The Welfare Consequences of Mergers with Product Repositioning*

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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 will choose to change their product offerings after a merger. Using a model that endogenizes both product choice and pricing, we conduct equilibrium market simulations for mergers including the potential for offering changes in a variety of scenarios. We find that allowing for repositioning can have substantial effects, 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, much progress has been made in developing new econometric techniques for estimating equilibrium models of demand and pricing. Applying these methods, along with data from the industry of the proposed merger, can allow an analyst to assess the relationship between market concentration and price changes, providing critical information about market definition. In addition, economists can make a prediction regarding how prices would adjust following the merger of two industry participants. The process of 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 increasingly used as suggestive evidence of the likely effects of a merger on prices charged to consumers.[1]

This paper focuses on a shortcoming inherent in this approach to estimating demand and marginal cost and simulating the effects of mergers. While prices are explicitly included as choice variables of the industry participants, their product characteristics are treated as exogenous – they cannot adjust after the merger. This abstraction has consequences for the accuracy of some merger simulations to the extent that merged firms may cull duplicate products or competitors may introduce new varieties post-merger. Simulating mergers using the method sketched above constrains the set of differential products offered by market participants to be identical pre- and post-merger.

In this paper, we explore the impact of product repositioning on these outcomes by simulating mergers, allowing for industry participants to optimize on product choices as well as prices post-merger. Allowing firms to reposition recognizes that actual firm behavior and its effect on consumer surplus may well be more complex. In some cases, the merged firm may choose not to offer products that were once close competitors in product space. Alternatively, industry participants may choose to expand their product offerings given the new market structure. Impacts on consumer welfare associated with price increases may be reduced if consumers value characteristics of products that are made available after a merger. Our simulations allow us to tease apart these potentially offsetting effects, identify the range of parameter values for which ignoring repositioning would be problematic, and

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

describe the consequences.

The analysis and discussion presented here proceeds in three parts. First, we present some background from the economics literature on horizontal combinations that indicates the importance of accounting for endogenous product choice among industry participants primarily in the context of differentiated products settings. In addition, we provide some context for the following analysis by referencing a series of merger cases in which the issue of post-merger product repositioning was considered by the court or regulatory body evaluating the proposed merger. Second, we outline a tractable modeling approach that uses a differentiated products demand system to investigate the effect of allowing firms to have flexibility regarding their product offerings. As such, the approach endogenizes both price and product varieties decisions, allowing both to update as a result of a changed industry structure in the context of a merger simulation.[2] In the last part of the paper, we show how merger simulations can be carried out using such a model, allowing for both pricing and product offering changes post-merger. 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 analysts mis-estimate merger impacts by not incorporating product choice or repositioning post-merger. The number of products offered, the extent of differentiation, and the consumer welfare effect may be substantially different as compared to "price only" merger simulations, particularly when relatively undifferentiated firms merge. In analyzing various incentives for firms to change products 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. Therefore, regulators should incorporate product choice into the modeling of merger simulations to evaluate the full impact of these mergers.

[2]The approach here is based on the work of Draganska, Mazzeo, and Seim (2009) and is part of a growing literature proposing approaches for endogenizing product choice in empirical models of product differentiated demand. Crawford (2012) is a good summary of this growing literature.

2 Background

This section proceeds in two parts. First, we review some of the relevant economics literature on the relationship between market concentration and product variety. A small number of papers have focused directly on the effects of mergers on firm choice and market heterogeneity – these papers are highlighted. Then, we provide a brief survey of merger cases in which positioning of products after a proposed merger figured into the court's decision. Both the academic literature and the court records highlight a role for an analytical framework that endogenizes product choice.

2.1 Market Concentration and Product Variety: Literature

In the economics literature, a small number of empirical studies have addressed the related questions of (1) what is the relationship between the characteristics of products offered by competing firms and their industry's market structure and (2) what effect do mergers (i.e., changes in market structure) have on the set of products that competing firms offer. Evidence of a relationship between product offerings and market structure suggests that empirical analyses of mergers that do not allow firms to optimally adjust their product portfolios may be incomplete. The literature concerns primarily differentiated products industries, where consumers have heterogeneous preferences over the range of product characteristics with which firms could potentially endow their products. In such environments, price changes can either be mitigated or exacerbated by differences in product offerings when calculating consumer welfare. While not an exhaustive collection, the papers described below provide a flavor of the sort of empirical evidence researchers have compiled that relates to this problem.

A series of papers has investigated the relationship between observed market structure in a particular industry and the product offerings of competing firms.[3] For example, Alexander (1997) presents data from the music recording industry that suggests a nonmonotonic relationship between competition indices/concentration ratios in the market for music distribution and overall variety (on various technical dimensions) of the hit songs produced by the studios. In his data, high and low levels of concentration are associated with lower

[3]This literature is not nearly as extensive as the one examining correlations between prices and market structure. Weiss (1989) provides an extensive review of this literature and Whinston (2006) discusses the role of such studies in the literature as evidence in a regulatory/antitrust context. See Manuszak and Moul (2008) for a recent contribution, that revisits the price-concentration relationship in the office supply retail industry using structural methods (e.g., Mazzeo, 2002a) to address market structure endogeneity.

levels of product variety, while there is higher product variety overall in industries under intermediate levels of concentration. Related work by George (2007) examines the effect of market structure on product positioning and product variety in the market for US daily newspapers. Here, detailed measures of product offerings of competing firms are available (e.g., papers' assignment of reporters to particular topical areas), and more concentrated markets are characterized by more differentiated newspapers in terms of both the variety of topics and the number of topics covered.[4]

These papers examine the relationship between market structure and the overall level of product differentiation and availability in an industry; the product characteristic choices of individual firms underlie such market-level measures. A series of papers (e.g., Mazzeo, 2002; Seim, 2006) have developed methods for incorporating product choice decisions of firms into empirically tractable equilibrium models, including very detailed product characteristics choices. Watson (2008) is an excellent example focusing on the quality decision of eyewear retailers, as proxied by the number of product offerings sold by retailers.[5] As in Alexander (1997)'s aggregate results for the recorded music industry, Watson finds that per-firm product variety has a nonmonotonic relationship with competition. As the number of closer rivals – in terms of geographic distance – increases, firms tend to initially offer more options, but the number of varieties eventually declines with more competition.

These studies of market- and firm-level product variety thus suggest that merging firms would have more strategic instruments available to them beyond just price when maximizing profits after an increase in market concentration, and that the optimal response following a merger could be either to increase or decrease product variety, with opposite effects on consumer welfare.

A small number of papers have directly addressed the issue of product variety and optimal differentiation in response to merger activity. The most influential study is by Berry and Waldfogel (2001) who document the effect of mergers on station format choice in the radio

[4]The qualitative results in Gotz and Gugler (2006) for the Austrian retail gasoline market instead generate the inference that industry consolidation leads to less aggregate product variety across all initial levels of concentration. The authors also note that their results highlight the gap left by structural demand analyses that "neglect a key feature of market power in differentiated markets, namely that a merger between formerly competing firms may change product variety."

[5]In retail environments, the number of product offerings (or product variety) is often used as a summary measure or proxy of the firm's quality. Quality can also be a firm characteristic that competitors optimally adjust depending on market structure. See Mazzeo (2003) for an example of an analysis of competition and product quality, as well as a discussion of the challenges associated with empirical work in this area.

broadcasting industry. The 1996 Telecommunications Act prompted a merger wave in the broadcasting industry; this provided an instrumental variables identification strategy for measuring the effect of concentration on variety (as measured by the number of different radio "formats" represented in the market).[6] The results of the paper indicate that industry consolidation – that is, the decrease in the number of stations that followed the Telecom Act – increased both variety per station and overall variety in the market. Sweeting (2010) provides complementary evidence using micro-level data on the programming of individual radio stations to look directly at variation in stations' play lists following consolidation. Mergers appear to have motivated competitors to span larger portions of product space with their offerings, as pairs of jointly-owned local stations are more likely to be in different formats. While suggestive, these analyses do not constitute a formal model of product choice, as Berry and Waldfogel (2001) state, "our approach in this paper is to obtain qualitative empirical results that may guide more detailed subsequent modeling."

Fan (2012)'s study of the newspaper industry is based on such a fully developed equilibrium model of demand, firms' joint pricing (here, subscription and advertising rates) and product characteristic choices, such as news quality. In contrast to the discrete decision to offer a particular product that we consider below, these product characteristics are measured as continuous indices. Fan uses the estimated demand, marginal cost of circulation and advertising acquisition, and marginal cost of improving news quality, to 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. This bias in the estimated merger effects is more pronounced in larger markets and in markets with more inelastic demand.[7]

[6] Chu (2010) uses the entry of satellite broadcasting as a "natural experiment" and documents the changes in products offered (channel line-ups) by cable firms in response. A challenge to the analysis is that all geographic markets experience satellite entry at the same time, which makes it difficult to separate the effect of competition on product choice from other exogenous factors. Nevertheless, Chu's study demonstrates substantial changes in the cable firms' offerings that correlates with the timing of satellite entry, suggesting a competitive response by cable incumbents to the change in market structure.

[7] Richard (2003) endogenizes the flight frequency decision of airlines and predicts changes in flight frequency in a merger simulation; however, the model estimated is only a single-firm optimization – the first order conditions of optimal flight frequency do not include the decisions made by competitors.

The empirical papers cited above are partially motivated by the theoretical literature which (not surprisingly) can make almost any prediction about the optimal product differentiation behavior of competing firms depending on the assumptions in the model. The recent theoretical contribution by Gandhi, Froeb, Tschantz, and Werden (2008) is notable for its direct focus on post-merger product repositioning and its use of novel computational methods for finding market equilibria in prices and product space locations in a simultaneous move Hotelling (1929) set-up, both for single-outlet firms and for a potential "merger" scenario with two jointly owned establishments. In response to the gaps in existing merger simulation methodology, the paper compares outcomes in simulations in which industry participants re-optimize on price only to those when both price and location choices can adjust. For a wide range of utility and cost parameterizations, merging parties who 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." While the results cannot be extrapolated directly to any particular industry, the analysis frames the important issues that an empirical model should address.

In concluding this subsection, 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 postmerger."

Peters (2006) suggests that the real-world violation of this assumption is a source of the differences between economically-based merger simulation results and price effects of actual mergers that he uncovers in his comparison of the simulated and actual price changes associated with several airline industry mergers in the 1980s.[8] Peters goes on to decompose these differences based on other post-merger data from the industry, attributing a substantial portion of the post-merger price effect to observed changes such as entry/exit, flight frequency

[8]Papers by Ashenfelter and Hosken (2010) and Weinberg and Hosken (2012) perform similar analysis on a variety of industries in which recent mergers have been approved by regulators and have actually occurred.

and airport presence, as well as unobserved post-merger changes in demand and costs.[9] Peters concludes that "while merger simulation can be useful in understanding the effect of a merger on unilateral pricing incentives, such methods are likely to yield unsatisfactory predictions of a merger's overall effect... unless richer models of firm conduct are incorporated into the methodology." By explicitly modeling the post-merger product choice behavior of industry participants, this paper takes an important step toward addressing the concerns surfaced by these authors.

2.2 Merger Cases

Courts and regulatory agencies have taken some consideration of changes in the product offerings of differentiated competitors in the process of merger evaluation. However (perhaps because of the lack of an appropriate framework to simulate product changes), specific findings are not often cited as part of the merger case rulings. The discussion that follows is not meant to represent an exhaustive summary of the legal landscape on this issue, but instead includes a survey of some of the cases and decisions where postmerger product repositioning is explicitly referenced.

One recent relevant case involves the merger between Whole Foods Market and Wild Oats Market – two supermarkets that specialize in organic foods (FTC v. Whole Foods Market, Inc. 533 F.3d 869 (C.A.D.C.,2008.)). The government's expert testimony in this case argued that the merged firm would close a number of currently existing stores, resulting in a reduction of competition on non-price dimensions (over and above the anticipated price effects), with a loss of consumer surplus as a consequence. However, the identity and number of stores to be closed was not projected by a formal economic model or econometric analysis; instead, plans for the status of particular establishments in the merged company was obtained through discovery. Along with the price effects of the merger, assertions were made regarding consumer harm due to changes in "quality, service, and importantly, the breadth of product

[9]Similar concerns continue to be associated with mergers in the airline industry. For example, more than 40 percent of travel managers surveyed anticipated that the 2008 merger between Delta and Northwest would negatively impact access to smaller US markets and flight schedules/frequencies (Avery (2008)). Policy makers in Montana elicited an ex ante response – executives from the merging airlines wrote a letter to the Montana Senate delegation promising not to cut the total number of flights servicing the state after the merger. Senator Baucus of Montana promised to "keep an eye of this merger if it goes through" and "hold the NWA-Delta CEOs feet to the fire to make sure they follow through on their promises." (Bond (2008)).

offerings available to consumers."[10]

The district court, however, focused on the potential repositioning of competitors in response to the merger as mitigating these price and non-price effects in its decision, observing that several supermarkets "have already repositioned themselves to compete vigorously with Whole Foods and Wild Oats for the consumers' premium natural and organic food business" (Whole Foods, 502 F.Supp.2d at 48). In particular, the court decided that Whole Foods and Wild Oats competed among supermarkets generally and that the cost of other supermarkets expanding their product lines to include organic foods would not be prohibitive. While this conclusion was based on observations of the product lines of existing supermarkets, there was no underlying empirical analysis on which it was based nor an assessment of which markets would be more or less likely to experience supermarkets changing their product lines to become more direct competitors.[11]

Indeed, in several cases, the court seems more inclined to focus on the endogenous repositioning response of competitors following a merger. For example, in approving the merger between Oracle and PeopleSoft (U.S. v. Oracle Corp., 331 F.Supp.2d 1098 (N.D.Cal. 2004.)), the court found that "plaintiffs have not proved that SAP, Microsoft, and Lawson would not be able to reposition themselves in the market so as to constrain an anti-competitive price increase or reduction in output by a post-merger Oracle." This suggests opposing considerations associated with exploring issues of product choice endogeneity and post-merger product repositioning in the context of antitrust. The consideration of pricing, constraining merging parties to offer the same products after a merger, necessarily understates producer surplus gains (and potentially underestimates consumer surplus declines if product variety is reduced post-merger). At the same time, anticipating the consequences of product portfolio changes for merging parties invites consideration of the ability of other market participants to mitigate the merger's effects through their own repositioning following consolidation in their industry. In addition, optimal post-merger repositioning could conceivably result in more product heterogeneity, generating a positive effect on consumer surplus that nets away some of the harm done to consumers by higher prices.

From that perspective, an important issue becomes the relative ability of various industry participants – through cost synergies associated with scale economies, perhaps – to intro-

[10]Cited from the expert report of Kevin M. Murphy, PhD, downloaded from the FTC website.

[11]In early 2009, a settlement was ultimately reached in this case, requiring Whole Foods to sell a prescribed list of stores as a result of the settlement.

duce new products. For example, in the market for facial tissues (U.S. v. Kimberly-Clark Corp., No. CIV. A. 3:95-CV-3055-P., 1996 WL 351145 (N.D.Tex. April 04, 1996)), the court's decision stated that "because entry into the facial tissue market is difficult, requiring a significant investment in plant equipment and brand building, successful new entry or repositioning after the merger is unlikely to restore the competition lost through Kimberly-Clark's removal of Scott from the marketplace." In contrast, the court appears to have been swayed that the merger of the second and third largest manufacturers of jarred baby food would permit additional product innovation in the industry (FTC v. H.J. Heinz Co. 116 F.Supp.2d 190 (D.D.C.,2000)). The court cites the fact that fixed marketing and distribution costs are required to launch new products and "the conditions for increased competition in the form of product innovation and product differentiation will be enhanced by the merger, because the distribution of the combined entities will add Heinz's all commodity volume to Beech-Nut's all commodity volume." The court cites testimony from the defendants' expert that posited a particular volume threshold at which new product introductions would be pursued in the industry (though it is not clear how such a threshold was derived, or what the specific consequences of the product innovation ability would be).

This brief summary suggests that the effect of mergers on the extent of product differentiation in an industry can be is a relevant consideration for courts in judging their competitive impact and ruling on whether a given merger should be permitted. Evidence regarding post-merger product repositioning has been used in a variety of ways – to argue that merging firms will cause competitive harm over and above price effects, to justify a merger based on enhanced ability to introduce products against a more formidable competitor, or to dismiss concerns regarding anti-competitive behavior of merged parties based on the product differentiation of other industry participants. Indeed, section 6.1 of the 2010 revision of the Horizontal Merger Guidelines suggests that the DOJ and FTC consider competitor repositioning when evaluating potential merger effects.

However, consideration seems to be limited to exclude repositioning by the merging parties, and techniques for repositioning analysis are not specified. As such, evidence may be limited to circumstances in which the courts learn of explicit planned adjustments to product differentiation strategies through discovery or else may be speculative in practice. A more formal economic framework through which analysts can simulate how a merger might affect optimal product choice, industry heterogeneity, and ultimately consumer surplus may

well assist the agencies and/or courts in addressing this question in a systematic and more comprehensive manner.

3 The N-Product Model with Three Firms

We now pose a model of competition under differentiated products, within which we can analyze the effects of product choice in the context of merger simulation. While the model is restricted to three firms for simplicity of exposition, it can be easily expanded to include any number of firms.

Consider an industry with three firms identified by $i \in \{A, B, C\} \equiv I$. Each firm is in possession of a set of products with predefined characteristics. $\mathcal{J}_i$ represents the set of products firm i is endowed with and j represents one of these products.[12] The game has two stages: in the first stage firms simultaneously choose which products to offer 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 its offered products.

An equilibrium is a vector of offering choices and of prices, $(\mathbf{x}^\star, \mathbf{p}^\star)$. In this context, $\mathbf{x}^\star$ is the entry decisions for each firm: $\mathbf{x}^\star \equiv (\mathbf{x}_A^\star, \mathbf{x}_B^\star, \mathbf{x}_C^\star)$ where $\mathbf{x}_A = (x_{1A}, x_{2A}, ..., x_{jA})'$ and x_{1A} is one if the product is offered and zero if it is not. The price vector $\mathbf{p}^\star \equiv (\mathbf{p}_A^\star, \mathbf{p}_B^\star, \mathbf{p}_C^\star)$ consist of the prices that will arise given $\mathbf{x}^\star$ 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 $\mathbf{x}$ we find the equilibrium prices of the subgame and calculate the 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.

[12] We believe that products with predefined characteristics represent a useful characterization of post-merger activity insofar as industry participants can easily add or subtract existing products in response to the merger. Designing new products optimally may be a longer-term prospect. However, the current model can accommodate a setting in which firms choose location on a continuous variable (i.e., quality) by discretizing the continuous variable into categories and having all firms be endowed with all categories of such variable.

3.1 The Pricing Game

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

We model the pricing game under discrete choice demand functions. A consumer s has a specific preference for each product and has a utility from each product given by

$$u_{js} = \theta_{js} - \alpha_s p_j + \epsilon_{js} \tag{1}$$

where α_s 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 ϵ_{js} is drawn from a Type 1 Extreme Value distribution with scale parameter σ, while θ_{js} is drawn from an arbitrary distribution that allows for correlated shocks across products and non-zero means: $\theta_s \equiv (\theta_{1s}, \theta_{2s}, ..., \theta_{Js})' \sim F(\theta | \mu_F, \Sigma_F)$. The utility of not purchasing is given by $u_{0s} = \epsilon_{0s}$ and the total market size is M.

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

$$s_j(\mathbf{p}) = M \int \frac{e^{\frac{1}{\sigma}(\theta_{js} - \alpha_s p_j)}}{1 + \sum_{n \in \mathcal{K}} e^{\frac{1}{\sigma}(\theta_{ns} - \alpha_s p_n)}} dF(\theta_s | \mu_F, \Sigma_F) \tag{2}$$

Equation 2 is very informative: θ_{js} can be interpreted as a random coefficient on the intercept of each product. It can also be thought of as the transportation cost for an individual traveling to product j in a Hotelling model.[13] The scale parameter σ plays two roles in this model: on the one hand, it defines how important price and the correlations across products are relative to other unobserved characteristics. On the other hand, it controls how "smooth" the integrand is. In this sense, one can think of the idiosyncratic shock ϵ as a convenience tool that is used to form a Kernel to approximate the outer integral over the random coefficients, θ_{js}, where the scale parameter σ controls the bandwidth of such a

[13] Any Hotelling model in which all consumers can reach all products without having to travel over another product can be represented with this model by specifying an appropriate distribution F and setting σ (from the T1EV distribution) to zero. Two examples of such Hotelling models are Salop (1979)'s circular city model with two firms and a spherical city with three firms.

Kernel.

Assuming a product-specific constant marginal cost c_j, profits in the pricing game are then given by

$$\pi^i(\mathbf{p}) = \sum_{j \in \mathcal{K}_i} s_j(\mathbf{p}) \left(p_j - c_j\right) \tag{3}$$

and the equilibrium prices are defined as the solution to

$$\frac{\partial \pi^i(\mathbf{p})}{\partial p_j} = 0 \; \forall j \in \mathcal{K}_i \; i = \{A, B, C\} \tag{4}$$

Conditions for existence and uniqueness of equilibrium are given in Nevo (2000).

Let $\mathbf{p_x}$ define the equilibrium prices when the offering choice is $\mathbf{x}$ and let $\pi_{\mathbf{x}}$ denote the associated equilibrium variable profit. Before moving on to the entry game, we present the calculations for consumer surplus. Given the current setup, for an offering vector $\mathbf{x}$, consumer surplus can be defined as

$$CS_{\mathbf{x}} = \int M \ln \left[1 + \sum_{n \in \mathcal{K}} e^{\frac{1}{\sigma}(\theta_{ns} - \alpha_s p_{n,\mathbf{x}})} \right] dF(\theta_s | \mu_F, \Sigma_F) \tag{5}$$

which is a measurement of the equivalent variation as in McFadden (1973), modified to account for the random coefficients.

3.2 The Entry Game

We model a simultaneous move entry game. For this game, we take the vector of profits $\pi_{\mathbf{x}}$ 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 $\mathbf{g}_i \equiv (g_{1i}, g_{2i}, ..., g_{Ji})'$. In summary, the ex-post net profits for firm i of offering products $\mathbf{x}_i$ are

$$\Pi_i(\mathbf{x}_i, \mathbf{x}_{-i}) = \pi_{(\mathbf{x}_i, \mathbf{x}_{-i})} - \mathbf{g}_i' \cdot \mathbf{x}_i$$

All players know $\pi_{\mathbf{x}}$ but do not know rivals per-product fixed costs g_{ji}. These assumptions imply the game is of incomplete information. Firms prior beliefs on these fixed cost coincide with the population distribution of fixed costs and are given by $G(\mathbf{g}_i | \mu_G, \Sigma_G)$. This distribution allows costs to be correlated across products of the same firm but assumes they

are independent across products of different firms.[14]

The game described above is similar to traditional games of incomplete information as in Seim (2006). We modify this traditional game by introducing new information. We allow all firms to observe a public signal of each others' fixed cost. If this public signal is uninformative, then the game proceeds as before. If the signal is fully informative, then the game converts to one of complete information. If the signal is somewhat informative, the game will be a mixture of the two as we show next. The advantage of this approach is that it lets us nest both complete information and incomplete information models in a single model. This way we can do sensitivity analysis of the role of the information structure of the game relatively easily.

To the best of our knowledge Grieco (2013) is the only other work that has bridged both complete and incomplete information entry games in a single model. Greico allows for firms to have two distinct and additive profit shocks, one of which is common knowledge; the other is private information. Both Greico's model and ours deliver qualitatively similar results. The advantage of our model is that we model the degree of information asymmetry (the variance on the public signals) separately from the profitability of the industry (the variance in the fixed cost shocks). In Greico's model a change in the variance of the private shock affects both the degree of information asymmetry and the profitability of the firms. Thus, in his model, the public profit shocks have to be re-sized appropriately so that the profitability of the industry remains constant when changing the degree of information asymmetry.

The degree of information asymmetry (the noise in the public signal) can be identified from the coordination in entry decisions. In a complete information game firms coordinate entry decisions on both observable and unobservable (to the econometrician) factors, so as to not have negative post-entry profits. In an incomplete information entry game firms coordinate only on observable factors, but not on unobservable factors. In a partially incomplete information game firms coordinate on the observable factors and partially coordinate on the unobserved factors (the coordination is not as strong as it would be in a complete information game). It is also important to note that coordination on entry also depends on the degree of competition. Thus, information asymmetry and competition cannot both

[14]This last assumption simplifies significantly the model as firms cannot learn about rivals' costs by observing their own costs. The model can be easily extended to have common observed factors affect firms profitability (i.e., common labor costs), but these need to be observed by all parties, including outsiders.

be estimated solely from entry/exit decisions without strict structural assumptions.[15] An alternative approach to identification is to use price and quantity data to identify the degree of competition and entry/exit patterns to identify the degree of information asymmetry.

We model the public signal as a draw from a distribution centered at the true values: $\eta_{ji} \sim H(g_{ji}, \nu_H)$ where ν_H is the variance in the signal. All players update their beliefs given the realization of signals and prior beliefs. Let the updated beliefs be given by the distribution $\mathcal{G}(G, H, \eta, \nu_H)$ which is a function of prior distributions G and H, signals η, and commonly known variance ν_H. Since the signals are public information, all firms can form the updated beliefs $\mathcal{G}$.

These signals can be interpreted as publicly available information that firms know but not the econometrician. Examples include local labor costs, real estate and utility costs, or permits and government fees, with which firms can estimate rivals' costs without knowing them with certainty.

Firms use the signals to calculate the probability of entry of each rival given rivals' assessments of the firm's own probability of entry. Formally, let $\mathcal{P}_{\mathbf{x}_i}$ be the probability that all firms give to firm i's entry decision $\mathbf{x}_i$ given the posterior distribution $\mathcal{G}$. Let $\mathcal{P}_{\mathbf{x}_{-i}} = \Pi_{n \neq i} \mathcal{P}_{\mathbf{x}_n}$. A firm's entry decision is then given by:

$$\hat{\mathbf{x}}_i(\mathbf{g}_i, \mathcal{P}_{\mathbf{x}_{-i}}) = \arg\max_{\mathbf{x}_i} \sum_{\mathbf{x}_{-i} \in \Pi_{n \neq i} \mathcal{J}_n} \mathcal{P}_{\mathbf{x}_{-i}} \pi_{(\mathbf{x}_i, \mathbf{x}_{-i})} - \mathbf{g}_i' \cdot \mathbf{x}_i \tag{6}$$

and the entry probabilities $\mathcal{P}_{\mathbf{x}_i}$ are given by:

$$\mathcal{P}_{\mathbf{x}_i} = \mathbb{E}_{\mathcal{G}} \left[\hat{\mathbf{x}}_i(\mathbf{g}_i, \mathcal{P}_{\mathbf{x}_{-i}}) \right] \ \forall i \tag{7}$$

Equation 7 is a fixed point equation whose solution ($\mathcal{P}^{\star}_{\mathbf{x}_i}$) is used to determine entry decisions by each firm. These entry decisions are given by $\hat{\mathbf{x}}_i \left(g_i, \mathcal{P}^{\star}_{\mathbf{x}_{-i}} \right)$ in which the fixed point $\mathcal{P}^{\star}_{\mathbf{x}_{-i}}$ is a function of the realized signals η_{ji}. This fixed point equation may have more than one solution, when there are multiple equilibria. An equilibrium selection rule will need to be applied to obtain a unique solution, although that rule may depend on the public signals. It may not depend on the fixed costs since then the equilibrium selection rule would

[15] One such structural assumption could be that the competitive pressure a rival entrant imposes on an incumbent is the same as the rival entrant's pressure on two incumbents. This competitive pressure can then be estimated from the coordination on entry between two firms deciding to enter and the degree of information asymmetry from the coordination between these two firms and a third firm.

reveal to other players additional information about rivals' costs.

3.2.1 Expected Entry Patterns and Market Outcomes

The expected entry patterns differ from the entry probabilities in that they are not a function of the signals η_{ji}. To obtain the expected entry probabilities one must integrate over the distribution of signals and the distribution of fixed costs. Since the distribution of signals is a function of the realized fixed costs, one must solve the integral

$$\bar{\mathbf{x}}_i = \int \int \hat{\mathbf{x}}_i \left(g_i, \mathcal{P}^{\star}_{\mathbf{x}_{-i}} \right) dH(\eta|g, \nu_H) dG(g) \tag{8}$$

to obtain the expected entry patterns $\bar{\mathbf{x}}_i$.

Similarly, one can obtain the expected consumer surplus, producer surplus, and other market outcomes by engaging in a similar procedure:

$$CS = \int \int CS_{\hat{\mathbf{x}}} dH(\eta|g, \nu) dG(g) \tag{9}$$

$$PS_i = \int \int \Pi_i(\hat{\mathbf{x}}_i, \hat{\mathbf{x}}_{-i}) dH(\eta|g, \nu) dG(g) \tag{10}$$

3.3 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 each in the following section.

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 Costs A second major effect arises from the merging firms internalizing the effect their entry decisions have on each others' profitability. To the extent that products are partial substitutes for each other, the merging firm might want to reduce its offering (the number of products offered), decreasing the cannibalization of their own products, increasing price on the remaining products and saving on the fixed costs of the products being eliminated. In the merger case between Whole Foods and Wild Oats, 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.[16] The net effect would be a reduction in total product offerings, following the same rationale behind competition in strategic substitutes.

Coordinating on Favorable Equilibrium A third mechanism involves the merging firms' abilities to coordinate on a more favorable equilibrium. Since it now jointly determines the offering decisions for more products, the merged firm has effectively increased the set of actions it can undertake. It may utilize these actions to coordinate on a more favorable equilibrium, one that possibly excludes a rival from entry.

For example, in a setting in which the market can support only one of three firms, any three of the firms entering could be an equilibrium. When firms A and B merge, the previous equilibrium in which the least profitable of the two would enter 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 market with three potential entrants. Profits are such that A enters if either B or C enter, but not both. B enters if C enters, but not if A enters. Similarly, C enters if B enters but not A. 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 when competing against C are larger than B's profits when B competes against C.[17]

[16] In an incomplete information game as the one modeled here, a firm has a cutoff for fixed costs below which it offers a product (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.

[17] If 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.

This effect is opposite to the court's assessment of the Oracle-PeopleSoft merger, in which the court stated the plaintiffs had not proven how rivals would fail to reposition themselves in the market to constrain anti-competitive price increases by the merging party. In the example above, the merger allowed for the merging parties 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.

Coordinating with Incomplete Information When firms have incomplete information about rivals' profits, they must make decisions under uncertainty. These decisions can lead to outcomes that are not ex-post profitable. Hence, firms will show ex-post regret under some particular outcomes. This regret induces firms to be cautious when deciding on entry. Particularly, upon deciding to enter, a firm must make strictly positive profits under a 'good' outcome (rival does not enter) to justify the potential profit loss under a 'bad' outcome (rival enters). This implies firms enter only when their costs are low, and overall entry is less than when firms know rivals' profits. A merger provides the merging parties with information on each other's profits, allowing them to coordinate actions better. As coordination improves, entry increases as firms need not be as cautious as before.

Cost Efficiencies Finally, mergers may generate cost efficiencies for merging parties. As suggested by the facial tissue and baby food mergers discussed in Section 2.2, such efficiencies may be in the form of reductions in the fixed costs of offering a product. Depending on the size of this reduction, entry may increase post merger, offsetting any negative effects on consumer welfare.

We illustrate the significance of each of these forces in a set of simulations involving three firms with one product each. The next section lays out these simulations.

4 The Three Product Example

Our simulation results are organized around demonstrating the merger effects discussed above. We do this in a setting where each of the three firms is endowed with a single product each. The simulation results show how key market outcomes change as a result of a merger between firms A and B. The presence of a non-merging firm, firm C, allows for some competition to exist after the merger. It also allows for some information asymmetry to exist after the merger.

For all simulations we measure the change in consumer surplus and in producer surplus. To normalize the scale values, we measure percentage changes. We also measure the expected number of products in the market and the change in this value. This allows us to observe how market structure changes due to the merger. Some general primitives common to all simulations are given below.

4.1 Primitives

The entry model described above is characterized by a large set of primitives, which we fix to reasonable values and detail in a complete list, together with the chosen parameter values, in the appendix.[18] The cross price elasticities, market shares, and entry probabilities for the base specification are:

$$\nabla_{\mathbf{p}} s(\mathbf{p}) = \begin{bmatrix} -1.82 & 0.43 & 0.43 \\ 0.43 & -1.82 & 0.43 \\ 0.43 & 0.43 & -1.82 \end{bmatrix} \qquad s(\mathbf{p}) = \begin{bmatrix} 0.22 \\ 0.22 \\ 0.22 \end{bmatrix} \qquad \bar{\mathbf{x}} = \begin{bmatrix} 0.88 \\ 0.88 \\ 0.88 \end{bmatrix}$$

00 Among other key primitives, we use a censored normal distribution for the distribution of fixed costs ($G(\cdot)$), with censoring at zero and positive mean value. Specifically, we assume a symmetric mean value of 0.28 and a standard deviation of 0.07. With these levels of fixed costs and the assumed demand and variable cost structures, mean fixed costs amount on average to 80% of variable profit, so that most products are offered frequently, but not always, and there is scope for changes in product offerings post merger. The signal

[18] In implementing this model for merger simulation, these primitives would come from the industry in which the merger is taking place. To illustrate here, we used primitives based on estimates from the premium ice cream markets as analyzing in Draganska, Mazzeo, and Seim (2009).

distribution ($H(\cdot)$) is a normal distribution. This allows for the updated distribution $\mathcal{G}(\cdot)$ to be a censored normal distribution (for which a closed form solution is known). When modeling significant information asymmetry, the standard deviation in the signal distribution is 0.5, seven times larger than that of the fixed cost distribution. When modeling almost no information asymmetry (i.e. quasi complete information games), the standard deviation for the signal is 0.001.

When there are multiple equilibria, we use a heuristic similar to iterating best responses to select one set of equilibrium entry probabilities. In solving for the fixed point $\mathcal{P}_{\mathbf{x}_i}$ (eqn. 7), we iterate probabilities, calculating a new $\mathcal{P}_{\mathbf{x}_i}$ one firm at a time. The initial starting probabilities assign all the weight to not entering the market. The order of iteration is given according to who is most profitable firm (in expectation) if no one else were to enter. With two players, this would choose the ex-ante efficient equilibrium; with three players it has the same flavor but efficiency is not guaranteed.

For the T1EV draw and the random coefficients, we use a scale parameter of 0.1 and a standard deviation of 1, respectively. This implies that most variation comes from the random coefficients and the T1EV shock serves primarily as a smoothing kernel for the numerical integration. We vary the covariances on the random coefficients across simulations to show how results differ if products are closer or farther apart. We discuss these covariances in more detail below.

4.2 Mergers with Differing Degrees of Product Substitution

The covariance matrix of random coefficients allows us to model how close or far in product space products are from each other. Equidistant products are modeled with a covariance matrix of the form

$$\Sigma_F^{(I)} = \begin{bmatrix} 1 & \rho & \rho \\ \rho & 1 & \rho \\ \rho & \rho & 1 \end{bmatrix} \tag{11}$$

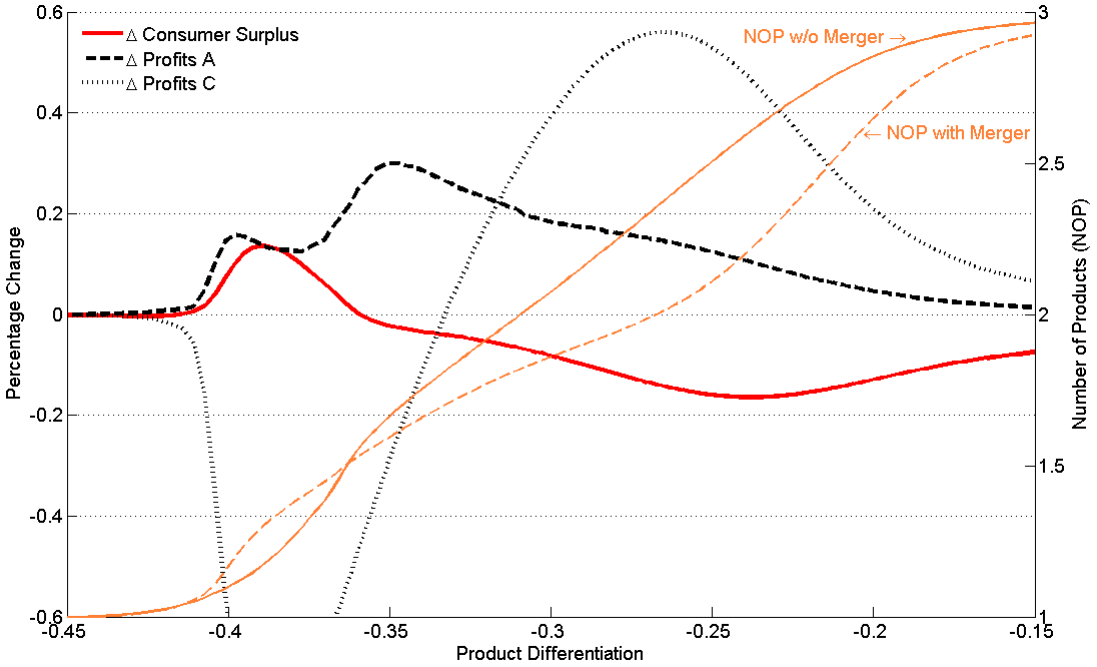
where we let ρ take values between -0.5 and 1,[19] which is the set of all admissible values for which the covariance matrix Σ_F retains positive-definiteness. A ρ value of 1 implies that products are perfect substitutes, large values of ρ imply close substitutes, a value of

[19]The range of possible ρ values (-0.5 to 1) is broken down into 200 equally spaced intervals and the simulations are calculated at each one of these values.

0 implies products substitute equally with each other and with the outside option, while finally negative values imply products are so far from each other that they compete more closely with the outside option than with each other: they resemble being local monopolies, splitting the market evenly.[20]

Our first set of simulations allow for significant information asymmetry in the entry game and thus capture all the effects described in Section 3.3. We begin with the aggregate effect, before breaking down and isolating each of these effects in the following subsections.

Figure 1: Net Effect of Merger as a Function of Degree of Product Differentiation: Three Equi-Distant Products



Product Differentiation, on the x-axis, is the cross-price elasticity between products A and B divided by A's own price elasticity, derived from the underlying value of ρ, the covariance of the random coefficients, $\rho \in [-\frac{1}{2}, 1]$. See text for details. Percentage change values are shown on a 0-1 scale. As products A and B are symmetric, only A's profits are shown.

Figure 1 captures the difference between a world with the merger and a world without it for key market outcome variables.[21] The figure is a double-axis plot. The left axis measures

[20]The specific discrete choice modeling implies products are ranked on a single vertical line. Hence, the most negative correlation that can exist between all three products is -0.5, as preferences for product A cannot be opposite of those for products B and C when preferences for B and C are opposite of each other too.

[21]All comparisons in this section compare ex-ante expected values post-merger with ex-ante expected

the change in expected consumer surplus and in expected profits generated by each product. The right axis measures the expected number of products offered in the market in a world with and without the merger.

The x-axis marks how close products are to each other. Instead of plotting the value of ρ, we show the cross-price elasticity between two products relative to the products' own price elasticity[22] as a measure of product closeness. We believe this measure of differentiation, which depends purely on cross- and own-price elasticities, is more readily available to economists and policy makers and is easier to understand than a primitive of the structural demand model.

At the extreme left of the plot, products are 'almost' perfect substitutes (ρ is one) and the cross-price elasticity divided by the own price elasticity is close to -0.5; when firm B increases its price by a fraction, firm A gets half of all of B's sales and firm C gets the other half.[23] At the extreme right products are far from each other and cross-price elasticities are close to zero. As the correlation between all three products' base preference can never be less than -0.5, there will always be some minimal competition between products (over and beyond that induced by the T1EV distribution).

The size of the effects shown in Figure 1 are large and vary significantly with the degree of substitution. For intermediate values of product substitution consumer welfare can decrease by up to 16% due to the merger. At the extreme right and the extreme left the merger has minimal effects on consumer surplus and producer surplus. At the extreme right products are so far from each other that they can be considered local monopolies. A merger does not change market power as each product already had all the market power possible in its 'local' market. At the extreme left products are so close substitutes that the market can support

values pre-merger. It is the relevant comparison for firms considering a merger prior to entry into a new market. As the analysis averages welfare changes across all possible market outcomes, it is also the relevant comparison for policy makers looking to develop guidelines that affect mergers in all markets. An alternative comparison would relate observed pre-merger values to ex-ante expected post-merger values. While this second comparison would be useful in analyzing specific merger cases, it would need to be done for each possible merger case (for each potential market outcome). In addition, given the model posed here has incomplete information, strategic decisions may be subject to ex-post regret. There are various options for how firms might deal with such ex-post regret, and thus how to analyze a merger. For example, do merging parties use the merger to 'fix' the outcomes causing ex-post regret or has the market already corrected itself such that there are no markets with firms having ex-post regret? The answers to these questions would affect the evaluation of the ex-ante post-merger values.

[22]The cross price elasticity and own price elasticity are calculated at equilibrium prices when all products are offered in the market and no firms are pricing jointly.

[23]Because of the infinite support on the T1EV distribution products will always be partial substitutes to each other, which is why products are never perfect substitutes nor perfectly differentiated (local monopolies).

only one product (as shown by the Number of Products in Figure 1). If two product were to be offered they would be priced at marginal cost and not recoup their fixed costs. In this case transferring ownership of potential products does not change anything, as the market continues to support solely one product independent of ownership. At intermediate levels of differentiation, merging firms gain substantial market power and have the potential to utilize it. How they utilize it can result in welfare either decreasing or increasing, depending on how much consumers value variety and the incentives of the merging parties to offer more or less products.

As can be seen in Figure 1, these incentives vary significantly across different values of product differentiation. We explore these forces in detail, each one in isolation, and then come back to this figure.

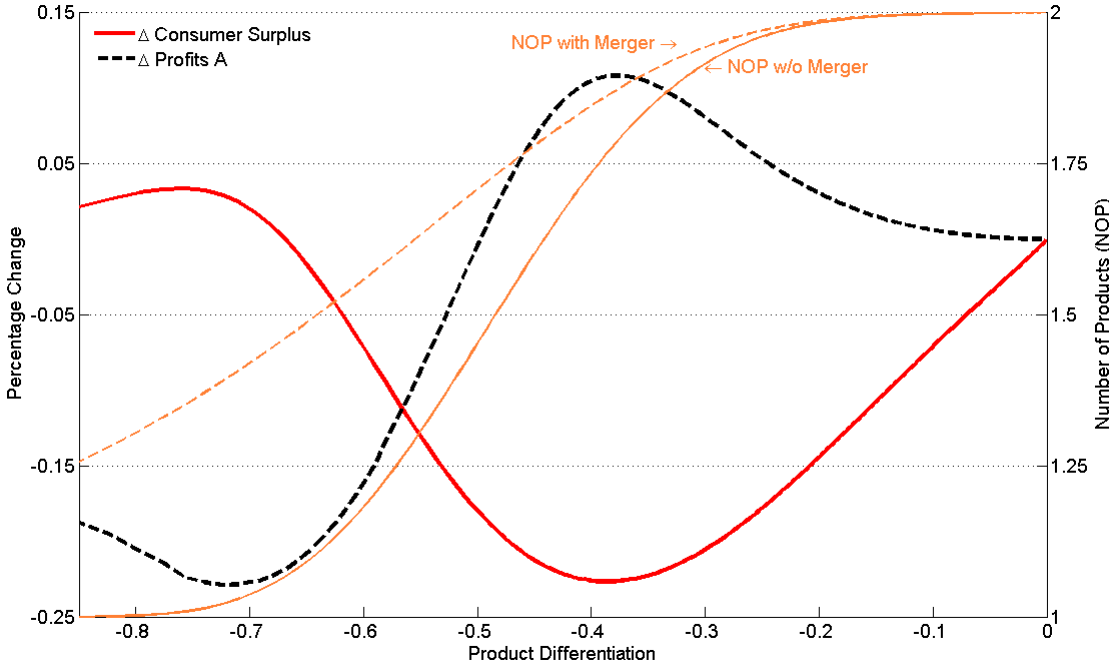
4.3 Increasing Prices

To begin, we would like to illustrate how the increase in prices post merger may induce firms to increase the products offered. To isolate this effect from the others, we remove the non-merging firm (firm C is endowed with zero products) and we remove all information asymmetry (the variance in the public signals is set to 0.001). We also abstract from any cost synergies by assuming firms have the same costs with and without a merger. Finally, to abstract from the incentive to cutback on product offering (to save on fixed costs) we model the merger as one in which both firms make entry decisions independent of each other and independent of the effect entry has on the other's profits, but acknowledge that they are pricing jointly after entry. This special merger situation should capture the additional entry induced from being able to jointly price without being confounded by other incentives. As with the previous simulation, we analyze market outcomes for all potential values of ρ in which ρ captures the covariance between the base preferences for products A and B.[24]

The outcomes of this merger can be seen in Figure 2. As only two products are potentially offered, the x-axis now ranges from -0.85 to 0. At -0.85, ρ is 1 and products are very close substitutes; a small increase in A's price shifts all of A's sales to B. At the other side of the axis, a ρ of -1 implies products are very far from each other, hence the cross-price elasticity is close to zero.

[24]Covariance with C is irrelevant as we have removed it entirely from the simulations.

Figure 2: Increasing Prices



Product Differentiation is the cross-price elasticity between products A and B divided by A's own price elasticity. It spans all admissible values of differentiation: $\rho \in [-1, 1]$. Percentage change values are shown on a 0-1 scale. As products A and B are symmetric, only A's profits are shown.

The number of products increases after the merger for most values of product differentiation. The increase is strongest when products are very close substitutes. It is when products are closest together that the price increase due to joint pricing is greatest. The higher prices induce the firms to offer their products more frequently, and this increase in product offering *increases* consumer surplus: for values of product differentiation up to -0.7, the change in consumer surplus is indeed above zero.

It is also at this cross-price elasticity that the change in profits are at their lowest: a 22% loss in profits. This is due to the additional entry. Prior to the merger, for most values of fixed costs, only one product would fit in the market and reap monopoly profits.[25] The merger causes firms' profits post-entry to increase and causes both products to be offered. This reduces firms' profits significantly.

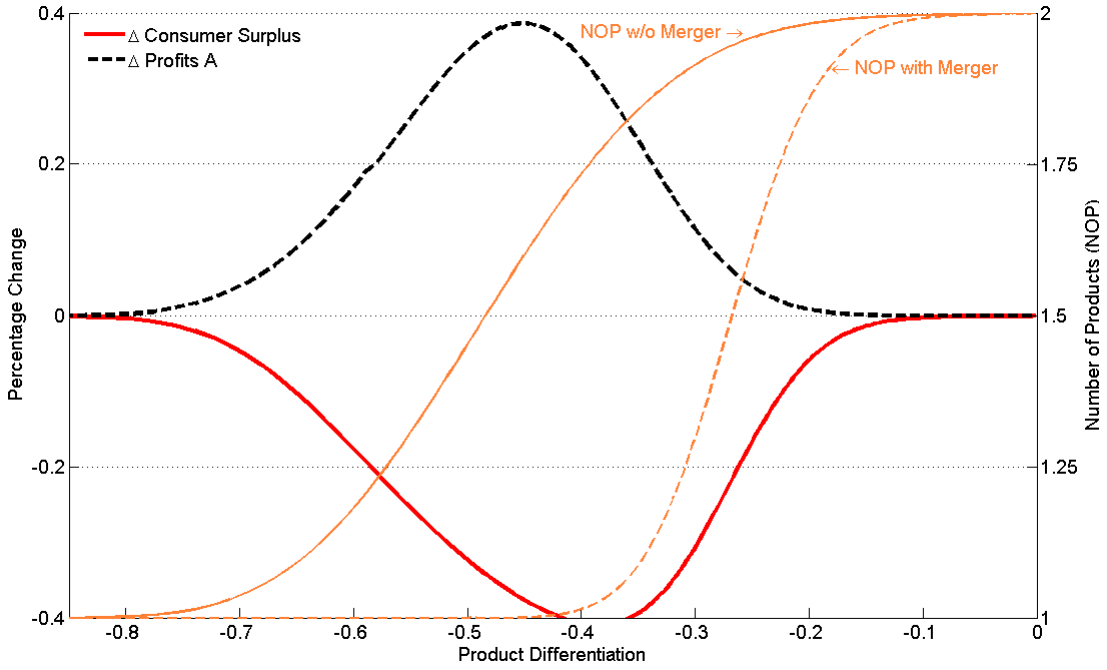
[25]The expected number of products pre-merger is exactly 1.5 at a product differentiation value of approximately -0.5, which is where the difference in profits is exactly zero. For product differentiation values below approximately -0.5, the expected number of products is below 1.5, implying that for the majority of fixed cost values only one product fits in the market.

While this particular effect on profits is driven partially by the fact that after the merger firms continue to make independent entry decisions, it illustrates how more entry can result simply due to higher prices, that the additional entry is non-negligible and that it can even be sufficient to benefit consumers despite higher prices.

4.4 Saving on Costs

As described above, firms may reduce products offered after a merger to save on fixed cost and have the remaining products serve a fraction of the market the culled products served. To illustrate this force and abstract from other effects we remove from the setting the non-merging firm (firm C), information asymmetries, and cost synergies. We also assume that firms continue to price as if they had not merged after entry decisions are made and that they know they will price so when making entry decisions. Nevertheless, they make the entry decision jointly, recognizing each others' interdependencies.

Figure 3: Saving on Costs



Product Differentiation is the cross-price elasticity between products A and B divided by A's own price elasticity, derived from the underlying value of $\rho \in [-1, 1]$. Percentage change values are shown on a 0-1 scale. As products A and B are symmetric, only A's profits are shown.

Figure 3 shows the outcomes of such a merger. The drop in consumer surplus due to the culling of products amounts to up to 40% for some values of product differentiation. This effect is strongest for medium levels of differentiation. At low levels products are so different that they do not cannibalize each others' sales and there would be no gain from culling a product. At very high levels only one product is offered even without the merger. Since one product is the minimum required to make any sales, there are no cost savings to be achieved. The cost savings are largest when products cannibalize each other significantly *and* both are offered in the non-merger world. It is also in these cases where the effect on culling a product is largest for consumers, as they are not only deprived of variety but they also see prices of the remaining products increase.

Firms' profits thus increase by up to 40% by culling back on products. As suggested in the analysis of the Whole Foods - Wild Oats merger, the ability to close a rival's stores may be a much larger motive for merging than the ability to jointly price. This also implies that colluding on store location may be much more profitable than colluding on pricing.

4.5 Coordinating on Favorable Equilibrium

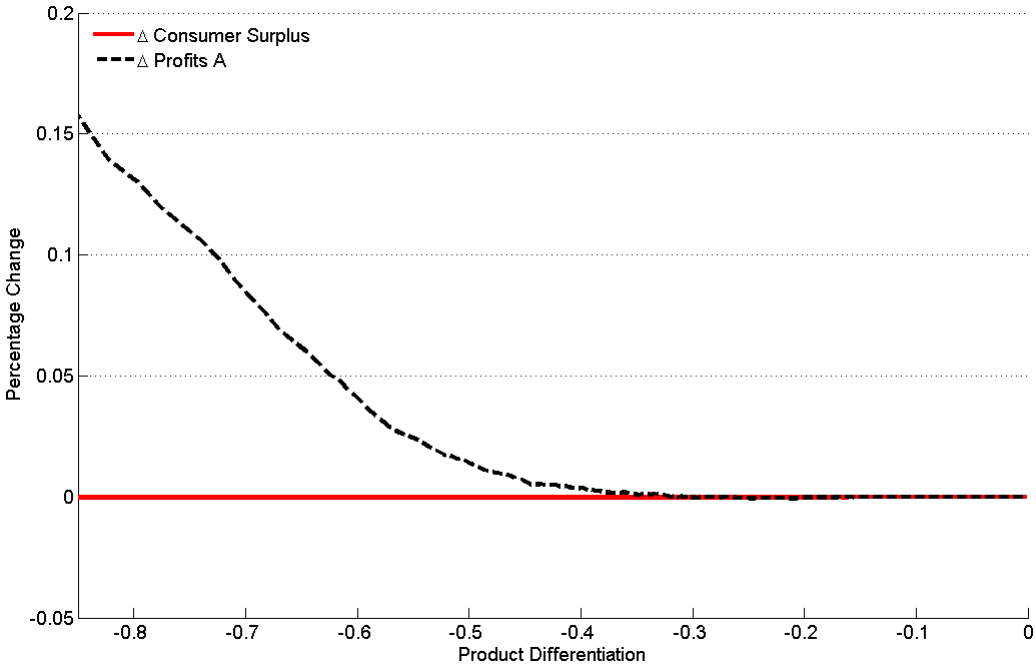
To isolate the coordination effect, how it affects profits, and how it can hurt non-merging parties, we show two different simulation sets. In a first simulation set we show how much merging firms can gain from coordinating on the most profitable equilibrium. In the second set of simulations, we show how merging parties can use the ability to coordinate to exclude a potential rival from the market.

4.5.1 Coordinating to Increase Profits

We analyze the coordination on a 'good' equilibrium absent non-merging rivals. As in Section 4.4, we exclude firm C, information asymmetries, and cost synergies. Similarly, we assume firms price as if they had not merged, and that they know this when making entry decisions. Hence, we are replicating the simulation from the the previous section, with two changes: (1) we censor fixed costs such that only two potential market outcomes may arise pre-merger: A enters and not B, or B enters and not A. (2) We change the equilibrium selection rule such that the order in which we iterate firms while searching for the fixed point is random.

The first change implies that, in the selected sample, only one product is offered for all

Figure 4: Coordinating on Favorable Equilibrium: Increase in Profits



Product Differentiation is the cross-price elasticity between products A and B divided by A's own price elasticity, derived from the underlying value of $\rho \in [-1, 1]$. Percentage change values are shown on a 0-1 scale. Distribution of fixed costs is censored such that only one product is offered pre-merger.

values of our product differentiation. The second change implies pre-merger firms need not coordinate on the ex-ante socially efficient equilibrium (i.e. A entering and not B when B's profits are higher than A's).

Figure 4 shows the results. Consumer surplus is unaltered, as with or without the merger a single product is offered. Nevertheless, being able to coordinate on the favorable equilibrium does provide significant benefits for the merging firm, as profits may increase up to 15% (when products are homogenous).Hence, firms may seek to merge so as to be able to offer the most efficient product in markets that are currently served by an inefficient product of one of the merging firms. Such mergers would be extremely beneficial as consumers go unharmed but firms gain significant profits.

4.5.2 Coordinating to Exclude Rival

Next, we analyze coordination on an equilibrium that excludes third parties. We introduce into the above setting a non-merging firm, firm C. Furthermore, as explained in section 3.3, we need to introduce profit asymmetry between firms. Specifically, the game needs to have two equilibria prior to a merger: (1) A enter and not B nor C, and (2) B and C enter, but not A. This happens when A is a close competitor to B and C, but B and C are not close competitors to each other. The following covariance matrix builds such a substitution structure:

$$\Sigma_F^{(II)} = \begin{bmatrix} 1 & \rho & \rho \\ \rho & 1 & -\rho \\ \rho & -\rho & 1 \end{bmatrix}$$

with $\rho \in \left[0, \frac{1}{2}\right]$.[26] As with the previous setting, we censor the sample of fixed costs such that without a merger A enters but not B nor C, or B and C enter but not A.

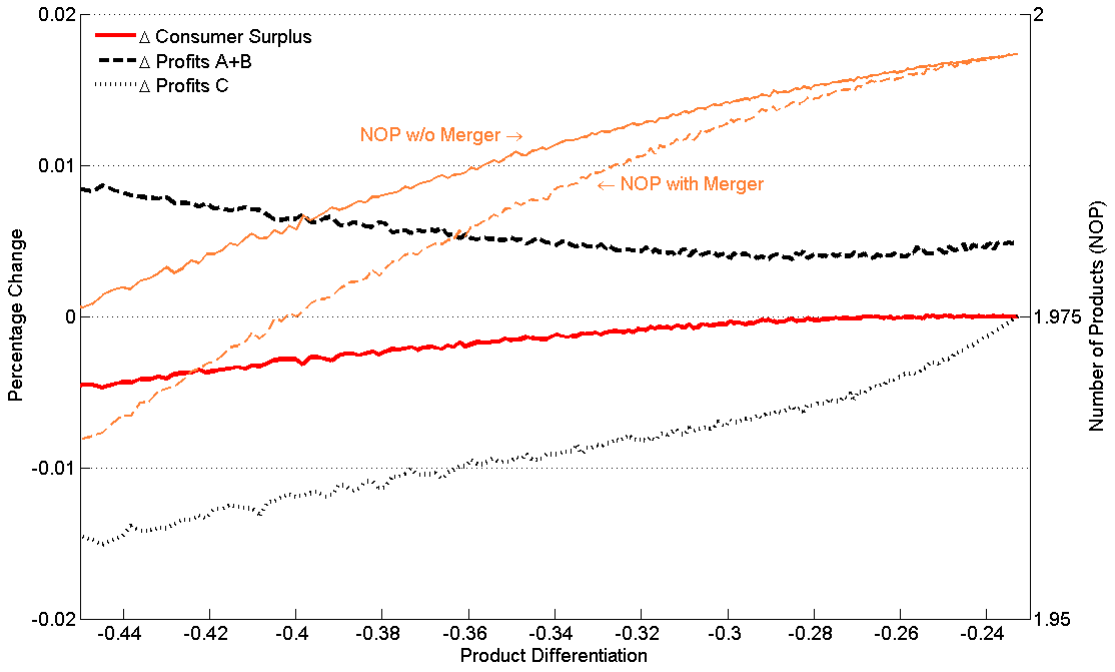
Figure 5 shows how the merging firms benefit from coordinating on the equilibrium in which only firm A enters and not firm B and C. The effect is small; the profits of the merging firms is less than 1% higher with the merger than without it. As the profit increase arises from switching from one equilibrium with two firms (B and C) to one with only one firm (A), consumer surplus is also slightly lower with the merger than without it as the expected number of products drops slightly.

The drop in expected number of products, and the increase in profits for the merging firms, is very small because there are few values of fixed costs that give rise to multiple equilibria. For many values of fixed costs, it is more profitable to offer B instead of A, regardless of C's actions, which occurs when B's costs are much smaller than A's. Specifically, in only 0.6% of the unconditional distribution of fixed costs do we see this shift in equilibrium from B and C entering to only A entering (1% of the conditional distribution plotted).

Why are such multiple equilibria rare? It is useful to think about the above situation as firms located on a line, with A in the middle. As B is located far away from C, B's profits are almost unaffected by C's entry: B is a quasi-monopolist as long as A does not enter. On the other hand, in the equilibrium in which A enters and B and C do not, A is a monopolist. Hence, the difference in A and B's joint profits between the two equilibria is minimal, as in

[26] Although ρ could take on negative values, these would produce correlations which are not of interest: they would imply A is far from both B and C and that these two are close to each other.

Figure 5: Coordinating on Favorable Equilibria: Exclusion of Rival



Product Differentiation is the cross-price elasticity between products A and B divided by A's own price elasticity. Random coefficients covariance matrix given as in $\Sigma_F^{(II)}$ and ρ spans all values of differentiation in which A is close to B and C, but these last two are far from each other: $\rho \in [0, \frac{1}{2}]$. Percentage change values are shown on a 0-1 scale.

both cases the profits of the joint firm are those of a quasi-monopolist.

4.6 Coordinating with Incomplete Information

As described in section 3.3, when there is incomplete information costly mis-matches may happen. These occur when firms offer products expecting rivals not to offer theirs and rivals behave similarly. The end result is too many products being offered. A merger helps mitigate these costly mis-matches in that private information is shared between the merging parties, eliminating the mis-matching between them. In addition, higher prices due to joint pricing mitigates losses from mis-matches, inducing firms to offer more.[27]

4.6.1 Coordination without Rivals

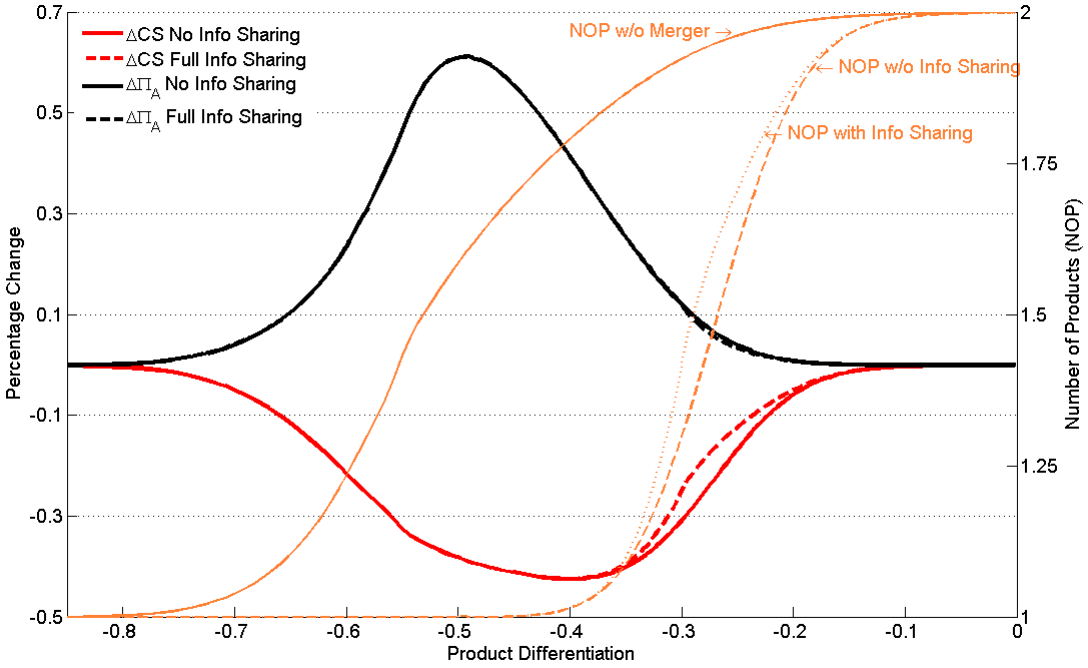
To study the value of information we allow for a setting with significant information asymmetry. Specifically, we let the public signals on firms' costs to be uninformative, and thus set the signal's variance to 0.5, the largest value we consider. To abstract from other forces at play, we remove from the setting non-merging firms (firm C) and any cost efficiencies. We also assume that firms continue to price as if they had not merged after entry decisions are made and that they know this when making entry decisions. Furthermore, we have the ex-ante most profitable firm move first in the equilibrium selection heuristic.

In this setting we study two different types of mergers. The first type is one in which the merging parties share information and make entry decisions jointly. The second type is one in which firms internalize each other's interdependencies but make the entry decisions independently and without knowledge of the other merging party's entry decision. This merger resembles how two divisions of a firm would act if they did not share information. The contrast between the two types of mergers elicits the value of transferring information. The only other forces at play in these mergers are the product culling effect and the coordination on a 'favorable' equilibrium. This latter effect is very small as the equilibrium selection rule selects the ex-ante efficient product offering, which, with two firms, is the most profitable offering.

Figure 6 plots the change in consumer surplus and the change in profits for both mergers, relative to the case without a merger). Since products are symmetric, we show the profits

[27] This second effect is the same *Increasing Prices* argument discussed earlier, but in an incomplete information framework.

Figure 6: Coordination with Incomplete Information: No Rival



Product Differentiation is the cross-price elasticity between products A and B divided by A's own price elasticity. It spans all admissible values of differentiation: $\rho \in [-1, 1]$. Percentage change values are shown on a 0-1 scale. Two different types of mergers are contrasted: in the "No Info Sharing" merger merging firms consider each others' profits when making entry decision, but do not jointly decide on entry. In the "Full Info Sharing" merger merging firms jointly decide on entry, with full knowledge of each others' costs. In both mergers merging firms are symmetric, hence we show only A's profits.

of one of the two products.

There is no significant difference between the two mergers, implying most of the benefits of the merger arise from the saving on costs, and not from the transfer of information.[28] For low levels of product differentiation there is a noticeable difference, accounting for a ~5% difference in consumer surplus. This difference in consumer surplus is driven by more entry in the first merger than in the second. That is, as described earlier, coordination allows the merging parties to avoid costly mis-matches, reducing the need to be as cautious when choosing to enter: entering at higher fixed costs. The effect is largest when the expected losses of a mismatch are largest: when the probability of both entering is high and there is significant cannibalization. It is rare that both of these factors occur jointly, which happens only for moderate levels of product differentiation. When products are very different there is little cannibalization so the losses of a mis-match are small. When products are very similar the probability that both are offered is very small. In the above merger simulations, both firms internalize the profit loss that their entry has on the rival product. If products are very close and the probability that the other product is offered is high, the best response is to stay out of the market so as to not cannibalize the other product's sales.

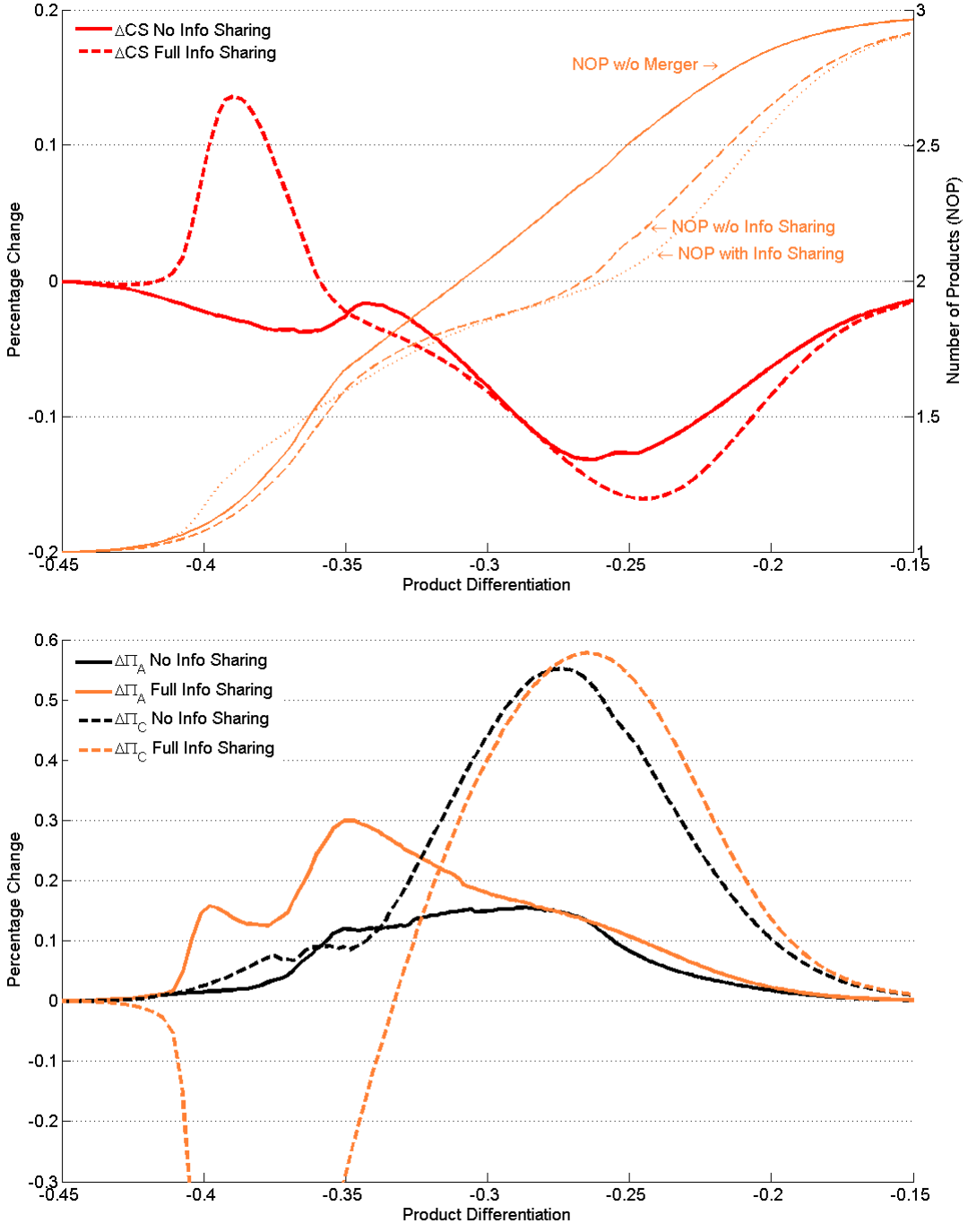
4.6.2 Coordination with Rivals

The value of information changes significantly in the face of a rival. Figure 7 repeats the simulation above but includes a non-merging firm, firm C, in the game. In the top panel, the solid line shows the changes in consumer surplus when the merging firms share information and jointly decide on entry ("Full Info Sharing"). The dotted line shows the changes in consumer surplus when the merging parties act as two different divisions of the same firm ("No Info Sharing"). It is important to recall that the variable profits obtained in any subgame are the same both with and without the mergers: we have removed all benefits from joint pricing.

When products are close to each other, very few fit in the market. Firms are very cautious about entering the market, since mis-matches (two firms entering) are very costly. This caution persists even when firms A and B internalize the effect of their entry on each other's expected profits ("No Info Sharing"). When A and B are allowed to share information in

[28] By focusing on rivals' fixed cost, the current setting considers only one of several sources of imperfect information. It is possible that if we considered imperfect information about other inputs into the rivals' decisions – such as their variable costs, the value of transferring such information would be larger.

Figure 7: Coordination with Incomplete Information under the Presence of Rival



Product Differentiation is the cross-price elasticity between products A and B divided by A's own price elasticity. It spans all admissible values of differentiation: $\rho \in [-\frac{1}{2}, 1]$. Percentage change values are shown on a 0-1 scale. See caption of Figure 6 for a description of the mergers. As firm A and B are symmetric, the right panel shows only A's and C's profits.

addition to internalizing each others' interdependencies, they can now coordinate on entry ("Full Info Sharing"). Because they can coordinate on entry they increase the fixed cost threshold at which they enter. This effect is reinforced by firm C's response to reduce its threshold further, entering less often, which in turn incentivizes the merged firm to increase its threshold even more.entering more often. The cascading effect can drive C completely out of the market. This is extremely profitable for the merging firms, as they succeed in excluding a rival from the market. The second panel of Figure 7 shows this, where the difference in the merging firms' increase in profits can be as large as twenty percentage points (for product differentiation values of approx. -0.35).

At the same time, when products are close substitutes ($\rho \to 1$, left side of plots), only one product fits in the market. The benefits from coordination are minimal as firms are already coordinating on entry: the firm with the advantageous cost signal enters, and the other two firms abstain. The result is that the merging firm cannot drive the non-merging firm out of the market and the difference in the change in profits between the two types of mergers is not significant.

4.7 Summary of Effects with No Cost Efficiencies

After illustrating each of the forces independently, we now return to Figure 1. Of the four forces driving the competitors' entry decisions analyzed so far, two effects dominate: the tendency to increase entry due to increased prices, and the tendency to cull products to save on costs. But these two act in opposite directions in terms of their impact on the number of products offered.

To the right of the plot the culling effect dominates. This is where products are not close substitutes and where almost all three are offered pre-merger. Because there is some degree of substitution between products, the merging parties can change from offering two products to offering one, save on fixed costs, and have the remaining product absorb some of the sales of the culled product. Joint pricing does not have a significant advantage at this level of differentiation as products are still significantly different.

As the culling effect dominates, the non-merging firm is the one who benefits the most from the merger. The merging parties reduce their offering and the non-merging firm responds by increasing its offering. In addition, the non-merging firm enjoys higher prices when all three products are offered.

As products become closer substitutes (medium levels of differentiation) it becomes rarer for the two merging parties to both offer their product pre-merger, and the benefit from culling products falls . At the same time, since products are closer substitutes, joint pricing helps increase prices significantly. This induces the merging parties to offer their products more often, inducing a net increase in the number of products offered. Since consumers value variety, consumers benefit from these actions.

Now the non-merging firm is really hurt by the merger as it is pushed out of the market. It is pushed out in multiple ways. First, as the merging parties increase their offering because of the higher prices they can achieve after entry, the non merging firm has to reduce its offering in response: the market supports two products, not three. In addition, the merging parties are able to coordinate entry decisions, allowing them to enter more often. As firm C cannot participate in this coordination, firm C is better off retreating from the market. As firm C retreats, this gives an additional incentive to the merging firms to offer their products more often, reinforcing the initial effect. Finally, it is important to note that even as firm C is being pushed out of the market, consumers benefit from this as the merging parties are 'flooding' the market with their products. Figure 1 illustrates how a merger may be *beneficial* to consumers without any cost efficiencies and at the expense of non-merging firms.

Before exploring cost efficiencies, we show how the welfare effects discussed above differ when the non-merging firm is not positioned to compete against any of the merging parties' products and when the merger is between two non-competing products. We model these two cases with the following two covariance matrices for the random demand intercepts:

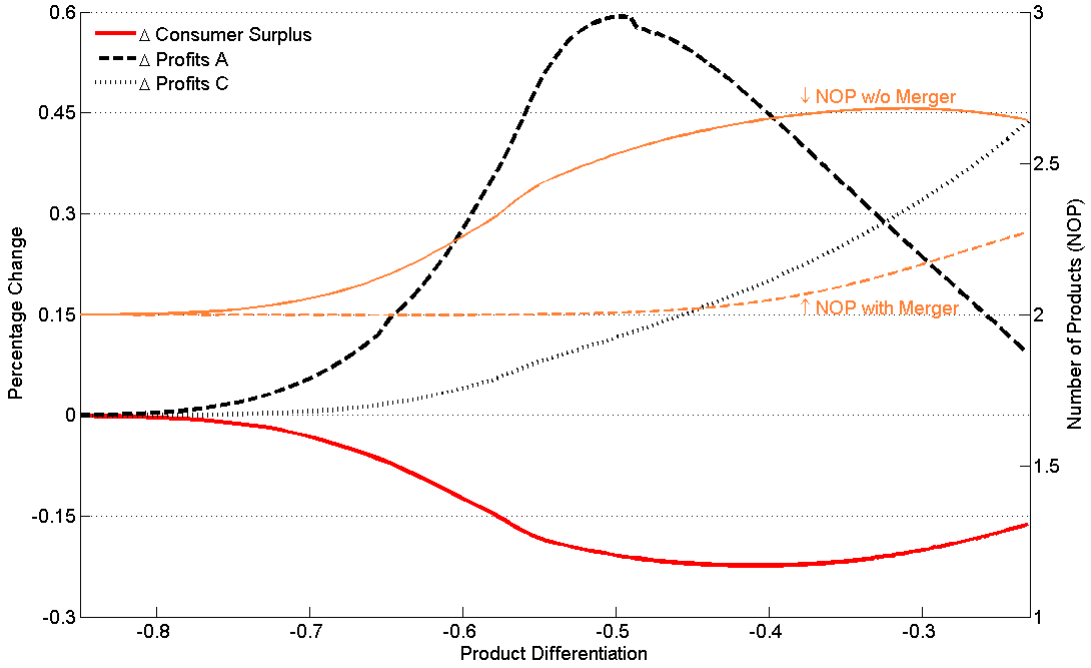
$$\Sigma_F^{(III)} = \begin{bmatrix} 1 & \rho & -\rho \\ \rho & 1 & -\rho \\ -\rho & -\rho & 1 \end{bmatrix} \qquad \Sigma_F^{(IV)} = \begin{bmatrix} 1 & -\rho & \rho \\ -\rho & 1 & -\rho \\ \rho & -\rho & 1 \end{bmatrix}$$

The first one implies that products A and B are very close to each other but far from product C when ρ is high, so that the non-merging firm does not compete strongly against either of the merging firms' products.[29] High ρ values in the second covariance matrix imply products A and C are close substitutes and far substitutes from product B. For both

[29] An analogy that may be useful is that A, B, and C sit on the corners of an isosceles triangle where the lengths of the legs CA and CB are equal, and larger than the length of the side AB.

covariance matrices we vary rho only between 0 and 1 (although negative values would be admissible), since this range produces the correlations of interest. Positive values of ρ in $Sigma_F^{(III)}$ implies products A and B are close to each other and far from C, while negative values imply A and B are far from each other and close to C, which is not of interest.

Figure 8: Rival Product Highly Differentiated Merging Parties' Products



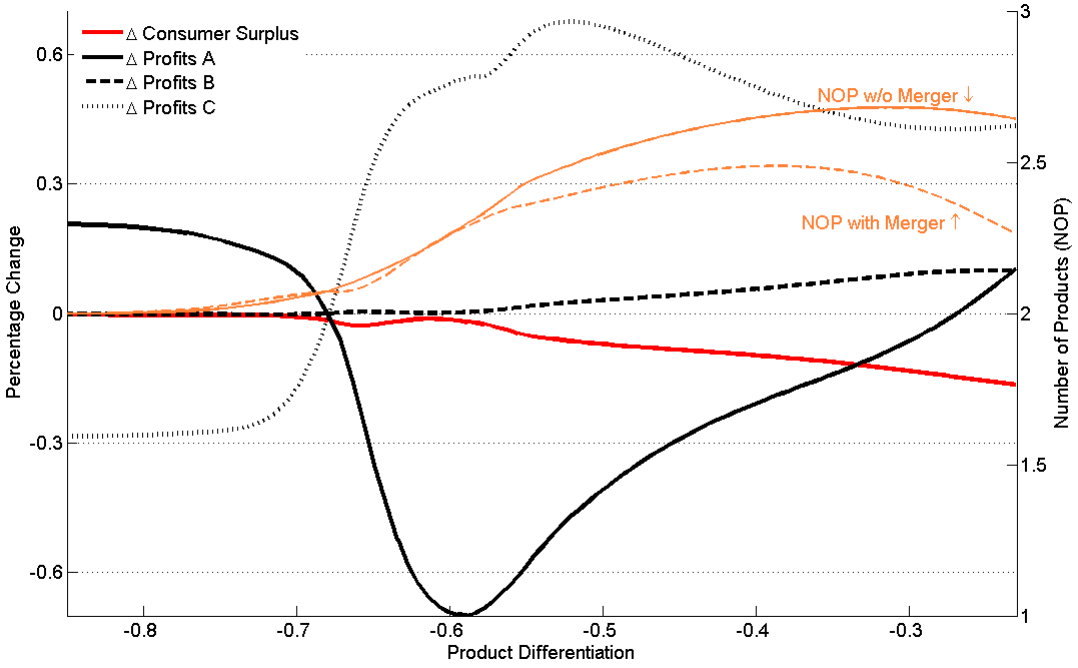
Product Differentiation is the cross-price elasticity between products A and B divided by A's own price elasticity. Random coefficients covariance matrix given as in $\Sigma_F^{(III)}$ and ρ spans all values of differentiation in which firms A and B are closer to each other than to C: $\rho \in [0, 1]$. Percentage change values are shown on a 0-1 scale. As firms A and B are symmetric, only A's and C's profits are shown.

Figures 8 and 9 illustrate the changes in key market outcomes the two sets of alternative product space configurations. When the non-merging firm is not well positioned to compete against either of the merging parties (Figure 8), the merger has strong effects on welfare. As soon as products A and B are not perfect substitutes (which happens at the extreme left of Figure 8) the merger allows the merging parties to cut back on products when both are offered, diminishing cannibalization. The non-merging firm cannot steal market share from the merging parties, so most of the market share of the culled product goes to the merging firm. In addition, the benefits from joint pricing are large as C cannot compete against A nor B.

The fact that post-merger only two products (C, and A or B depending on fixed costs) are offered for almost the full range of differentiation implies the culling effect dominates the pricing effect. Consumers do not have access to products that would be offered without the merger.

The merging parties benefit significantly from the merger, with profit increases of up to 60%. Consumers, on the other hand, see a drop in surplus of up to 20% (significantly higher than the 10% drop of Figure 1). The non-merging firm benefits slightly from the merger, as the merging firm cuts back on product offering. Nevertheless, as products were differentiated to begin with, the benefit is small.

Figure 9: One Merging Party's Product Differentiated from Other but Similar to Rival Product



Product Differentiation is the cross-price elasticity between products A and C (the two nearby products) divided by A's own price elasticity. It spans all values of differentiation in which firms A and C are closer to each other than to B: $\rho \in [0, 1]$. Percentage change values are shown on a 0-1 scale.

On the other hand, if the non-merging party is close to one of the merging parties, the effect of the merger on consumer surplus is minimal. Figure 9 depicts this merger, in which A and C are close to each other and far from B. At the far left, where A and C are very close competitors, the merger allows the merging parties to coordinate on entry and to 'push' the

non-merging party out of the market as discussed previously. This benefits A the most, as C is its close competitor.

Nevertheless, as A and C become more differentiated and B gets closer to A, the merging firm benefits more from culling one of the two products. Since A is under pressure from C, this is the product the firm decides to cut back on. B benefits as it no longer competes with A. But firm C benefits most, as it sees its close rival being shut down. Prices rise significantly and consumers are hurt.

4.8 Cost Efficiencies

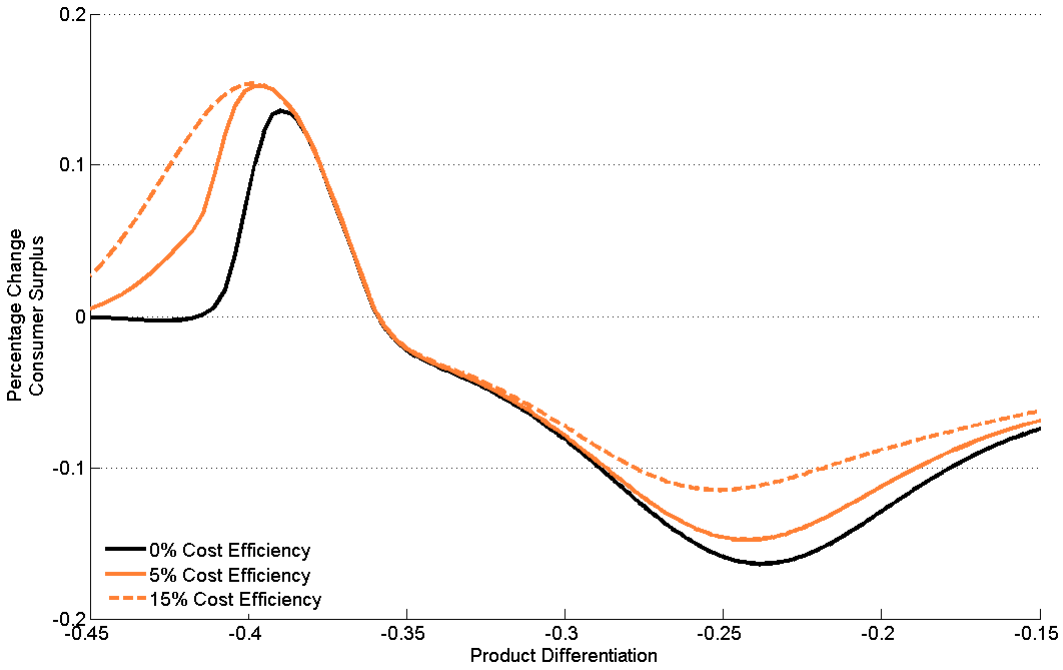
It is natural to ask: how large must cost efficiencies induced by the merger be so that the merger be beneficial to consumers? Farrell and Shapiro (1990) take a first stance at this question, calculating the size of the cost efficiencies in a symmetric Cournot setting.[30] We follow a similar analysis, and show the consumer surplus change post merger for two different levels of cost efficiencies: 5% and 15% cost reductions in fixed costs. Figure 10 shows these results, where the setting is one with significant information asymmetry and with the presence of a non-merging firm (same as the setting of Figure 1).

The effects of fixed cost efficiencies appear to be small. A 15% cost reduction results in only a moderate mitigation of welfare loss, and only for low levels of product differentiation. When products are significantly differentiated, all three products are offered regardless of mergers and cost efficiencies. At moderate levels of product differentiation, merging firms are facing two major forces, going in opposite direction: on the one hand, the product culling effects are large, inducing the firm to remove products so as to save on the fixed cost of offering them. On the other hand, cost efficiencies reduce the fixed costs per product, making it attractive to retain both products in the market. At very low levels of differentiation cost efficiencies make it more likely for the merging firm to offer both products instead of just one; this induces the non-merging firm to be even more cautious to offer its product, reducing the threshold at which it offers the product. This in turn increases the incentives of the merging parties of offering both products.

For which levels of differentiation are the benefits from cost efficiencies largest? The profit gains are highest when the merged firm would offer, absent cost efficiencies, one product in expectation. At this degree of differentiation, the fixed-cost threshold the firm bases its

[30] Other work in this question is Levin (1990) and McAfee and Williams (1992)

Figure 10: Change in Consumer Surplus for Differing Values of Cost Efficiencies



Product Differentiation, on the x-axis, is the cross-price elasticity between products A and B divided by A's own price elasticity. It spans all admissible values of ρ in the random coefficients matrix $\Sigma_F^{(I)}$: $\rho \in [-\frac{1}{2}, 1]$. See text for details. Percentage change values are shown on a 0-1 scale.

entry decision on (the largest fixed costs can be and still justify entry) is at the middle of the distribution of potential fixed costs for both of its products. A cost efficiency that reduces fixed cost would shift the distribution of potential fixed costs down. As the distribution of fixed cost has most of its mass in the middle (symmetric and single peaked), cost efficiencies shift a significant mass of this distribution across the threshold, hence increasing significantly the number of potential realizations of fixed costs that justify entry. For very low or very high levels of differentiation, the threshold on fixed cost at which a firm is just indifferent between offering or not offering a product is at the extremes of the distributions, where there is not a lot of mass. In these cases, moving the entry-threshold via cost efficiencies does not have a large impact on the probability of offering the product.

5 Conclusions

In this paper, we have begun to analyze the potential welfare impacts of post-merger product repositioning. 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 repositioning qualitatively, merger simulations have almost entirely focused on price effects. We demonstrate that post-merger repositioning can have a substantial impact on industry equilibrium, exacerbating or diminishing 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. A simulation that allows for repositioning 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 the repositioning effects, noting their potential to offset in the overall analysis. Parties appear to cite only the repositioning impact favorable to their position; while we show these effects do exist, considering all repositioning impacts is necessary to accurately simulate the merger.

While the analysis here considers one possible and general demand scenario, the modeling strategy employed here could also, in principle, be adapted to compute post-merger repositioning impacts in an actual merger simulation. As mention 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.

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A Primitives of the Model

The pricing game is characterized by price coefficients (α), the distribution of random coefficients ($F(\mu_F, \Sigma_F)$), market size (M) and variable costs (c_{ji}). The price coefficient is set to $e^{-0.75}$, which is approximately 0.47. The random coefficients distribution is a multivariate normal with mean $\mu_F = (1.2, 1.2, 1.2)'$. The covariance matrix, Σ_F, is detailed in the text, has a variance of one, and covariance elements that vary between -0.5 and 1. Market size is 0.76 units and variable costs are $c = (1.5, 1.5, 1.5)'$. The T1EV distribution uses a scale

parameter of $\sigma = 0.1$ and the integrals over the distribution of random coefficients are solved using numerical integration, taking one hundred thousand draws from a Sobol sequence.

If all products are present in the market, these primitives imply pre-merger prices of 3.32,[31] market shares of 24.4%, variable profits of 0.35, own price elasticities of -1.82, and cross price elasticities of 0.43. Gross margins are of 55%.

The entry game is characterized by a distribution over fixed costs (G) and a distribution over signals (H). We use a censored normal distribution for fixed costs, with censoring at zero, a mean value of 0.28, and a standard deviation of 0.07.[32] H is a normal distribution with variance 0.5. All integrals regarding either H or G are executed through numerical integration. We use forty thousand draws for the G distribution integrals and one thousand draws for the H distribution. All draws are taken from Sobol sequences so as to increase the accuracy of the integrals.

The large variance in the distribution of signals, H, compared to the more modest variance of G, imply the game is close to the classical game of incomplete information: the standard deviation of the updated distributions $\mathcal{G}$ is 0.069 – calculated as: $\sigma^2_{\mathcal{G}} = \left((\sigma^2_G)^{-1} + (\sigma^2_H)^{-1} \right)^{-1}$. With these distributions, the expected pre-merger entry probability for a given product is 0.88, which implies the expected number of products offered is 2.64. The expected net profits are 0.09 units (a net margin of 15% using pre-merger prices of 3.32 and market shares of 24.4%).

[31] Due to symmetry, all prices, market shares, and variable profits are identical.

[32] This mean and standard deviation does not coincide with the μ_G and σ_G parameters of the distribution since G is a censored-normal distribution. In this particular case, since the censoring is at zero and zero is more than two standard deviations below the mean value (0.28), μ_G and σ_G are almost identical to the mean and standard deviation values.