiple equilibria. To isolate the coordination effect and how it affects profits of the merging firms, we explore conditions under which multiple equilibria arise. One consequence of a merger could be that the merging firms make offering decisions that maximize their joint profit. For example, if $(1,0,0)$ and $(0,1,0)$ are both equilibrium outcomes, the merged firm controlling both $A$ and $B$ chooses the more profitable option. When operating independently, however, this choice does not necessarily arise depending on the particular equilibrium selection rule. The profitability of coordination, then, depends on the frequency of multiple equilibria that involve the merging firms’ offering one, but not both, of their products and the difference between the profits in the two equilibrium outcomes.

Similar to the effects discussed above, the importance of this mechanism depends on the extent of substitutability between the merging firms’ products. To illustrate, we return to the original simulation described at the start of Section 4 and displayed in Figure 1. Above, we note when multiple equilibria occur (see Table 2) and now replicate the overall incidence under alternative diversion ratios from $A$ to $B$ in the first row of Table 3 for reference. We then focus on the subset of simulation draws that entail multiple equilibria that lend themselves to coordination effects by the merged firm. As we see in the table, similar to
Table 3: Coordinating on Favorable Equilibrium

<table>
<thead>
<tr>
<th>Diversion Ratio</th>
<th>4%</th>
<th>15%</th>
<th>30%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incidence of multiple equilibria (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overall</td>
<td>0.07</td>
<td>1.33</td>
<td>6.87</td>
</tr>
<tr>
<td>With Coordination Opportunity for Merging Firms*</td>
<td>0.05</td>
<td>1.00</td>
<td>4.96</td>
</tr>
<tr>
<td>Median Increase in Profit (%), Most relative to Least Profitable Equilibrium</td>
<td>44.8</td>
<td>55.2</td>
<td>76.3</td>
</tr>
</tbody>
</table>

This table summarizes the incidence of multiple equilibria at the calibrated mean brand preference and price sensitivity parameters and three alternative brand preference covariances, $\rho$, expressed as diversion ratios from $A$ to $B$ when all products are offered. $N = 100,000$ draws from the calibrated fixed cost distribution $G$. In addition to the overall incidence of multiple equilibria, we display the percentage of simulation draws with multiple equilibria where the equilibria have the merging firms offer different products in at least two of the equilibria.

*Defined as there existing at least one of the following pairs of equilibria: $\{(1,0,0),(0,1,0)\}$, $\{(1,0,1),(0,1,1)\}$, $\{(1,0,1),(0,1,0)\}$, $\{(0,1,1),(1,0,0)\}$, $\{(1,0,1),(1,1,0)\}$, $\{(0,1,1),(1,1,0)\}$.

Multiple equilibria in aggregate, multiple equilibria with coordination opportunities are not common: at the calibrated diversion ratio of 4 percent, there are less than 0.05 percent of instances of multiplicity of equilibria in which $A$ and $B$ have coordination opportunities. For an intermediate diversion ratio of 15 percent, such instances occur with only 1 percent probability, and at the much higher diversion ratio of 30 percent, this probability increases to 5 percent. At all three diversion ratios, the incidence of multiple equilibria with coordinating opportunities is near 75 percent of the incidence of multiple equilibria overall. Hence, most instances of multiple equilibria involve coordination opportunities.

When such multiplicity of equilibria with coordination opportunities occurs, there are potentially large gains from $A$ and $B$ coordinating on the most profitable equilibrium through the merger. We compare profit gains in moving from the least profitable equilibrium to the most profitable equilibrium and display median gains across simulation draws in the last row of Table 3. Simply by coordinating on the most favorable equilibrium, the joint firms can increase joint profits relative to their worst equilibrium by, at the median, approximately 45 to 75%, depending on the degree of differentiation.

---

29 We define multiple equilibria with coordination opportunity as the existence of at least two equilibria in which one of $A$ and $B$'s products is not offered under one equilibrium, but is offered under the other. There are six such pairs of equilibria: $\{(1,0,0),(0,1,0)\}$, $\{(1,0,1),(0,1,1)\}$, $\{(1,0,1),(0,1,0)\}$, $\{(0,1,1),(1,0,0)\}$, $\{(1,0,1),(1,1,0)\}$, $\{(0,1,1),(1,1,0)\}$.

30 We focus on median gains across simulation draws since post-merger profit in the least profitable equilibrium is frequently close to zero, resulting in very large average percent but small absolute profit gains. We compare the most to the least profitable equilibrium, rather than the one chosen by a particular equilibrium selection rule since the latter determines in part the magnitudes of the gains to coordination. Under the
4.5 Benefits from Additional Information

We have so far assumed that firms have complete information regarding the each others’ fixed cost of offering flavors, and profitability more generally. However, it may be the case that information about rivals is not complete and firms must make decisions under uncertainty. These decisions may lead to outcomes that are not ex-post profitable; in an effort to avoid this, firms are cautious when choosing whether to offer their product. In particular, upon deciding to enter, a firm must make strictly positive profits under a ‘good’ outcome, when the rival does not enter, to justify the potential profit loss under a ‘bad’ outcome, when the rival does. This implies that firms enter only when their own product offering costs are low, and overall expected entry is less than when firms know rivals’ profits, as a consequence. A merger provides the merging parties with information on their former rival’s profit, allowing them to avoid being unnecessarily cautious and enter more frequently.\(^{31}\)

To illustrate the effects of a merger in the presence of incomplete information, we modify the entry game described in section 2, following Seim (2006). Specifically, the fixed costs \(g_i\) are known to firm \(i\) but not to rivals. Rivals’ believe that the \(g_i\) are distributed according to the population distribution \(G_i\), and both \(G_i\) and rivals’ beliefs are common knowledge. To calculate a firm’s expected profits and entry decisions, let \(P_{x_i}\) be the probability that all firms assign to firm \(i\)’s entry decision \(x_i\) given \(G(\cdot)\) and define \(P_{x_{-i}} \equiv \Pi_{n \neq i} P_{x_n}\). A firm’s entry decision is then given by:

\[
\hat{x}_i(g_i, P_{x_{-i}}) = \arg \max_{x_i} \sum_{x_{-i} \in \Pi_{n \neq i} J_n} P_{x_{-i}} \pi(x_i, x_{-i}) - g_i' \cdot x_i
\]

and the entry probabilities \(P_{x_i}\) are given by:

\[
P_{x_i} = \mathbb{E}_{G}[\hat{x}_i(g_i, P_{x_{-i}})] \quad \forall i
\]

Equation 14 is a fixed point equation whose solution \((P_{x_i}^*)\) is used to determine entry decisions by each firm. Entry decisions are then given by \(\hat{x}_i(g_i, P_{x_i}^*)\).\(^{32}\)

\(^{31}\)In an incomplete information game, a firm has a cutoff for profitability above which it offers a product (e.g. when fixed costs are low enough, the firm offers the product). Increasing this threshold results in the firm offering the product more often. This is what we imply when we state that firms increase their product offering.

\(^{32}\)As Equation 14 may have more than one solution, an equilibrium selection rule is needed again. We
This figure plots changes in outcomes when, due to a merger, firms A and B learn each others’ fixed offering costs, when previously they knew them in distribution only. Firms continue to make product offering and pricing decisions independently for their products. Product differentiation, on the x-axis, is the diversion ratio from A to B, derived from the underlying value of \( \rho \). The left axis corresponds to the solid lines, showing percentage change in consumer surplus, average market price, and profits. The right axis corresponds to the dotted lines, corresponding to the frequency with which each products is offered whenever A and B are merged. See text for details.

We construct a simulation in which the only effect a hypothetical merger has is that the two merging firms learn each others’ profits as a consequence of the merger. The resulting entry game is one of incomplete information, but one in which firms A and B know each others’ costs but not firm C’s, and firm C does not know either A or B’s costs (see Appendix for details). To isolate the effects of the information gain, we assume in these simulations that firms continue to make entry and pricing decisions independently and without internalizing their actions’ effects on the other’s profits.

Figure 9 plots the effects of such merger. Producer surplus increases significantly, especially when products are close substitutes. The increase in producer surplus is driven by firm
offering its product more often, despite firm $A$ reducing how often it offers its product. The increase in producer surplus is driven both by products being offered more often, and by reducing the number of ‘incorrect’ entry decisions: cases in which both firms chose to offer their product, but the market profitably supported only one. As a result of the decrease in these ‘mis-matches’, price increases and consumer surplus decreases, albeit modestly.

Why does $B$ increase its product offering and why is the increase largest when products are closest substitutes? As described above, when firms have incomplete information about rivals’ actions, they may be overly cautious to avoid losses under an ‘incorrect entry decision.’ This cautiousness increases as the losses from an ‘incorrect entry’ increases, which depends on how close products are to each other and how often rivals enter. $B$ loses more than $A$ from an ‘incorrect entry’ because (a) due to fixed costs and demand, $A$ is in general offered more often then $B$, and (b) due to differences in demand $B$’s drop in profits from $A$’s entry is 10% higher than $A$’s drop from $B$’s entry. As such, $B$ gains the most from eliminating mis-matches, resulting in $B$ offering its product more often. Although $A$ also gains from access to information, and this incentivizes it to offer more, the increase in offering by $B$ causes $A$ to offer less, and the latter incentive dominates. Similarly, $C$’s best response to $B$’s increase in product offering is to retreat from the market, reducing how often it offers its product. This further increases the profits of the merged firm and reduces consumer surplus.

4.6 Sequential Product Offerings and Commitment to Proliferation

In this last section we analyze the value of committed investments, and how such value is affected by joint decision making. A firm with control of multiple products and with a first mover advantage may choose to offer more than one product as a way of deterring other firms from offering products themselves.

In order to study this incentive, we once again modify the entry game. While we return to the perfect information setup, we now consider a setting where firms move sequentially, and not simultaneously, when choosing to offer their products. As the order in which firms move highly affects outcomes, we randomize this order such that for any hypothetical market, all firms have equal opportunity to move first. We then preserve the randomly chosen order in which firms move across the base scenario, where firms operate independently, and the merger scenario, which we discuss below.

Once product offerings are fixed, the merging brands then continue to price simultane-

\[33\] Although $C$’s best response to $A$’s retreat from the market is to offer its product more often, the opposing incentives from $B$’s increase in product offering dominates.
We depict the case where in the pre-merger baseline, firms $B$ and $C$ offer their products. Product differentiation, on the x-axis, is the diversion ratio from $A$ to $B$, derived from the underlying value of $\rho$. The left axis corresponds to the solid lines, showing percentage change in consumer surplus, average market price, and profits. The right axis corresponds to the dotted lines, corresponding to the frequency with which each products is offered whenever $A$ and $B$ are merged. See text for details.

Initially as above. To avoid confounding the incentives generated by commitment with others, we model $A$ and $B$ as pricing independently after product offering decisions have been made.

We model a merger between $A$ and $B$ as one in which $B$ obtains decision rights over offering $A$’s product. The merger affects the sequence of product offering decisions as follows. If we randomly drew the sequence of moves to be $A$, followed by $C$ and lastly $B$, the brands would, when operating independently, make their product offering decisions sequentially in this predetermined order. Under a merger that assigns $B$ decision rights over $A$’s offering decision, $C$ would move first and $B$ would move last, making offering decisions for both brand $A$ and its own products. Brand $B$’s position in the order of moves pre-merger thus determines when both $A$ and $B$’s product offering decisions get made post-merger.

We focus here on the pre-merger product configuration in which $B$ and $C$ offer their products in equilibrium, or $(0,1,1)$. It is in this baseline structure that a merger gives $B$ the opportunity to offer $A$’s product as a way to deter $C$ from offering its. Since $A$ enjoys the highest mean product preference and a larger impact on $C$’s profit than $B$, $B$ being able to coordinate $A$’s offering decision has a larger deterrence effect on brand $C$ where $C$ to make its offering decision last than in the analogous case of $(1,0,1)$ (considered in the Appendix) where $A$ adds $B$ to its portfolio.

Figure 10 shows how at high diversion ratios, $B$’s ability to offer $A$ results in $A$ being
offered more often, sometimes at the expense of B’s own product and other times jointly with B. The former occurs when the profits from offering A are higher than the profits from offering B, only one of the two products fit in the market, and, because of sequential entry, in the pre-merger setting brand B moved before brand A, preempting A. The merger allows the merged firm to offer A instead of B, increasing profits. On occasion, this move also induces brand C to not offer its product, which it would have offered otherwise: C is profitable when competing against B but not against A. As demand for A is higher than demand for B, switching A for B results in higher market prices, which is only exacerbated by C’s retreat from the market. The increase in prices and C’s retreat from the market affect consumer surplus negatively. However, all these effects are small since, as discussed in section 4.4, it is rare to have situations in which the market could have supported A or B, but not both, and A would have been more profitable than B.

5 Conclusions

In this paper, we have begun to analyze the potential welfare impacts of post-merger product choice decisions. While the industrial organization literature has documented a relationship between differentiation and market concentration and the courts and regulatory agencies have considered the potential for new offering decisions qualitatively, merger simulations have almost entirely focused on price effects. We demonstrate that post-merger product choice can have a substantial impact on industry equilibrium, significantly altering the impact on consumer welfare depending on the circumstances. Overall, the impacts are particularly acute in cases where the merging firms offered relatively similar products prior to the merger exacerbating the profit gains and consumer welfare losses the merger would otherwise produce. A simulation that allows for re-optimizing offering decisions can also accommodate the impact of fixed cost synergies, which tend to be positive for consumer welfare because the merged firm offers its products more often when fixed costs are lower. We isolate the sources of these effects, noting their potential to offset each other in the overall analysis. Parties appear to cite only the particular impact favorable to their position; while we show these effects do exist, considering all the impacts of product portfolio re-optimization is necessary to accurately simulate the merger’s expected effect.

The analysis here considers one possible yet general demand scenario. The modeling strategy employed here could also, however, be adapted to compute post-merger product choice impacts in an actual merger simulation. As mentioned in Section 2, a number of researchers have been developing empirical techniques to accommodate product choice into merger analysis. Our approach is most applicable to a shorter-run analysis in which the
industry’s firms can optimize on which existing product varieties to continue offering after a merger. Incorporating these effects, along with pricing impacts, increases the informative value of a merger simulation to regulatory agencies trying to judge the impact of mergers on consumers. An interesting avenue for future research would be an investigation of the longer-run effects of a merger on product positioning: how does the merged firm choose to adjust the characteristics of the products it offers, in reoptimizing its product portfolio in the more concentrated environment?

Finally, while we have altered substitution patterns around values produced by our estimation exercise, the analysis is specific to the underlying features of this example. In particular, our calibrated demand is such that we have one relatively dominant firm (Breyers), an intermediate firm (Dreyers) and one weaker firm (Composite). One may wish to examine mergers in an industry that is more balanced at the onset or between the less dominant firms in a similar industry. While the simulation results would be different depending on the context of the exercise, insights from any relevant combination or industry structure (including one representing conditions in a real merger scenario) could be generated using our framework.

References


A Demand Estimation

In this section, we detail how we use the ice cream sales and price data to estimate the primitives of a discrete choice demand system, from which we calculate price elasticities which are then used to calibrate the demand parameters we rely on in simulations, as described in Section 3. Consider the first the setup. Three ice cream brands offer a set of flavors each. There are a total of $J$ brand-flavor combinations and $j$ indexes one of these. Consumer $i$’s utility from purchasing one container of ice cream $j$ in market $n$ is given by

$$u_{ijn} = \theta_{jn} + \tilde{\theta}_{ijn} + \epsilon_{ijn}$$

$$\theta_{jn} = \alpha p_{jn} + x_{jn}^{(1)} \beta + \zeta_{jn}$$

$$\tilde{\theta}_{ijn} = x_{nj}^{(2)} \Sigma \theta \epsilon_{ni}$$

where $\epsilon_{ijt}$ is distributed according to a type one extreme value distribution with scale parameter equal to one, $\zeta_{jn}$ is a common unobserved product-market specific taste shock, $\epsilon_{ni}$ is an $L$-dimensional, standard normal shock, $\Sigma_{\theta}$ is a symmetric, $L$-by-$L$, parameterized matrix, and $x_{jn}^{(1)}$ and $x_{jn}^{(2)}$ are vectors of product-market characteristics. $x_{jn}^{(1)}$ includes the market specific covariates average temperature, percentage of African-Americans, percentage of males, percentage of individuals in the age groups of 18-24, 25-44, 45-64, and 65-and-above, average household size, median household income, number of WalMart stores, flavor and brand fixed effects, month dummies, and region dummies. See Draganska et al. (2009) for details on the importance of these covariates as demand shifters. $x_{jn}^{(2)}$ is comprised of price and brand

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34 The three brands are Breyers, Dreyers, and Composite. The latter is a composite brand of regional brands Deans, Friendly, Hilland, Hood, Kemps, Mayfield, Pet, Prairie Farms, Tillamook, Turkey Hill, United Diary, Wells Blue Bunny, and Yarnells.

35 These primary flavors are Vanilla, French Vanilla, Natural Vanilla, Homemade Vanilla, Extra Creamy Vanilla, Vanilla Bean, Vanilla Custard, and Double Vanilla. More rare flavors Angel Food Vanilla, Country Vanilla, Golden Vanilla, New York Vanilla, and Real Vanilla are bundled into the outside option along with all non-vanilla flavors of ice cream.
dummies. Σθ has the form

\[
\Sigma_\theta = \begin{bmatrix}
\sigma_p & 0 & 0 & 0 \\
\sigma_B & \rho_{BD} & \rho_{BC} \\
\sigma_D & \rho_{DC} \\
\sigma_C 
\end{bmatrix}
\]  

(16)

The utility from not purchasing is given by \( u_{in0} = \epsilon_{in0} \).

Integrating over the random shocks ϵ and ε, the share of a given brand-flavor is

\[
s_j(x, \xi, \theta) = \int \frac{e^{\alpha_p n + x^{(1)}_{jn} + x^{(2)}_{jn} \sum_{0} + \zeta_{jn}}}{1 + \sum_{t \in J_n} e^{\alpha_p n + x^{(1)}_{tn} + x^{(2)}_{tn} \sum_{0} + \zeta_{tn}}} dN(\epsilon) \quad \forall j \in J_n
\]  

(17)

Let \( s^* = (s^*_1, \ldots, s^*_n) \)′ be the observed market shares, where the total market is defined as all sales of 3.5-4 qt containers of premium ice cream of any flavor. Berry et al. (1995) and Nevo (2000) show how using observed shares, one can invert the above equations by way of Montecarlo integration to obtain the residual, \( \zeta_{jn} \), as a linear function of the covariates

\[
\zeta_{nj} = s^{-1}(s^*_n, x, \Sigma_\theta) - \alpha_{jn} + x^{(1)}_{jn} \beta \quad \forall j \in J_n \forall n
\]  

(18)

Given a 1-by-K vector of instruments \( z_{jn} \), we then estimate the parameter vector \( \theta = (\alpha, \beta, \sigma_p, \sigma_B, \sigma_D, \sigma_O, \rho_{BD}, \rho_{BO}, \rho_{DO}) \) by minimizing the GMM equation

\[
Q_N(\theta) = m_N \Omega m_N^t
\]

(19)

\[
m_N = \sum_{n=1}^{N} \sum_{j \in J_n} z_{jn} \zeta_{jn}
\]

\[
\Omega = \left( \sum_{n=1}^{N} \sum_{j \in J_n} z_{jn}^t z_{jn} \right)^{-1}
\]

where \( n \) indexes the \( N = 1,449 \) market-months (63 markets over 23 months) detailed in section 3.

We follow Gandhi and Houde (2016) in choosing instruments. As prices do not vary across flavors of the same brand and there is limited temporal variation in brand pricing within a market, we do not instrument for price. Thus, the remaining parameters that we seek to identify with exclusion restrictions are the parameters of the variance-covariance matrix of the brand-level tastes. We include (a) the variance in price differences a product has with all other products in the same market: \( z_{jn}^{\sigma_p} = \frac{1}{J_{n-1}} \sum_{t \in J_n \setminus j} (p_{jn} - p_{tn})^2 \); (b) for
each brand, the number of flavors offered by the brand in a given market: e.g. $z_{jn}^{B} = J_{nB} \cdot 1 \{ j \in J_{nB} \} + (J_{n} - J_{nB}) \cdot 1 \{ j \notin J_{nB} \}$, where $J_{nB}$ is the number of Breyers’ flavors offered in market $n$ and $1 \{ \cdot \}$ is the indicator function; (c) for each pair of brands, the total number of unique vanilla flavors offered by the two brands together: e.g. $z_{jn}^{BD} = (J_{nB} + J_{nD}) \cdot 1 \{ j \in J_{nB} \cup J_{nD} \} + (J_{n} - J_{nB} - J_{nD}) \cdot 1 \{ j \notin J_{nB} \cup J_{nD} \}$. Each of these instruments proxy for the availability of close products to the product under consideration, in terms of products offered by the same brand or of the same type, or of similar prices (limited variation in price differences to other products). Comparing the market shares for the product, and the brand’s aggregate market share relative to that of flavors produced by other brands, in situations where the brand offers many flavors versus in situations where it offers few, allows identification of the degree of brand-specific heterogeneity in preferences from observing how much substitution occurs to similar versus less similar products. In using variation in price differences, we implicitly exploit our assumption above that price at the level of the flavor is not endogenously determined.

We calculate brand-level elasticities as

$$\xi_{bb'n} = \frac{p_{b'n} d\hat{s}_{bn}}{\hat{s}_{bn} dp_{bn}} \quad \forall (b, b') \in \{B, D, O\}^2$$

(20)

$$\hat{s}_{bn} = \sum_{j \in J_{nB}} s_j(x, \hat{\zeta}, \hat{\theta})$$

where $\hat{\theta}$ and $\hat{\zeta}$ are the estimated parameters and residuals.

The estimated parameters and confidence intervals are available from the authors upon request.

**B Estimation of Flavor Offering Cost Distribution Parameters**

In this Appendix, we describe how we use the estimated demand model, together with data on flavor offering decisions to infer the fixed costs associated with offering a particular flavor in a particular market-month. We use the estimated parameters of the entry cost distribution in generating Column 3, labeled “Estimate”, in Table 1.

As with the demand estimation, we observe $N$ market-months. In each market-month (henceforth, simply ‘market’) we consider three ice cream brands, each with a pre-endowed $Y_{bn}$ potential flavors ($b$ indexes brand, $n$ a ‘market’). Of these flavors, a firm may choose a set $J_{nb} \subset Y_{nb}$ to offer, and $J_{n}$ represents the flavors offered by all firms: $J_{n} = J_{1n} \cup J_{2n} \cup J_{3n}$.
Let $\mathcal{Y}_{bn}$ denote the set of offering choices available to brand $b$, $J_{bn} \in \mathcal{Y}_{bn}$, and $\pi_{bn}(J_n)$ be $b$’s variable profits associated with market offering $J_n$:

$$
\pi_{bn}(J_n) = M_n \sum_{j \in J_{bn}} s_j(x_n, \hat{\theta}, \hat{\xi}) \cdot (p_{bn} - \hat{c}_{bn})
$$

$$
\hat{c}_{bn} = p_{bn} \left(1 + 1/\hat{\xi}_{iin}\right)
$$

where $x_n$ are the observed covariates discussed in section A, $(\hat{\theta}, \hat{\xi})$ are the estimated parameters from the same section and $\hat{\xi}_{iin}$ are estimated elasticities (see Equation 20).

Finally, let $\gamma_{bn} \sim F(\psi_b)$ be a draw of size $Y_{bn}$ from brand $b$’s fixed costs, such that $b$’s profits, conditional on particular product offering choices by the three brands, $J_n$, are

$$
\Pi_{bn}(J_n) = \pi_{bn}(J_n) - \sum_{j \in J_{bn}} \gamma_{jn}
$$

As in most of the analysis of the paper, we estimate a simultaneous move complete information entry game: firms simultaneously chose $J_{bn}$ to maximize $\Pi_{bn}(J_n)$, with knowledge of rivals’ profits. We address multiplicity of equilibria by selecting the equilibrium that is most profitable for the three-brand industry as a whole. Let $y^*(\gamma_n)$ be such an outcome, for a given cost vector $\gamma_n \equiv (\gamma_{1n}, \gamma_{2n}, \gamma_{3n})$. Given the parametric distribution $F(\psi_b)$ and realizations of specific offering decisions $\hat{y}_n$ in the data, we form the likelihood of observing such decisions as $\Pr[\gamma_n | \hat{y}_n = y^*(\gamma_n)]$ and estimate $\psi \equiv (\psi_1, \psi_2, \psi_3)$ by maximizing the latter:

$$
L(\psi) = \sum_{n=1}^{N} \ln \left[\Pr[\gamma_n | \hat{y}_n = y^*(\gamma_n)]\right]
$$

Given the equilibrium selection rule, $\Pr[\gamma_n | \hat{y}_n = y^*(\gamma_n)]$ does not have a closed-form solution. We therefore approximate it by simulating 1,000 draws from $F(\psi_b)$ and counting the frequency with which $\hat{y}_n$ is the equilibrium derived from the simulated draws. We employ a Nelder-Mead optimizer to compete the maximization. We then calculate standard errors using a parametric bootstrap procedure based on 200 bootstrap samples, as the variable profits are estimates themselves. Results are available from the authors upon request.

**Specific data considerations** We assume Breyers has only one optional flavor, Natural Vanilla. Similarly, Dreyers is assumed to have three optional flavors: Natural Vanilla, Double

\[\text{As } \xi_{jn} \text{ is unknown for those products not offered, we do not use the product specific residual when calculating shares, but a brand specific residual, which is the averaged across all products offered by such brand in the given market: } \hat{\xi}_{bn} = \frac{1}{|J_{bn}|} \sum_{j \in J_{bn}} \xi_{jn}.\]
Vanilla, and Vanilla Custard; and the Composite brand is assumed to have two: Natural Vanilla and Extra Creamy Vanilla. All other flavors are taken as exogenous, as offered in each market. We use the sales of all 3.5-4pt containers of any flavor of premium ice cream as total market size $M_n$.

C Equilibrium in the Post-Merger Entry Game with Asymmetric Information: Computational Detail

In this Appendix, we provide additional detail on how we construct the counterfactual simulation exercise in Section 4.5 that investigates the contribution of learning about a former rival’s cost through a merger on post-merger product offering decisions and economic outcomes. We describe here how we calculate optimal responses in the post-merger equilibrium, where brands $A$ and $B$ learn each other’s fixed offering costs through the merger, but do not make either pricing or product offering decisions jointly. As in the pre-merge incomplete information setup, $C$ continues not to observe $A$ and $B$’s costs but in distribution. The fixed cost distributions $G_A(\cdot)$, $G_B(\cdot)$, $G_C(\cdot)$ are common knowledge, as are players’ beliefs about each others’ beliefs.

Let $\mathcal{P}_{x_C}$ be the common belief on $C$ offering $x_C$. $A$’s best response to $B$’s offering decision and its guess at $C$’s offering decision is ($B$’s is symmetrical):

$$x_A(\mathcal{P}_{x_C}, x_B, g_A) = \arg\max_{x_i \in J_A} \sum_{x_C \in J_C} \mathcal{P}_{x_C} \pi^A_{(x_i, x_B, x_C)} - g_A' \cdot x_A$$

(21)

$A$’s and $B$’s best responses, jointly, determine a paired outcome $(x^*_A(\mathcal{P}_{x_C}, g_A, g_B), x^*_B(\mathcal{P}_{x_C}, g_A, g_B))$. Since these equilibrium offering decisions may not be unique, we use – as in the full complete information setup – an equilibrium selection rule to choose between equilibria when there are multiple. We impose as before that the chosen equilibrium maximizes the joint expected profit earned by brands $A$ and $B$. Let $\mathcal{P}_{x_Ax_B}$ be brand $C$’s belief.

---

37All other flavors were taken as exogenous given the little to no variation there is in their observed offerings. This is not to say that firms do not strategically consider offering such flavors, but that unmodeled incentives (e.g. brand issues, distribution issues, market conditions, etc.) induce firms to either always offer or never offer such flavors. As these incentives are beyond the scope of this exercise, we take the offering of such products as exogenous. As such, the recovered fixed costs are not those corresponding to operating in a given market, but of adding a specific flavor to a market the brand already operates in. We identify such fixed costs from the observed variation in offering the specific, aforementioned vanilla flavors.
that such a paired outcome arises. C’s best response is

$$x_C(P_{x_Ax_B}, g_C) = \arg \max_{x_i \in J_C} \sum_{(x_A, x_B) \in J_A \times J_B} P_{x_Ax_B} \pi_C^{x_i}(x_i, x_A, x_B) - g_C', x_C$$  \hspace{1cm} (22)$$

Beliefs are given by

$$P_{x_C} = \mathbb{E}_{G_C}[x_C(P_{x_Ax_B}, g_C)]$$

$$P_{x_Ax_B} = \mathbb{E}_{G_A G_B}[(x_A^*(P_{x_C}, g_A, g_B), x_B^*(P_{x_C}, g_A, g_B))]$$

(23)

which define a fixed point in firms’ offering probabilities. As this fixed point may have more than one solution, we apply a second equilibrium selection rule to choose between equilibrium beliefs when there are multiple that satisfy the system of equations. We do so by implementing an iterated best response heuristic. We start by assuming that beliefs are that no product is offered initially and proceed iteratively. In each iteration of the algorithm, we cycle through the three brands’ decisions, letting A and B jointly respond first to beliefs on C’s actions, before having C responds to the updated beliefs on A and B’s actions, and so forth. We use a Gauss-Seidel algorithm in that brand C when being updated best responds to the strategies of brands A and B that come first in the order and have already been updated in the current iteration of the algorithm, rather than to their strategies from the previous iteration of the algorithm. The algorithm comes to a halt if no brand has an incentive to change its strategy from the previous iteration. The equilibrium is then determined by applying Equations and using the solution from Equation.

D  Additional Figures

In section 4.1 (Increasing Prices) and section 4.6 (Sequential Product Offering) we presented simulations results for a few baseline product offering sets. Here, in figure 11, we present the same simulations for alternative baseline product offering sets for which we would also expect the merger to potentially impact market outcomes.
Each panel corresponds to a specific baseline product offering set. Product differentiation, on the x-axis, is the diversion ratio from $A$ to $B$, were all three products offered, derived from the underlying value of $\rho$. The left axis corresponds to the solid lines, showing percentage change in consumer surplus, average market price, and profits. The right axis corresponds to the dotted lines, corresponding to the frequency with which each products is offered whenever $A$ and $B$ are merged. See text for details.