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Pass-Through By Multiproduct Firms

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Pass-Through by Multiproduct Firms

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Abstract

How does cost pass-through to prices depend on the number of products a multiproduct firm owns? Using a structural demand model for the Swedish beer market, we simulate equilibrium cost pass-through for varying counterfactual ownership patterns. We find that a firm with a larger number of products in its portfolio and a higher degree of substitutability among these products optimally adopts a lower cost pass-through rate than a firm selling fewer and less substitutable products. Our results are robust to a wide range of cost shocks, changes to the available number of products, and deviations from Nash-Bertrand play between firms. (JEL E31, L11, L13)

1 Introduction

A string of recent articles highlight the role of multiproduct firms and economies of scope in menu costs for price adjustment patterns (Midrigan, 2011; Alvarez and Lippi, 2014; Bhattarai and Schoenle, 2014). These models are interesting not only for understanding micro patterns in the data but also for showing that synchronization of price changes within firms can greatly increase the real effects of monetary shocks in models with nominal rigidities (Goloso and Lucas, 2007, is an important single product benchmark for these studies). This body of work assumes that desired markups are independent of the set of products that a firm controls and the multiproduct aspect only enters via the menu cost. If a firm takes the menu cost to change one price it is free to also change additional prices. In this paper we are motivated by a complementary question. We disregard nominal rigidities

and ask: How is cost pass-through to prices impacted by the number of products a multiproduct firm owns? Specifically, we allow all products to be substitutes, so that a price change of one product affects the demand for all other products. When jointly maximizing profits, a multiproduct firm optimally takes into account this substitutability within its product portfolio. We find this to have a dampening effect on cost pass-through to prices.

The pass-through of a cost change has previously been shown to depend on factors such as the curvature of costs, the curvature of demand, and the form of competition (Bulow and Pfleiderer, 1983; Weyl and Fabinger, 2013). Despite multiproduct firms being a pervasive feature of a modern economy, the comparative statics of pass-through for multiproduct firms are relatively unexplored.¹ Analytical results in settings with general functional forms depend on the relative magnitudes of a large number of second-order effects that are not readily observable. Besanko, Dubé and Gupta (2005) provide a discussion of some of the challenges facing studies of multiproduct pass-through and survey the literature.

In this paper we first examine the comparative statics of how price responds to cost changes for single-product and multiproduct firms. We do this for a linear approximation of demand and allow cross-price effects to be asymmetric between products. We show that for a relatively wide range of own- and cross-price effects pass-through by a multiproduct firm is lower than the corresponding pass-through for single product firms. This holds both for own-price pass-through and for cross-price pass-through (the pass-through of a product specific cost shock on the price of other products controlled by the same firm). Intuitively, when a multiproduct firm raises the price of a product, some of the diverted sales for the multiproduct firm will go to other products that it controls which will affect the optimal price adjustment. Conversely, when it lowers the price of one of its products some of the acquired sales are drawn from other products that the firm controls. Our theoretical

¹A notable exception is Moorthy (2005) who examines a setting with two retailers each selling two brands. He shows that brand specific cost changes will in general also result in price changes for the other product and that even in this highly stylized setting results depend in rich ways on second-order effects. Another exception is Hamilton (2009) who examines the pass-through of excise taxes for multiproduct firms. The key mechanism in his model is that higher excise taxes lead firms to hold smaller product portfolios.

examination shows that such cannibalization serves to mute price changes under many circumstances.

To systematically explore the relation between pass-through and the set of products controlled by firms we want to study a market with a large number of differentiated products where the data is rich enough to allow for the estimation of the own- and cross-price effects that will be important determinants of pass-through. We have chosen to examine this question using monthly data from the Swedish beer market for 1996 to 2003. The institutional setup of this market suits our purposes well. In Sweden beer is retailed through a government owned monopoly retail chain which allows us to use scanner data covering all products sold on a national market. The retailer adds a deterministic markup over the wholesale price, which is set by independent profit maximizing wholesalers and brewers. We thus have detailed data in a setting where multiproduct firms each control a set of products that are differentiated along several dimensions.² There are some 200 products in our data each month, something which implies that in a counterfactual where each variety is owned by one firm monopolistic competition may not be a too farfetched approximation. Following Berry, Levinsohn and Pakes (1995; henceforth BLP) we estimate a random coefficient logit model of demand for differentiated products and simulate counterfactual outcomes under the assumption of Nash-Bertrand price setting by multiproduct firms. In contrast to our stylized theoretical example, our empirical model gives rise to nonlinear demand with asymmetric substitution patterns and the approach has been used in numerous studies to flexibly model demand in differentiated product markets. The data and structural model that we build on have previously been used to evaluate the role of divestitures in a major merger in this market (Friberg and Romahn, 2015). While the data and the estimates of the demand model have been used previously, the research question and the counterfactual simulations are unique to this article.

Empirical studies of pass-through of variables such as exchange rates and taxes abound (Burstein and Gopinath, 2014; Fullerton and Metcalf, 2002). A common finding is that the pass-through elasticity lies between 0 and 1. With our data and estimated model as base we want to understand if muting of pass-through by

²Beer markets have been a common testing ground for both the analysis of mergers and of pass-through (Hausman, Leonard and Zona 1994; Goldberg and Hellerstein, 2013).

multiproduct firms is quantitatively important. To do so we compare counterfactual responses of prices to cost shocks under different assumptions regarding the set of products that the firms control. In one exercise we explore the relation between pass-through and the characteristics of firms' product portfolios by examining pass-through for the 162 possible counterfactual duopolies that can be generated by combining the portfolios of the eight firms in the market. This provides one clear way of examining how pass-through depends on the set of products controlled in a differentiated product market of the type that has been of interest to researchers. As suggested by our stylized theory, adding products to the portfolio of a firm lowers the pass-through elasticity. In this market, adding one more product to the portfolio lowers pass-through by .11 percentage points. While this may seem like a small number, its effect can of course be sizable when 100 products or more are included in a portfolio. Our theoretical sketch also points to that the greater the cross-price effects on demand between the products under a firm's control, the more muted will a multiproduct firm's pass-through be. This prediction is also borne out in the simulations: A one standard deviation increase in the average cross-price elasticity dampens the multiproduct firm's pass-through by around 1.4 percentage points.

Another way to gauge the quantitative implication of multiproduct firms on pass-through is to compare pass-through under different assumptions regarding the number of firms that control the available products. The differences in pass-through between the actual market structure (with eight firms each controlling between 12 and 42 products) and a counterfactual where every product stands alone are limited. For instance we find that the market-level pass-through elasticity for a marginal cost shock falls from around 83 percent when the market is populated only by single product firms to 81 percent under the actual ownership pattern. This limited effect may be potentially relevant for the literature on multiproduct menu costs that we referred to at the outset. Empirical price adjustment patterns are likely to reflect both changes to the desired "frictionless" price and nominal rigidities. As noted, the multiproduct menu cost literature makes strongly simplifying assumptions on the optimal markups to focus on the nominal rigidities, whereas we focus on markups and pass-through while disregarding nominal rigidities. Ultimately one will want to combine both elements but we note that in differentiated product markets real and nominal rigidities intertwine in possibly complex ways (Flodén and Wilander,

2006; Gopinath and Itshoki, 2010). For instance, other things equal, if the desired pass-through is lower for multiproduct firms then cost shocks are less likely to shift prices outside of the bounds of non-adjustment in a menu cost model. Apart from the concerns about the explosive nature of the state space when modeling both multiproduct pass-through and multiproduct menu costs in a dynamic oligopoly (essentially extending Nakamura and Zerom, 2010, to a multiproduct setting in a market with a large number of products) the institutional details that provide us with a rich source of data also create a rather special case as regards menu costs and dynamic price adjustment. In particular the wholesalers do not bear the physical menu costs and price for a given product is uniform across the country. Nevertheless we interpret our findings as providing some reassurance to the multiproduct menu cost literature. While the muting effect of multiproduct pass-through is clear in our study the effects are quantitatively minor even as we move to a relatively concentrated market structure (close to 90 percent of the volume is accounted for by the four leading firms in the Swedish beer market), which would suggest that concerns raised by disregarding multiproduct markup adjustment in a market with many products are limited with regards to the dynamics of price adjustment.

However, this reassuring result comes with a caveat. As we move towards highly concentrated market structures the effects on pass-through of multiproduct firms are substantial: We explore all possible counterfactual combinations of duopolies in this market and find that pass-through falls to on average 74 percent under duopoly. If we were to move to a monopoly the pass-through rate falls to a mere 44 percent in this market.

In the next section we compare single and multiproduct pass-through in a simple stylized setting and in section 2 we describe the data and the Swedish beer market. Section 3 presents the demand model and estimation results before we turn to the key counterfactual simulations in section 4. Section 5 explores robustness along several dimensions and section 6 concludes.

2 Theoretical Predictions

To motivate our empirical investigation of multiproduct firm pass-through, we use a stylized setting, which yields clear theoretical predictions that can be falsified when

taken to the data. In this setting, we consider a market with two differentiated products that are produced at constant marginal costs. The profits accruing to each product are $\pi^i = q^i(p^i - c^i)$ for $i = 1, 2$, where p , q , and c are price, demand and marginal cost, respectively. Equilibrium in the market is determined by Bertrand-Nash competition; each firm takes the price of its rival as given when maximizing profits and best-response functions are upward sloping. We consider two cases. First, each product is owned by a separate firm. Second, we allow one firm to jointly maximize profits for both products.

In what follows, we abstract from the curvature of demand for two reasons. First, working with a linear approximation to cost pass-through to prices is analytically convenient and thereby allows us to characterize the differences between single- and multiproduct firms with clear-cut results. Moreover, we demonstrate that these are not knife-edge results, which implies that the theoretical predictions are still valid if demand is not too nonlinear. Second, given that we use a flexible demand model in our empirical investigation, the theoretical predictions can be refuted by the data. Our choice for analytical convenience, therefore, does not limit the validity of our empirical approach.

2.1 2 Products, 2 Firms

We index firms by superscripts and adopt the following notation for derivatives: $q_j^i \equiv \partial q^i / \partial p_j$. Using this notation we can write the profit maximization conditions as follows.

$$\begin{aligned} f^1 &= q_1^1(p^1 - c^1) + q^1 = 0 \\ f^2 &= q_1^1(p^2 - c^2) + q^2 = 0 \end{aligned} \tag{1}$$

To obtain the comparative statics of price changes in response to a cost shock to good 1, we totally differentiate the system and rewrite the result using matrix notation.

$$\begin{pmatrix} f_1^1 & f_2^1 \\ f_1^2 & f_2^2 \end{pmatrix} \begin{pmatrix} dp^1 \\ dp^2 \end{pmatrix} = - \begin{pmatrix} f_{c^1}^1 \\ f_{c^1}^2 \end{pmatrix} dc^1 \tag{2}$$

Recall that we set all second-order derivatives to zero. Detailed calculations are shown in the Appendix.

$$\begin{aligned}\frac{dp^1}{dc^1} &= \frac{2q_1^1 q_2^2}{4q_1^1 q_2^2 - q_2^1 q_1^2} > 0 \\ \frac{dp^2}{dc^1} &= \frac{-q_1^1 q_1^2}{4q_1^1 q_2^2 - q_2^1 q_1^2} > 0\end{aligned}\tag{3}$$

We obtain the well established result that both prices increase as the marginal cost of product 1 goes up. Faced with higher costs, it is optimal for firm 1 to raise the price of its product. Given that best responses are upward sloping, firm 2 reacts by raising p^2 .

2.2 2 Products, 1 Firm

When a single firm owns both products, the firm internalizes the cannibalization between the varieties when setting prices. This affects both the level of prices and how prices are adjusted in response to cost shocks. Given that the products are substitutes, the firm owning both products sets higher prices than the single-product firms. For now we abstract from this effect, and thus we capture the differences between single- and multiproduct pass-through rates up to a first-order approximation. Even though prices differ, the slopes of the demand functions are identical for both cases. Moreover, marginal costs are not affected by the change in the ownership pattern.³ The profit function for the multiproduct firm is $\Pi = q^1(p^1 - c^1) + q^2(p^2 - c^2)$. As above, we totally differentiate the system of first-order conditions and solve for the optimal price changes in response to a marginal cost shock to good 1.

$$\begin{aligned}\frac{dp^1}{dc^1} &= \frac{2q_1^1 q_2^2 - q_2^1 (q_2^1 + q_1^2)}{4q_1^1 q_2^2 - (q_2^1 + q_1^2)^2} > 0 \\ \frac{dp^2}{dc^1} &= \frac{q_1^1 (q_2^1 - q_1^2)}{4q_1^1 q_2^2 - (q_2^1 + q_1^2)^2} <> 0\end{aligned}\tag{4}$$

The price of good 1 unambiguously increases in response to a positive shock to c^1 . The sign of the price change of good 2, however, is ambiguous. The sign of the numerator depends on $q_1^1 (q_2^1 - q_1^2)$. If demand is symmetric, the bracketed term vanishes and the price of good 2 does not react to the increase in c^1 . For

³Thus, we do not think of the example as letting the single-product firms merge. In such circumstances, there might be post-merger efficiency gains, which decrease marginal costs.

the multiproduct firm, this outcome is intuitive, because it optimally trades off the effect that a price change in good 1 has on the profits of good 2. If demand is symmetric and if prices are profit-maximizing, the two effects balance. With asymmetric demand, the multiproduct firm raises the price of good 2 if consumers substitute more willingly to this variety in response to an increase of p^1 , than they substitute towards good 1 in response to a hike in p^2 . By raising p^2 , the multiproduct firm shifts part of the consumers that substituted to good 2 back to good 1 and thereby optimally reallocates demand within its portfolio of products.

2.3 Comparing Single- and Multiproduct Pass-Through

We are now in a position to compare pass-through under the two ownership settings. First, we compare the direct or own-cost pass-through. To be clear, these are dp^i/dc^i . We then move on to indirect or cross-cost pass-through, which are dp^i/dc^j . Both give similar results. The single-product firm adopts a higher pass-through of the change in c^1 to p^1 than the multiproduct firm if the following inequality holds.

$$\frac{2q_1^1 q_2^2}{4q_1^1 q_2^2 - q_2^1 q_1^2} > \frac{2q_1^1 q_2^2 - q_2^1 (q_2^1 + q_1^2)}{4q_1^1 q_2^2 - (q_2^1 + q_1^2)^2} \quad (5)$$

If demand is symmetric, the inequality simplifies to $0 > -q_2^1 (q_2^1 + q_1^2)$, which holds trivially as long as products are (strict) substitutes. Thus, with symmetric demand, single-product pass-through is indeed greater than multiproduct pass-through. With asymmetric demand, however, there are two effects that work in opposite directions. As $q_j^i > 0$, it is clear that the numerator of the right-hand side (rhs) is smaller than the numerator on the left-hand side (lhs). The denominator on the lhs, however, is greater than the denominator on the rhs. Thus, it is not clear which effect dominates. The extent of the asymmetry in demand is crucial in this regard.⁴

We rearrange (5) so that the lhs only depends on the ratio of the own-price and cross-price derivatives of demand, while the rhs only depends on the cross-price derivatives. Define $w^1 \equiv q_2^1 / (q_2^1 + q_1^2)$ and $w^2 \equiv q_1^2 / (q_2^1 + q_1^2)$ as each product's share

⁴Note that in consumer theory a frequently used result is that compensated cross-price effects are symmetric for infinitesimal price changes (see e.g. Varian, 1992). As we want to allow income effects to affect demand and furthermore are interested also in discrete price changes we allow demand to be asymmetric.

of the sum of the cross-price derivatives. For detailed calculations see the Appendix.

$$\frac{2}{4 - \frac{q_2^1 q_1^2}{q_1^1 q_2^2}} < \frac{w^1}{1 - w^1 w^2} \quad (6)$$

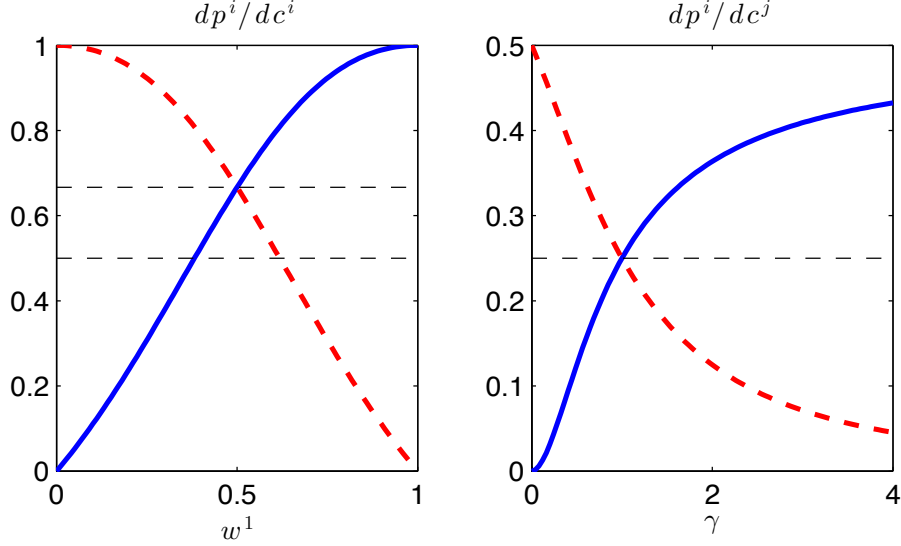
With the products being strict substitutes, the ratio $q_2^1 q_1^2 / (q_1^1 q_2^2)$ is bounded from above by 1 and bounded from below by 0. The lhs of the inequality, therefore, lies in the interval $(1/2, 2/3)$. It is easy to establish that the rhs is bounded on the open unit interval. Thus, there is a region where the multiproduct firm optimally chooses a lower pass-through than single-product firm 1. Performing the same calculations for dp^2/dc^2 yields an interesting symmetry.

$$\frac{2}{4 - \frac{q_2^1 q_1^2}{q_1^1 q_2^2}} < \frac{w^2}{1 - w^1 w^2} \quad (7)$$

Compared to the inequality for dp^1/dc^1 , the lhs is unchanged, while the rhs is inversely related to its counterpart in (6). When w^1 is close to zero and therefore (6) does not hold, w^2 is close to one and (7) holds. Thus multiproduct pass-through is lower for at least one of the two products. We illustrate this in the left panel of Figure (1).

The range of values that the lhs of both inequalities is bounded on, is depicted by the solid horizontal lines. If the cross-price derivatives of demand have the same magnitude as the own-price effect, the value of the lhs is $2/3$, while if the ratio of the cross- and own-price derivatives tends to zero, the value of the lhs is $1/2$. The solid curve plots the rhs for dp^1/dc^1 , which is (6), while the dashed curve plots the rhs for dp^2/dc^2 , which is (7). The two curves cross at $w^1 = 1/2$ and have a value of $2/3$. This is the case where demand is symmetric and both inequalities hold for any admissible value of the lhs. If we hold the value of the lhs fixed at its upper bound and move away from symmetric demand, so that $w^1 \neq 1/2$, we see that only one of the products has a lower pass-through rate under multiproduct ownership. This is the product from which consumers switch away more willingly in response to an increase in its price. Its price response is dampened, because the multiproduct firm optimally reallocates demand within its portfolio of products by increasing the price of its remaining product. A single-product firm cannot rebalance demand in this

Figure 1: Single- Versus Multiproduct Pass-Through



Note: The solid (blue) curves plot the rhs for $i = 1$, while the dashed curves show the rhs for $i = 2$. The horizontal lines show the upper and lower bounds of the corresponding lhs. In the right panel, the lower bound is zero (the x-axis). In the left panel, $w^1 \equiv q_2^1/(q_2^1 + q_1^2)$ and in the right panel, $q_1^2 = \gamma q_2^1$. Both measure the extent of demand asymmetry. For $w^1 = 1/2$ and $\gamma = 1$ demand is symmetric. If an rhs curve lies above the lhs, then the corresponding multiproduct firm pass-through rate is strictly less than its single-product firm counterpart.

way and therefore the entire adjustment falls on a single price. If we move away from the upper bound of the lhs, we can see that there is a range for w^1 , where the multiproduct firm adopts a lower pass-through rate for both of its products. Thus, the case where the multiproduct firm adopts lower pass-through rates on both products is not based on a knife-edge result.

The right panel of Figure (1) shows the analogous plot for the indirect or cross-cost pass-through rates. The multiproduct firm changes p^2 less in response to the change dc^1 , if the following inequality holds.

$$\frac{q_2^1 q_1^2}{4q_1^1 q_2^2} < \frac{1}{2 + \gamma + \gamma^2} \quad (8)$$

γ is the ratio of the cross-price derivatives of demand and therefore captures the asymmetry of demand. Specifically, $q_1^2 = \gamma q_2^1$. Analogously, the price reaction

of product 1 to the cost shock dc^2 is less under multiproduct ownership than the reaction of single-product firm 1, if the following inequality holds.

$$\frac{q_2^1 q_1^2}{4q_1^1 q_2^2} < \frac{\gamma^2}{1 + \gamma + 2\gamma^2} \quad (9)$$

Both inequalities hold trivially for symmetric demand, $\gamma = 1$. At this value, the two curves intersect and cross the strict upper bound for the lhs. Thus, at this point, the pass-through rate adopted by the multiproduct firm is lower than single-firm pass-through for both products. Moving γ away from 1 at this point reiterates our finding for direct cost pass-through: one of the multiproduct firms' products is guaranteed to have a lower pass-through than its single-product firm counterpart. Moreover, moving below the upper bound of the lhs again yields a region where both pass-through rates are lower than under single-product firm ownership. We summarize our findings in two predictions.

Prediction 1: With moderately asymmetric demand, multiproduct firm pass-through is less than single-firm pass-through for all products owned by the multiproduct firm.

Prediction 2: With highly asymmetric demand, multiproduct firm pass-through is less than single-firm pass-through for the products it owns with relatively high cross-price elasticities.

The predictions apply to both own- and cross-cost pass-through, dp^i/dc^i and dp^i/dc^j .

3 The Swedish Beer Market

Sweden enforces a retail monopoly for the sale of alcohol in the form of beverages with an alcohol content of at least 3.5 percent of volume. Drinks below this threshold, mostly low alcohol beer and cider, can be freely sold in supermarkets. Drinks above the threshold are only available to consumers in the outlets of the retail monopoly, called Systembolaget. For all beers sold the monopolist supplied product-level scanner data on a monthly frequency covering January 1996 to January 2003. Apart from quantity information we also observe prices at the retail- and

wholesale-levels and several non-price characteristics, relating to a beer’s packaging, category, domestic or foreign origin, alcohol content, and taste. There is no price variation across stores and quantity is aggregated to the national level.

Descriptive statistics on price and the other observable characteristics are given in Table (2). The taste information consists of scores from 1 to 12 on richness, bitterness, and sweetness, which is generated by the monopoly and made freely available to its customers. A higher score indicates a more intense taste along that dimension. There are five beer categories, of which light lagers make up the bulk of the available beers. We limit analysis to the eight largest suppliers to Systembolaget, which account for more than 95 percent of volume. We keep track of the major packages, which are the .33 and .5 liter bottles and cans. Our definition of a beer relies on name and characteristics, such as Stella Artois Premium Lager with an alcoholic content of 5.2 percent. Some beers are available in several package sizes and we define a product as a beer-package size combination. Stella Artois Premium Lager with an alcoholic content of 5.2 percent in .33 liter bottle is thus an example of a product.

We also include a measure of indirect advertising expenditure. During the sample period, advertising for beverages sold by the monopolist is banned, but advertising for drinks with an alcoholic content of at most 2.25 percent of volume is legal. Less than 9 percent of our observations have low-alcohol twins that are sold in supermarkets and have positive marketing expenditure. We therefore allow for spillover effects stemming from this form of marketing in our model of demand.

3.1 The Firms, Their Product Portfolios and the Retailer Markup Rule

The suppliers to Systembolaget are profit maximizing firms. The sample covers six brewers that also act as wholesalers for some imported beers: Åbro, Carlsberg, Kopparbergs, Krönleins, Pripps and Spendrups. In addition there are two pure wholesalers, Bibendum and Galatea. In February 2001 Carlsberg and Pripps merge, leaving seven firms for the remainder of the sample. Table (1) presents descriptive statistics on the firms using the pre-merger period. The Appendix reproduces the table for the post-merger period. We can see that Galatea, which is the smallest

Table 1: The Firms in the Sample

Firm	Number of Products	Volume Share	Share of Foreign Beers	Share of Light Lagers	Share of Ales
Carlsberg	41	.308	.385	.816	0.028
Pripps	28	.250	.516	.913	0.036
Spendrups	42	.228	.328	.917	0.047
Åbro	31	.098	.239	.849	0.071
Kopparberg	14	.057	.042	.928	0
Krönleins	16	.051	.211	.887	0
Galatea	12	.003	1.00	.446	.347
Bibendum	13	.015	1.00	.648	.200

Note: The reported figures are based on the Carlsberg-Pripps pre-merger sample period, which stretches from January 1996 to January 2001. The figures for the post-merger period are reported in the Appendix.

firm in the market holds on average 12 products. Bibendum, the second smallest firm sells 13 products. Galatea and Bibendum also sell relatively few light lagers.

Kopparberg and Krönleins are comparable to the two smallest firms in terms of the number of beers that they sell. They do account for a much larger share of market volume, however. Both of these firms have very few foreign-brewed beers and are therefore best described as domestic producers that focus on the dominant light lager segment. In terms of brewing origins and beer categories sold, Åbro is very close to Kopparberg and Krönleins, but sells on average 31 products and accounts for almost ten percent of market volume. The remaining three producers sell between 28 and 42 products. Half of Pripps' products are brewed abroad and imported by the company. Carlsberg and Spendrups only import somewhat more than a third of their products. Similar to the smaller domestic producers the top three brewers mostly sell in the light lager segment.

The Swedish beer market thus has some characteristics that are also seen in many other differentiated product markets: There are many products (197 as reported in

Table 2: Prices and Product Characteristics

	Mean	Std. Dev.		Fraction
Price (SEK/Liter)	32.89	7.26	Bottle (.5 Liter)	.22
Richness	5.70	1.75	Can (.33 Liter)	.06
Sweetness	2.22	1.33	Can (.5 Liter)	.37
Bitterness	6.08	2.06	Ale	.07
Alcohol (% of Vol.)	5.43	1.03	Dark Lager	.04
Advertising (Mln SEK)	.16	.80	Light Lager	.83
Foreign	.42	-	Stout	.03
Bottle (.33 Liter)	.35	-	Wheat	.03

Note: Based on 16,867 observations. Means for discrete characteristics measure the fraction of observations for which the indicator equals one.

Table 1) on average taking a small share of the market. The average share of volume accounted for by a product is 0.15 percent. The distribution is skewed and the largest products are more important; the product at the 99th percentile accounts for 4.5 percent of volume. The large number of products and small market shares per product contrasts with concentration at the wholesale level. The three largest firms control 79 percent of volume and the Herfindahl-Hirschmann Index (based on monthly volumes) for the pre-merger period equals 0.23, which corresponds to a moderately concentrated market.

One feature of the market that simplifies the counterfactual analysis is that the final retail prices are based on a simple formula that applies to all products.

$$p_{jt}^r = (p_{jt}^w + x_{jt}^a \tau_t^a)(1 + \tau_t^c)(1 + mk_t^s) + d_{jt} \quad (10)$$

p_{jt}^r and p_{jt}^w denote the retail and wholesale or producer price of beer j at date t , respectively. τ_t^a and τ_t^c are the alcohol excise tax and value added tax rates and x_{jt}^a is beer j 's alcohol content. d_{jt} is the deposit that is charged for the package type of beer j . mk_t^s is the monopolist's markup. The monopolist has no control over its own markup, the alcohol excise tax or the value added tax, which are all determined

by Swedish parliament. By observing the retail prices, we can therefore back out producer prices precisely and we do not have to contend with differential markup adjustments at the retail level or retail competition.

4 Structural Demand Model

To obtain a structural model of demand, we follow the approach of BLP and estimate a random coefficient logit model using the nationally aggregated scanner data. The indirect utility that consumer i derives from purchasing product j at date t is

$$u_{ijt} = x_{jt}\beta - \alpha p_{jt}^r + \sum_{k=1}^K \sigma^k x_{jt}^k v_i^k + \sigma^p v_i^p p_{jt}^r + \xi_f + \xi_t + \iota_{j \in I} \xi_{b_j} + \xi_{jt} + \epsilon_{ijt}, \quad (11)$$

where x is a vector containing the observable characteristics listed in Table (2). β is the vector of consumer tastes for these characteristics, α is the price coefficient, and σ^k is the standard deviation of the random coefficient for observable characteristic k . We include random coefficients on price, the sweetness score, the alcohol content, and the constant term. The latter allows for consumer heterogeneity with regard to the preference for the outside choice. ϵ_{ijt} is an idiosyncratic error term that we assume is distributed type I extreme value. ξ_{jt} is the structural error term or unobserved product characteristic, while ξ_f and ξ_t are firm and market fixed effects, respectively. The inclusion of the market fixed effects prevents any errors in our definition of the relevant market to affect the point estimates of the structural parameters. Finally, ξ_{b_j} is a beer fixed effect. If a beer is only available in a single packaging, our definition of beer and product coincide. Given that non-price product characteristics are fixed once a product has entered the market, we only allow for beer fixed effects if a beer is present in all the months of our sample in order to leave sufficient variation for our instruments. $\iota_{j \in I}$ is an indicator variable that equals one if a beer is a member of this set and zero otherwise. There are 52 such products for which fixed effects enter the specification. Almost 85 percent of these fixed effects turn out to be statistically significantly positive. Thus, most of these products enjoy higher demand, possibly due to a buildup of brand capital, which we capture by including the fixed effects.

4.1 Instruments

The vector of unobservable product characteristics, ξ , poses an endogeneity problem. All else equal, consumers' willingness to pay for product j increases in the realization of ξ_{jt} . The firm that sells j optimally incorporates this into its pricing. Thus, the unobservable product characteristics and product prices are positively correlated, which biases the price coefficient towards zero. To deal with this endogeneity we make the assumption that product characteristics can be treated as exogenous. We view this assumption as appropriate in our sample, because once a product has entered the market, its characteristics remain fixed. Thus, for all price changes that follow a product's introduction it is indeed the case that for our intent and purpose the existing products' characteristics are exogenous. The identifying variation of our instruments therefore stems from observable entry and exit. During the sample period, the number of products range from 157 to 213, so that the data is quite rich along this dimension.

As excluded instruments for a specific beer we use the characteristics of all other products sold by the same firm, the sum of the characteristics of all products sold by competing firms, and the average of all characteristics that are present in the market. To raise the variation of the instruments at the product-level, we compute them within the different categories (ale, light lager, and so forth). This practice follows Bresnahan et al. (1997). Finally, we observe the brewing location of each product, which allows us to include the log of the exchange rate between the brewing origin and Sweden as an additional instrument.

The first stage regression shows that our excluded instruments explain about half of the observable variation in price and that they are jointly highly statistically significant. Moreover, the estimated price coefficient is approximately three times higher than the price coefficient we obtain in the uninstrumented BLP model. For a more extensive discussion of our treatment of endogeneity and further estimation details, we refer the interested reader to our companion paper Friberg and Romahn (2015).

Table 3: Estimation Results

	Mean	Std. Dev.		
Price (SEK/Liter)	-.2063	.0439	R^2	.42
	(.0239)	(.0142)	Wald Stat. $\sim \chi^2(4)$	278.6
Sweetness	-.2458	.4305	$\bar{\eta}_{jj}$	-5.95
	(.0531)	(.0334)	$\bar{\eta}_{jk}$.0202
Alcohol (% of Vol.)	-1.543	1.221	$\bar{\eta}_{jk,logit}$.0031
	(.6057)	(.2649)	$\#\eta_{jj} > -1$	0
Constant	.1115	.1765		
	(.9603)	(5.255)		

Note: Based on 16,867 observations. Standard errors are reported in parentheses. $\bar{\eta}_{jj}$, $\bar{\eta}_{jk}$ are the average own- and cross-price elasticity implied by the point estimates. $\bar{\eta}_{jk,logit}$ is the average cross-price elasticity obtained when setting all random coefficients to zero.

4.2 Estimation Results

Table (3) presents the estimation results. To be concise, we focus on the estimated random coefficients. Except for the constant, which allows for heterogeneity in preferences for the outside choice, all the standard deviations of the random coefficients are highly statistically significant. The Wald statistic allows us to clearly reject the logit model against the BLP model. In the right panel of Table (3) we can also see that setting the random coefficients to zero yields an average cross-price elasticity that is smaller by a factor of about 6. Thus, the random coefficients are not only significant statistically, but also have a substantial impact on the estimated substitution patterns in the market. The average own-price elasticity is close to -6 and there is not a single observation for which demand is inelastic. The average own-price elasticity is close to the estimates reported in Hausman, Leonard and Zona (1994) and Slade (2004), who study the French and UK beer markets, respectively.

Table 4: Producer-Level Marginal Costs and Markups

Percentile	Marginal Cost (SEK)	Markup (Percent)
1 st	1.92	17.3
5 th	3.24	19.9
10 th	3.90	21.8
median	6.50	38.7
mean	8.07	37.9
90 th	15.4	50.9
95 th	17.3	55.7
99 th	22.1	67.1

Note: Based on pooling all 16,867 observations. Producer-level markups are defined as $(p_j^w - mc_j)/p_j^w$.

4.3 Producer-Level Marginal Costs

To back out the estimates of producer-level marginal costs that are consistent with our structural demand estimates, we impose the standard assumption that firms compete Nash in prices. At each date $1, \dots, F_t$ firms populate the market and each firm f jointly maximizes profits for all the beers in its product holdings, \mathcal{F}_f . Its profit function is $\pi_{ft} = \sum_{j \in \mathcal{F}_f} M_t s_{jt} (p_t^r)(p_{jt}^w - mc_{jt}) - C_{ft}$, where C_{ft} is the firm's fixed cost of operating and M_t is the market's size. With the monopolists's pricing function publicly known, we can precisely back out producer-level marginal costs. We define $\kappa_t \equiv (1 + \tau_t^c)(1 + mk_t^s)$ and write the firm's profit maximization conditions as follows.

$$\sum_{k \in \mathcal{F}_f} \frac{\partial s_{jt}}{\partial p_{kt}^r} (p_{kt}^w - mc_{kt}) = -\frac{s_{jt}}{\kappa_t}$$

To be able to switch to matrix notation and collect all firms' profit maximization conditions in a single expression, we define the matrix of market share derivatives Ω_t with entries $\Omega_{jk,t} = \partial s_{kt} / \partial p_{jt}$ and the matrix of product holdings \mathcal{H}_t with entries $\mathcal{H}_{jk,t} = 1$ if $j, k \in \mathcal{F}_f$ and zero otherwise. Denoting the element wise product by \odot ,

all profit maximization conditions for market t can be succinctly written as follows.

$$(\mathcal{H}_t \odot \Omega_t)(p_t^w - mc_t) = \frac{s_t}{\kappa_t}$$

Backing out the producer-level marginal costs only requires a reshuffling of the matrix equation.

$$mc_t = p_t^w + (\mathcal{H}_t \odot \Omega_t)^{-1} \frac{s_t}{\kappa_t} \quad (12)$$

The second term on the right hand side is the negative of the markup vector. Table (4) presents descriptive statistics on the distribution of product-level marginal costs and markups. We use this vector of producer-level marginal costs as an input for our pass-through simulations. On average marginal costs amount to roughly 8 SEK per liter, and average markups are close to 38 percent. As is implied by all product-level demands being elastic, we have no backed out marginal costs that are negative.

5 Pass-Through Simulations

We are now ready for the counterfactual simulations. Let us first consider the ideal experiment that can test whether firms owning many products adopt lower pass-through rates than firms owning fewer products. To identify the effects for a given market, we hold everything constant, except for the ownership of the existing products in the market. Then, simply by varying the ownership pattern and hitting marginal costs with the same shock across the different runs of the experiment, we can observe how the price responses to these shocks depend on the ownership structure. Implementing such an experiment on the scale of an entire industry is of course not feasible. We therefore use our structural demand estimates to simulate the outcomes of this experimental approach. Naturally, our results are subject to the caveat that our structural demand model is an approximation to the true unobserved demand system.

In the main text, we focus on the effect of common or aggregate cost shocks. In the Appendix, we report the results for idiosyncratic cost shocks. The qualitative findings for the two cases are identical. To illustrate our findings we pick August 1997 as the baseline market for all counterfactuals.⁵ With 198 products this market

⁵None of the qualitative findings are affected by this choice.

is very close to the average number of products during the sample period, which is 198.4. With an average marginal cost of 8.1 SEK per liter and an average markup of 36.4 percent this market is also very close to the sample averages.⁶ The set of beers that is available in this market is held fixed for all counterfactuals. Without loss of generality, we assume that the product-level marginal costs are identical for all counterfactual scenarios.⁷ The baseline vector of marginal costs is consistent with the actually observed prices, market shares, and product holdings in the data and is computed as follows.

$$\widehat{mc} = p + (\mathcal{H} \odot \Omega)^{-1} s \quad (13)$$

As we select one market for all counterfactuals, we drop the t subscript to reduce notation. \mathcal{H} is the product holding matrix and keeps track of the ownership pattern in the market, while p and s are the observed prices and market shares in the data.

To trace out the pass-through rates in the different counterfactuals, we perturb the vector of marginal costs and solve for the new equilibrium prices. Throughout this section we assume a proportional cost shock of 10 percent that hits all products. In the Robustness section, we vary the size of this shock between -25 and 25 percent. Our qualitative findings are unaffected. We denote the perturbed vector of marginal costs by $\widetilde{mc} = (1+g)*\widehat{mc}$, where $g = .10$ is the common net proportional cost shock. The equilibrium prices that are consistent with \widetilde{mc} are pinned down by re-computing firms' profit maximizing prices.

$$p^{(1)} = \widetilde{mc} - (\mathcal{H} \odot \Omega^{(1)})^{-1} s^{(1)} \quad (14)$$

We superscribe the perturbed equilibrium outcomes with ⁽¹⁾ and the pre-perturbation equilibrium outcomes with ⁽⁰⁾. Market shares and their derivatives are also affected by the changing prices. Only the product holdings are fixed. We measure product-level pass-through as the ratio of the net relative change in price, $(p^{(1)} - p^{(0)})/p^{(0)}$, and the net relative change in marginal cost, g . Thus, an 8 percent increase in price in response to the 10 percent increase in marginal cost, gives us a pass-through rate of .8 or 80 percent. More generally, the pass-through rate for product j is defined

⁶In this month 8 SEK was the equivalent of 1 USD.

⁷The alternative is to assume that actually observed prices apply to all ownership settings and compute the implied different vectors of marginal costs.

as follows.⁸

$$\psi_j = \frac{p_j^{(1)} - p_j^{(0)}}{g * p_j^{(0)}} \quad (15)$$

An idiosyncratic cost shock for product j is easily accommodated: $\widetilde{mc}_j = (1+g)*\widehat{mc}_j$ and $\widetilde{mc}_k = \widehat{mc}_k$ for all $k \neq j$.

Our main interest lies in comparing how the optimally chosen pass-through rates compare between single- and multiproduct firms. We consider three sets of counterfactuals with different ownership structures. First, we compute pass-through rates under the actually observed ownership structure in the market. Second, we pin down how more concentrated ownership affects firms' optimal price responses to marginal cost shocks. We consider all possible duopolies that can be formed from the 8 existing firms. There are 162 such counterfactual duopolies.⁹ Third, we create a monopolist that jointly maximizes profits for all 198 products in the market. This is the ownership setting where the substitutability within the firm's portfolio of products has the greatest impact on pass-through rates.

Note that each of these counterfactuals will be associated with not only a different pass-through but also a different level of prices. Contrary to our theoretical motivation, it is therefore the case that each beer is located at a different point along its demand schedule across the different counterfactuals. In the Robustness section and the Appendix we demonstrate both empirically and theoretically that this feature of our counterfactual simulations leads to conservative estimates of the multiproduct firm dampening effect on cost pass-through rates.

5.1 Pre-Perturbation Prices Across the Counterfactuals

Our benchmark setting is the counterfactual market where each product is a stand-alone firm. With only single-product firms in the market, we eliminate the effect of multiproduct holdings on pass-through rates by construction. We obtain the prices

⁸Since the pass-through rate relates two percentage changes we might also view it as synonymous with a pass-through elasticity. However since elasticities often are defined by derivatives and thus refer to small changes we highlight that we also consider large changes with the our use of the term pass-through rate.

⁹Let $(4, 4)$ denote the duopolies, that obtain by merging 4 out of the 8 firms to form each of the duopolists. This gives $\binom{8}{4} = 70$ possibilities. The remaining 92 possibilities fall on the cases $(3, 5)$, $(2, 6)$, and $(1, 7)$. Note that the order of the elements in the tuple does not matter.

that are consistent with the single-product firm equilibrium in the market by solving the following system of first-order conditions.

$$p_{single}^{(0)} = \widehat{mc} - (\mathcal{I} \odot \Omega_{single}^{(0)})^{-1} s_{single}^{(0)} \quad (16)$$

\mathcal{I} is the identity matrix, and imposes that each stand-alone firm ignores all cross-price elasticities when setting its profit-maximizing price.

The equilibrium prices that are consistent with the baseline vector of marginal costs for the two sets of multiproduct firms are given as follows.

$$\begin{aligned} p_{duo,k}^{(0)} &= \widehat{mc} - (\mathcal{H}_{duo,k} \odot \Omega_{duo,k}^{(0)})^{-1} s_{duo,k}^{(0)} \\ p_{mono}^{(0)} &= \widehat{mc} - (\mathbf{1} \odot \Omega_{mono}^{(0)})^{-1} s_{mono}^{(0)} \end{aligned} \quad (17)$$

$\mathcal{H}_{duo,k}$ denotes the holding matrix that captures the k^{th} out of the 162 counterfactual duopolies. $\mathbf{1}$ is a matrix of ones. With our choice of product-level marginal costs, the pre-perturbation prices that are consistent with the actually observed ownership are simply the observed prices in the data.

Table (5) compares the equilibrium prices across the different ownership settings be ore marginal costs are perturbed. Comparing the outcome between firm level and product level prices there are several beers, for which there is no difference in price. This finding applies to beers owned by Galatea and Bibendum, which both account for a negligible share of market volume at the time. Demand spillovers between these beers are thereby so small, that these two firms cannot draw any market power from their product portfolios.¹⁰ At the other end the price difference increases to more than 5 percent for beers owned by Pripps, Carlsberg and Spendrups, which at the time are the largest firms in terms of market share and the number of products sold. On average, the actually observed firms can charge prices that are roughly 2.6 percent higher than the prices we see under single-product ownership.

To assess the additional pricing power that firms gain in a duopoly setting, we compute the relative price increases over the actually observed prices for each of the 162 counterfactual duopolies. We then average the reported percentiles and the mean over all duopolies. On average, the duopolists charge prices that are 9.4 percent higher than the actually observed firms. This additional markup reaches

¹⁰The gain in market power is so small that the price increases disappear when prices are rounded to two digits.

Table 5: Pre-Perturbation Price Differences (in percent)

percentile	$(p - p_{single})/p$	$(\bar{p}_{duo} - p)/p$	$(p_{mono} - p)/p$
1 st	0	2.07	19.3
5 th	0	2.77	26.9
10 th	0	3.62	27.4
median	3.25	9.85	36.2
mean	2.56	9.40	36.6
90 th	4.70	14.4	47.8
95 th	4.93	15.8	50.7
99 th	5.41	18.2	56.7

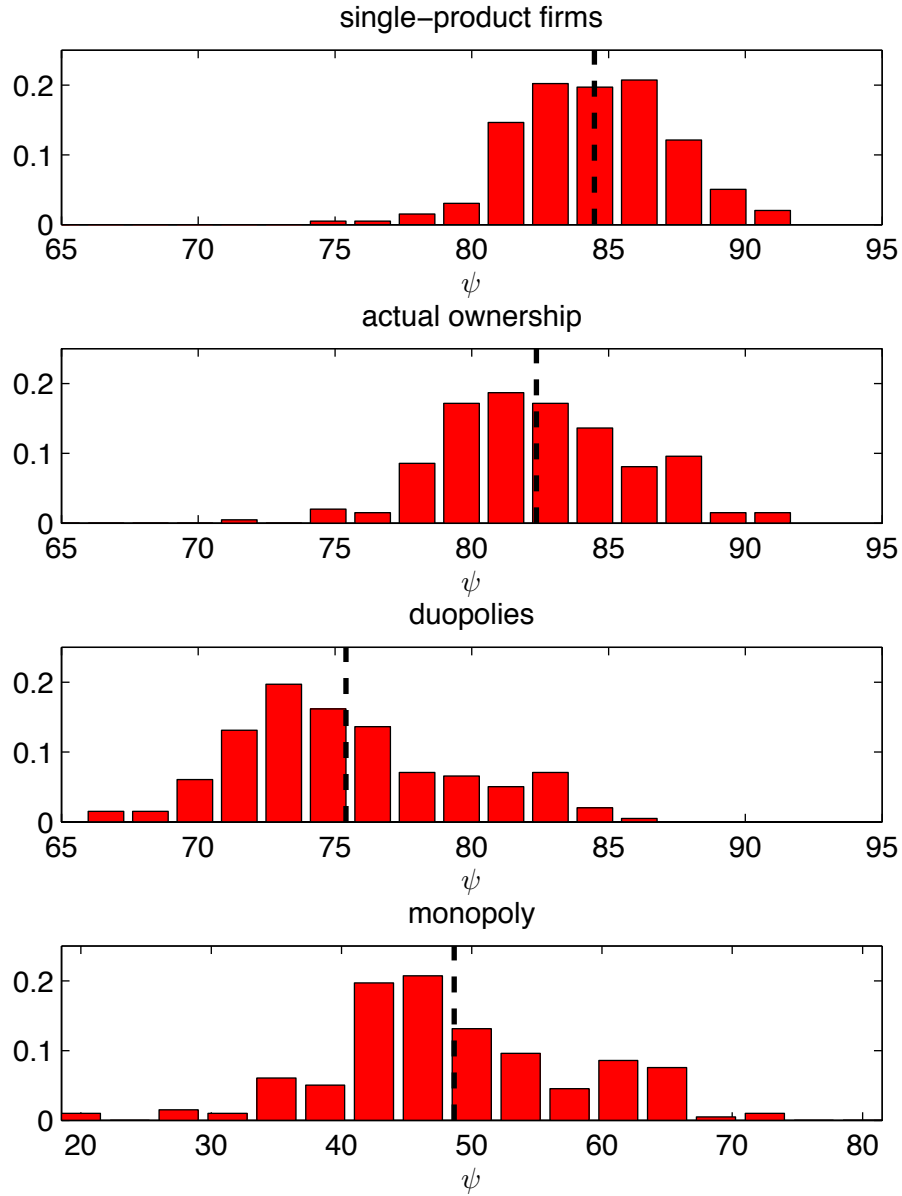
Note: p is the vector of actually observed prices in August 1997. The baseline price differences that are reported in the second column are obtained by first computing the percentiles and the mean for each of the 162 duopolies. We then average over the 162 percentiles and means to arrive at the reported figures. The zero entries are due to rounding prices to two digits.

more than 18 percent in the right tail of the distribution. Moving to monopoly naturally produces the largest increases in price relative to the prices observed under the actual ownership in the market. On average prices are almost 37 percent higher. This increase reaches more than 50 percent at the 95th percentile of the distribution.

5.2 Comparing Counterfactual Pass-Through Rates

Figure (2) plots the empirical distributions of the product-level pass-through rates for all counterfactuals. The first three panels show the outcomes for the counterfactuals that impose single-product holdings, the actual ownership pattern in the market and all possible duopolies. With regard to the latter, for each of the 198

Figure 2: Empirical Distributions of Product-Level Pass-Through Rates



Note: The figure shows relative frequency histograms of the simulated product-level pass-through rates for all 198 products that are available in August 1997. The duopoly plot is based on the product-level pass-through rate averages for all 162 counterfactual duopolies. The bottom panel plots the relative frequencies of the pass-through rate under counterfactual monopoly. The vertical dashed line shows the location of the average pass-through rate for each of the counterfactuals.

Table 6: Pass-Through Rates at the Market- and Firm-Level

	(1)	(2)	(3)	(4)
	Single-Product Firms	Actual Ownership	Duopolies	Monopoly
Market	83.31	80.54	73.56	43.72
Carlsberg	83.22	79.64	72.76	44.21
Pripps	83.83	80.52	72.81	43.81
Spendrups	82.73	80.07	74.65	44.48
Åbro	84.14	81.82	73.51	39.87
Kopparberg	83.83	83.56	72.58	36.78
Krönleins	81.97	81.62	72.78	43.90
Galatea	87.44	87.42	80.71	57.56
Bibendum	85.96	85.95	79.99	57.84

Note: All reported numbers are based on product-level pass-through rates that are aggregated using product level market shares. We compute the aggregation for all 162 counterfactual duopolies and report the average.

products we take the average pass-through rate over all 162 counterfactuals and compute the relative frequencies based on these product-level means. The bottom panel plots the pass-through frequencies for the counterfactual monopoly. Note that the first three panels have the same range on the x-axis, while we shifted this range to the left for the monopoly plot. The dashed vertical lines indicate the location of the mean for each of the distributions. It is immediately obvious that more concentrated ownership settings yield a reduction in pass-through rates. When moving from a less concentrated market to a market with a more concentrated ownership, the entire distribution of pass-through rates shifts to the left. This pattern holds across the board and is naturally most pronounced for the counterfactual monopoly.

Table (6) reinforces this point. There, we aggregate the pass-through rates by volume sold at the market- and firm-level. At both levels of aggregation we obtain a clear ranking. Pass-through is highest when the market is populated only by single-product firms and decreases for the more concentrated market settings. For

each of the counterfactuals, we keep track of the set of beers that are owned by the actually observed firms in the data. This allows us to illustrate that the reduction of pass-through rates appears at both the market- and firm-level. Focusing on the comparison between single-product firms and the actual ownership pattern, we see that the moderate concentration level in the data has a limited impact. At the market-level, the pass-through rate drops by roughly 2.8 percentage points. At the firm-level, the effect is largest for Carlsberg with a 3.6 percentage point drop. Even though the impact of the actual ownership pattern is limited in quantitative terms, the reported point estimates are statistically significant at the market-level and for the four largest firms (Carlsberg, Pripps, Spendrups, and Åbro). We evaluate the statistical significance with a parametric bootstrap procedure, the results of which are reported in Table (15) in the Appendix. In fact, out of 1,000 bootstraps there is not a single case, where the market-level pass-through rate implied by the actual ownership pattern is greater than the corresponding market-level single-product firm pass-through rate. This difference between these two counterfactuals is therefore statistically significant at any confidence level. Moreover, for the three largest firms the difference in firm-level pass-through rates is statistically significant at the 99 percent confidence level. Thus, even at a moderate concentration level, the effect of multi-product firms is highly robust. For the smaller firms, we find a negligible impact on firm-level pass-through rates, which also turns out to be statistically insignificant.

If we move to the more concentrated settings of duopoly and monopoly, we see that the quantitative effects become very large. On average, when moving from single-product firms to duopoly the market-level pass-through rate drops by roughly 10 percentage points. This effect is also visible at the firm-level. At the extreme of monopoly, the market-level pass-through rate almost drops by half.

5.3 The Determinants of Pass-Through Rates

To pin down the major determinants of pass-through rates, we focus on the counterfactual duopolies, because these 162 equilibrium outcomes give us sufficient variation in terms of pass-through rates and the composition of firm product portfolios to summarize our findings by means of simple regression analysis. Moreover, as

we have already demonstrated the impact of multiproduct holdings at the product-level, we aggregate pass-through rates by market share at the firm-level. As each duopolist takes into account its full product holdings when setting prices, this is the appropriate level of aggregation to assess the major determinants of pass-through rates.

To motivate our choice of explanatory variables for pass-through, we first look back at conditions (6) and (7). Recall that if both conditions hold, the multiproduct firm adopts uniformly lower pass-through rates than the single-product firms. The area in Figure (1), for which this result holds is maximized, if the ratios of cross- and own-price derivatives of demand tend to be small. Using our demand estimates for August 1997, we can easily compute these ratios for all products in the market. We find that the ratio with the largest magnitude is .095, while the average ratio has magnitude .0035.¹¹ As these ratios enter the denominators of the conditions as a product, it is immediately apparent that for our market setting with many products, the ratios of own- and cross-price demand derivatives are indeed small. Thus, in our setting, these ratios are unlikely to have a substantial impact on the relative magnitude of equilibrium pass-through rates between single- and multiproduct firms. We therefore turn our attention to equation (4), which determines the magnitude of the multiproduct firm's price change in response to a given marginal cost change. *Ceteris paribus*, the larger the cross-derivatives of demand, the more muted the response of prices to the change in marginal costs. Thus, the more substitutable the products, the stronger is the dampening effect of multiproduct holdings on pass-through rates. We therefore use the average of the cross-price elasticities within the firm as one explanatory variable. As an additional regressor we also include the number of products owned by the firm. Our baseline specification is given as follows.

$$\psi_f^k = \alpha_0 + \alpha_1 \bar{\eta}_{f,cross}^k + \alpha_2 N_f^k + \epsilon_f^k \quad (18)$$

¹¹In the conditions, each ratio q_j^i/q_i^i can be interpreted as a diversion ratio. A diversion ratio of .095 between products i and j tells us that 9.5 percent of the marginal revenue that is lost due to a price increase of product i is diverted to product j . Given that there are 197 substitute products in the market, an average diversion ratio of .0035 implies that roughly 70 percent of consumers switch to an alternative inside good in response to a price change, while the remainder switches to the outside good.

Table 7: Determinants of Duopolist Pass-Through Rates

	(1)	(2)	(3)
N_f^k	-1.1106 (.0022)	-	-
$\bar{\eta}_{f,cross}^k$	-1.373 (.0771)	-1.617 (.0809)	-
$\bar{\eta}_{f,own}^k$	-	-	.0109 (.1902)
portfolio size FE	-	Yes	Yes
constant	91.81 (.4707)	91.33 (.5617)	86.68 (5.614)
R^2	.89	.98	.93
observations	322	322	322

Note: For ease of interpretation, the average price elasticities are divided by their standard deviation. The coefficients on these elasticities therefore give the change in the pass-through rate (in percentage points) in response to a one standard deviation increase in the average own- or cross-price elasticity within the firm's portfolio. As we are only considering duopolists here, each counterfactual gives us two observations. One of these counterfactuals did not converge. We therefore drop these two observations.

$f = \{1, 2\}$ indexes the duopolists, $k = \{1, \dots, 162\}$ indexes the counterfactuals, so that ψ_f^k is the firm-level pass-through rate that we compute by volume-weighting. N_f^k is the number of products owned by firm f in counterfactual k , and $\bar{\eta}_{f,cross}^k$ is the average cross-price elasticity among the products owned by f in counterfactual k . Given that the total number of firms is fixed at 198, it is clear that there are some duopolists for which the average cross-price elasticity is close to the market average by construction. These are the duopolists, which hold the bulk of the available products and compete with a rival firm that owns relatively few beers. This can bias our coefficient of interest α_1 due to a selection effect. To tackle this potential bias, we generalize (18) by including fixed effects for the number of products owned

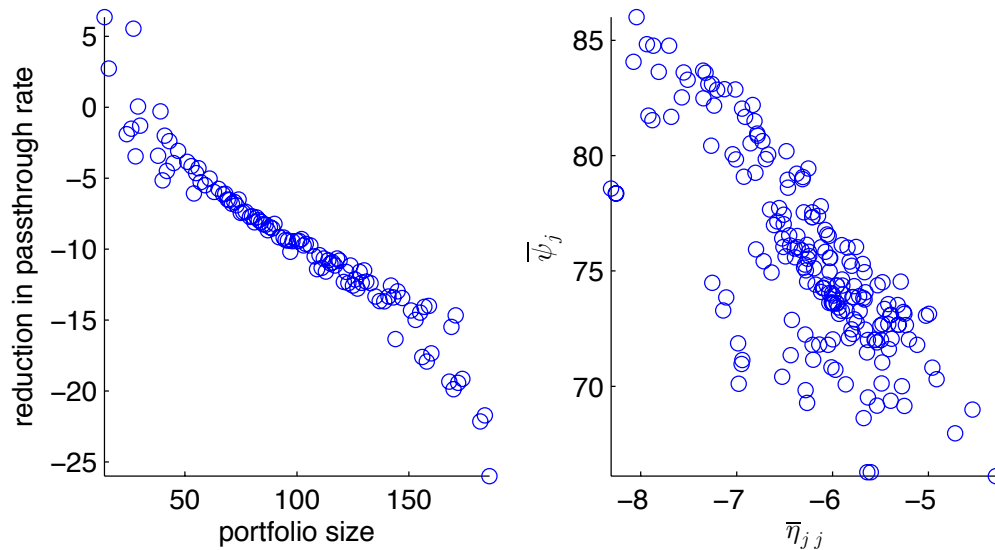
by firm f .¹² There are 111 such fixed effects and firm portfolio sizes vary between 12 and 186 products.

Table (7) presents the results. To ease interpretation of the estimated coefficients on the average elasticities, we have divided these elasticities by their standard deviations. Thus, the coefficients on the average own- and cross-price elasticity within the firm give the change in the firm-level pass-through rate in response to a one standard deviation increase in the average own- or cross-price elasticity. The results for the baseline specification in the column labeled (1) indicate that the number of beers in the duopolists' portfolios and the average cross-price elasticity within the product portfolios explain almost 90 percent of the simulated variation in the firm-level pass-through rate. Adding one more product to the portfolio of firm f reduces the pass-through rate by .11 percentage points. A one standard deviation increase in the average cross-price elasticity dampens the duopolist's price reaction to marginal cost shocks by roughly 1.4 percentage points. This effect might seem small at first pass, but the range of average cross-price elasticities across all the counterfactuals covers 10 standard deviations. Thus, the effect is sizable. Similarly, given that portfolio size varies between 12 and 186 products, it is also clear that the number of products has a substantial impact on the firm-level pass-through rate.

In specification (2), we allow each portfolio size to have a separate intercept to accommodate any selection effect between portfolio size and the average cross-price elasticity within portfolios. These fixed effects ensure that the coefficient on $\bar{\eta}_{f,cross}^k$ is identified based on the variation within portfolio sizes. The estimated coefficient on the average cross-price elasticity increases in magnitude by almost 20 percent, magnifying its negative effect on the pass-through rate. Moreover, with the portfolio size fixed effects, the specification explains roughly 98 percent of the simulated variation in firm-level pass-through rates. The left panel of Figure (3) plots the portfolio sizes against the estimated fixed effects. The reduction in the pass-through rate is expressed in percentage points. Relative to a duopolist with the smallest portfolio size, namely 12 products, a duopolist with an average-sized portfolio, namely 99 products, adopts a pass-through rate that is roughly 10 percent lower. For portfolio sizes between 150 and the maximum of 186, the effect increases

¹²The number of products owned by the competitor is simply the remainder $198 - N_f^k$. We therefore only have to include a fixed effect for one of the firms.

Figure 3: Portfolio Size Fixed Effects and the Impact of Own-Price Elasticities

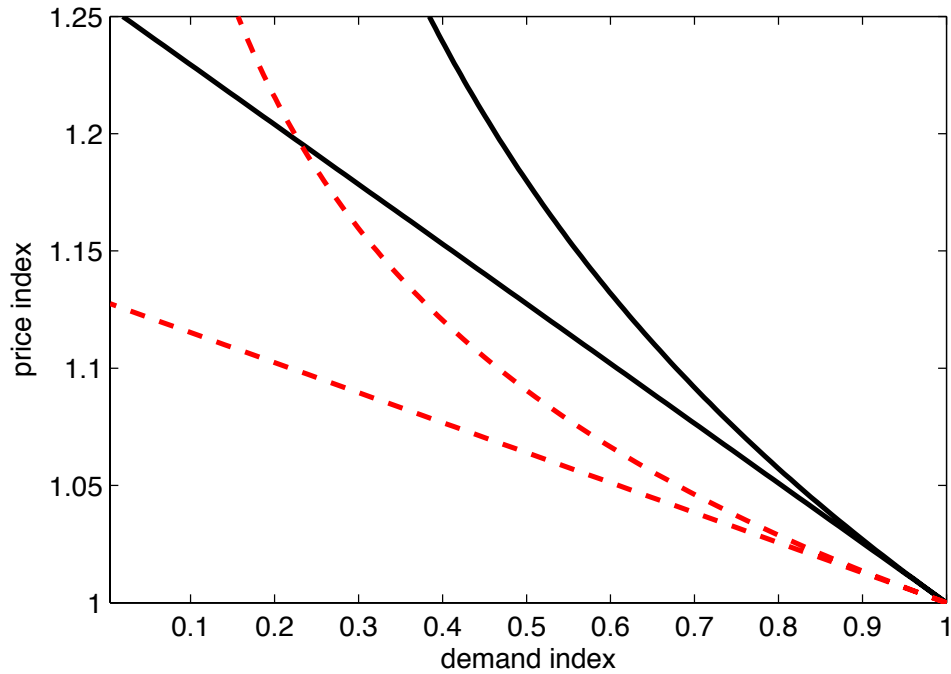


Note: In the left panel, the estimated fixed effects for the duopolist’s portfolio size is scattered against the implied reduction in that firm’s pass-through rate in percentage points. 108 of these 111 fixed effects have t-statistics exceeding 2. The base category is the minimum portfolio size of 12. The positive fixed effects indicate that there is a lot of variation in the firm-level pass-through rate for very small portfolio sizes. In the right panel, $\bar{\psi}_j$ and $\bar{\eta}_{jj}$ are, respectively, the pass-through rate and own-price elasticity for product j averaged over all counterfactual duopolies.

to between -14.3 and -26 percentage points. Thus, the number of products that a firm holds in its ownership does have a substantial impact on its pass-through of costs when we consider concentrated market structures.

Finally, we evaluate the impact of the average own-price elasticity within firm portfolios in specification (3). For the duopolists, the effect is statistically insignificant and the coefficient is close to zero, which suggests that the elasticity of the demand curve has a negligible impact on cost-pass-through. As the right panel of Figure (3) shows, this finding is an artifact of the aggregation at the firm-level. Product-level pass-through rates and own-price elasticities are strongly negatively related across all of the counterfactual duopolies. Thus, even though this effect washes out at the level of the duopolist, the simulations show that products facing

Figure 4: Product-Level Demand and Its Linear Approximation



Note: The solid black lines depict the demand curve for Tuborg Pilsener, which is sold by Pripps, and its linear approximation. The dashed lines plot the demand curve for Falcon Gammelbrygd, a beer that is sold by Carlsberg, and its linear approximation. Prices for each product are indexed by their actually observed values in the market and are increased by up to 25 percent. Demand for each beer is indexed by its actually observed market share.

less elastic demand have relatively low cost-pass-through.

6 Robustness

In this section, we consider changes to our counterfactual simulations to examine the robustness of our findings.

6.1 Demand Curvature

A crucial aspect of pass-through that our theoretical motivation abstracts from is the effect of demand curvature. The BLP demand model allows for nonlinear demand schedules that depend on unobserved taste heterogeneity among the population of consumers. While an exploration of this aspect is not a robustness exercise per se it is nevertheless useful to highlight that our empirical results do not depend on the linear approximation that we used in the theoretical motivation. In Figure (4) we trace out the demand schedule for two beers as a function of their own prices that are sold in August 1997. For each product, we increase its price by up to 25 percent, while holding all other prices fixed and then re-compute market shares. To be able to plot both schedules in the same figure, we index both price and demand by their actually observed values in the data. Therefore, demand is bounded between 0 and 1, while price is bounded between 1 and 1.25. At the actually observed price and market share, we compute the tangent line to the demand function. This is our linear approximation to the demand curve. Thus, at the point (1,1) the value of the linear approximation and the demand schedule are identical by construction. The two beers are Tuborg Pilsner, sold by Pripps, and Falcon Gammelbrygd, sold by Carlsberg, and they show the range of the relative errors that we obtain from the linear approximation. Tuborg, plotted with solid black lines, has the smallest relative error, while Falcon, plotted with dashed lines, has the largest relative error. A glance at the plot suggests for price changes of up to, say, 5 percent the linear approximation is quite accurate. For larger price changes, the linear approximation diverges substantially from the actual demand schedule. Table (8) provides more details on the relative error of the approximation across all 198 beers in the market. For a five percent increase in prices, the average error is slightly greater than 5 percent and the minimum error is 2.3 percent. If prices increase by 10 percent, we can already observe a large average relative error of more than 26 percent, with the maximum being 53 percent. If prices increase by at least 20 percent, the average relative deviation greatly exceeds 100 percent and the minimum lies above 50 percent. This clearly illustrates that overall a linear approximation to the estimated demand schedules performs very poorly. Our results, therefore, are not driven by an estimated demand model that is close to a linear demand model. Next, we demon-

Table 8: Linear Approximation to Product-Level Demand Curves - Relative Error (in percent)

percentile	$p_{ind} = 1.05$	$p_{ind} = 1.10$	$p_{ind} = 1.15$	$p_{ind} = 1.20$	$p_{ind} = 1.25$
5 th	3.477	16.20	42.49	88.20	161.0
10 th	3.789	17.77	46.92	98.10	180.0
15 th	3.909	18.34	48.44	101.3	186.4
50 th	5.045	24.17	65.28	139.6	261.5
85 th	6.982	34.47	95.62	209.3	404.6
90 th	7.821	39.04	109.8	244.3	478.1
95 th	9.146	46.17	131.4	296.2	588.8
min	2.291	10.39	26.52	53.53	95.01
mean	5.438	26.38	72.12	156.0	297.2
max	10.35	53.04	153.4	351.4	709.1

Note: Each beer's price is increased by 5, 10, 15, 20, and 25 percent. The beer's changed prices are indexed by the actually observed price for the specific beer. Thus, the indexed price, p_{ind} , is bound between 1 and 1.25. The reported figures are based on the relative approximation to each of the 198 available beers' demand curves. Only the price of one beer at a time is allowed to change. All other prices are held fixed.

strate that our results are not driven by imposing a small change in marginal cost that would make a linear approximation accurate by construction.

6.2 The Size of Marginal Cost Shocks

We have assumed a common cost shock that increases all marginal costs proportionally by 10 percent. Even if each demand schedule exhibits curvature, we are guaranteed to obtain results that are in line with the linearized example above, if we choose a sufficiently small perturbation to marginal costs. To demonstrate that this is not the case, we consider several alternative values for g , the net relative change in marginal costs. We conserve space by condensing all information in Table (9), where we report the average pass-through rate for each counterfactual and value

Table 9: Alternative Values for g

g	$\bar{\psi}_{single}$	$\bar{\psi}_{actual}$	$\bar{\psi}_{duo}$	$\bar{\psi}_{mono}$
-.25	84.3	82.1	75.6	48.9
-.20	84.3	82.3	75.7	48.4
-.15	84.3	82.2	75.8	48.0
-.10	84.4	82.3	75.8	47.7
-.05	84.2	82.2	75.8	47.5
.05	84.4	82.2	75.5	48.3
.10	84.5	82.4	75.4	48.7
.15	84.4	82.3	75.2	49.2
.20	84.3	82.2	75.1	50.1
.25	84.3	82.3	75.0	51.3

Note: $\bar{\psi}$ denotes the average pass-through rate. We compute the average pass-through rate for each of the 162 duopolies and report the mean of these averages.

of g .

For each counterfactual we see that the average of the simulated pass-through rates is hardly affected when varying g between -.25 and .25. The average pass-through under monopoly varies somewhat more over the different values of g , but is limited to a small range between 47.5 and 51.3 percent. Moreover, the pass-through rate does not seem to vary systematically with g . It falls initially from almost 49 percent to 47.5 percent when marginal costs fall by 5 percent instead of 25 percent, only to rise again to more than 51 percent for a 25 percent increase to marginal costs. Finally, there is not a single case where the ranking of the pass-through rates across the counterfactuals is altered. We therefore conclude that our results are not driven by imposing a shock to marginal costs that is too small.

6.3 The Role of Higher Prices in More Concentrated Markets

In the benchmark simulations we assume that marginal costs are identical across the counterfactuals. Each of these counterfactuals is associated not only with a different

Table 10: Pass-Through Rates At the Market-Level

	Single-Product	Actual		
	Firms	Ownership	Duopolies	Monopoly
(A) Identical Marginal				
Costs	83.31	80.54	73.56	43.72
(B) Identical Prices	83.89	80.54	71.01	37.72

Note: The market-level pass-through rates are aggregate using the post-perturbation market shares. The figures reported under (A) are identical to the figures reported in the first row of Table (6).

pass-through (dp/dc) but also with a different level of prices, which impacts the pass-through rate $(dp/dc) * (c/p)$. As prices in concentrated markets are higher, a given price change will then be lower in percentage terms. One may worry that this, somewhat trivial, mechanism is an important reason for the muted pass-through rates that we find for the more concentrated markets. We show that this is not the case, however. The key insight is that higher prices are also associated with a higher own-price elasticity. We document this effect empirically in the right panel of Figure (3). We provide some theoretical insight in the Appendix.

To show that a higher price level for more concentrated markets is not the main mechanism behind our quantitative findings we assume that the actually observed prices and market shares in the data apply to all counterfactual ownership settings before the aggregate shock hits costs and compute the different vectors of marginal costs that are consistent with this assumption.¹³ An economic rationale for this assumption is that there are economies of scale and/or scope that yield lower marginal costs for large multiproduct firms. Most importantly, however, this assumption allows us to fully shut down the influence of the pre-perturbation price level and thereby demand elasticity differences across the counterfactuals. The results of this

¹³Taking the market populated with single-product firms as an example, the marginal costs that are consistent with this assumption are computed by solving $\widehat{m}\widehat{c}_{single} = P + (\mathcal{I} \odot \Omega)^{-1}S$. Here, P , S , and Ω are the actually observed prices and market shares, and the matrix of market share derivatives that we obtain by using S and our structural demand estimates.

alternative implementation of the counterfactuals are shown in Table (10). For the sake of brevity, we only report the volume-weighted market-level pass-through rates.

If we impose identical pre-perturbation prices, the differences in cost pass-through rates across the counterfactuals widen. The quantitative impact on the comparison of single-product firms and the actual ownership is small. For the duopolies the effect is larger, and for the counterfactual monopoly the effect is largest and amounts to roughly 6 percentage points. Thus, the assumption of identical marginal costs across counterfactuals yields conservative estimates for the dampening effect that large multiproduct firms have on cost pass-through rates.

6.4 The Number of Beers

The number of available beers in our sample is large compared to other studies of beer markets. On average there are roughly 200 products, which includes beers that are sold in different packages. If we do not count these package varieties, we still see on average more than 127 beers over the sample period. In comparison, the U.S. sample of Goldberg and Hellerstein (2013) covers 16 beers, the data on the French beer market that is used in Hausman, Leonard and Zona (1996) has 15 beers, and the data on the U.K. beer market that features in Slade (2004) covers 63 products. The stores of the Swedish alcohol retail monopoly therefore seem to offer more choice to consumers.¹⁴ To assess whether this large number of products affects our results in a material way, we drop beers with very small market shares from the market we observe in August 1997 and re-compute the pass-through counterfactuals.

Specifically, we sort all beers by their volume sold from smallest to greatest and compute the cumulative sum of volume sold. The set of beers that accounts for the bottom 10 percent of cumulative volume is dropped. This leaves only 79 out of 198 beer varieties and Galatea, which at the time only produces very low volume beers, does not survive this operation. Clearly, there are many other potential criteria to decide which beers to drop from the market. Given that retailers have an inherent interest in offering those products to customers that generate the greatest volume or sales, we think that a volume ranking is a reasonable choice for a robustness

¹⁴Another potential explanation for this difference is that the data used in these existing studies do not cover market volume to such an extent as does the Swedish data. The existence of the retail monopoly makes it much easier to observe all beers that are available to consumers.

Table 11: Pass-Through Rates in the Counterfactual Market with Fewer Beers

percentile	ψ_{single}	ψ_{actual}	$\bar{\psi}_{duo}$	ψ_{mono}
5 th	80.2,78.9	77.5,75.0	69.4,68.5	34.6,34.5
20 th	82.0,81.1	79.6,77.3	72.0,70.1	41.8,39.4
median	84.5,83.3	82.2,80.3	74.5,72.4	47.1,44.3
mean	84.5,82.9	82.4,80.0	75.4,72.5	48.7,44.0
80 th	86.8,84.6	85.4,82.3	79.1,75.1	58.4,49.2
95 th	89.7,86.1	88.2,84.9	83.2,77.2	65.5,56.4

Note: ψ denotes the pass-through rate and the reported numbers are based on product-level pass-through rates. The first number reported applies to the counterfactual that is based on the full product offering in August 1997, 198 products in total, while the second number applies to the counterfactual that only retains the 79 largest products by volume.

exercise.

We condense the information in Table (11) by comparing the distributions of pass-through rates for the full and reduced product offerings. Overall, our qualitative results are unaffected and the outcome of the comparison is intuitive. Dropping the smaller products reduces the intensity of competition in the market, which, *ceteris paribus*, yields pass-through rates that are lower. This holds for all sampled points along the pass-through rate distribution. Importantly, the ranking of the counterfactual market settings in terms of the magnitude of pass-through rates is unaffected by reducing the number of products that are available to consumers. Thus, our results are also not driven by unusually large product portfolios at the level of the market or the firm.

6.5 Deviations from Nash-Bertrand Play Between Firms

Finally, we consider the possibility that our supply side is mis-specified, because the actual industry conduct might deviate from our assumption of Nash-Bertrand competition between firms in equilibrium. Our conduct assumption is embedded in the ownership or holding matrix, \mathcal{H} , where we impose that $\mathcal{H}_{(i,j)} = 1$ if $i, j \in \mathcal{F}_f$ and

$\mathcal{H}_{(i,j)} = 0$, otherwise. This assumption imposes that each firm f jointly maximizes profits for all the products in its portfolio and takes the prices of rival firms' products as given. To allow for deviations from Nash-Bertrand competition between firms, we replace the zero entries in the holding matrix by the (aggregate) conduct parameter ϕ . We define $\Phi_{(i,j)} = 1$ if $i, j \in \mathcal{F}_f$ and $\Phi_{(i,j)} = \phi \in [0, 1]$ otherwise. In this extension of the counterfactuals we therefore focus on the actually observed ownership pattern in the market. $\phi = 0$ yields our initial equilibrium, while $\phi > 0$ allows competing firms to take each other's profit maximization conditions into account. ϕ therefore controls the degree to which the existing firms in the market jointly maximize profit. $\phi = 1$ yields full collusion, which is equivalent to monopoly. For some given value of ϕ , pre-perturbation prices are pinned down by

$$p_\phi^{(0)} = \widehat{mc} - \left(\Phi \odot \Omega_\phi^{(0)} \right)^{-1} s_\phi^{(0)}, \quad (19)$$

and post-perturbation equilibrium prices are

$$p_\phi^{(1)} = \widetilde{mc} - \left(\Phi \odot \Omega_\phi^{(1)} \right)^{-1} s_\phi^{(1)}. \quad (20)$$

Table (12) presents results on the distribution of pass-through rates for five values of the conduct parameter lying between .1 and .9. Recall that the ownership setting is fixed and captures the actually observed firms in the market for all of the counterfactual values of ϕ . The effect of less competitive conduct than firm-level Nash-Bertrand yields the same effects as an increase in market concentration due to a changing ownership structure. For higher values of ϕ the entire distribution of pass-through rates shifts to the left. For $\phi = .5$ we obtain an average pass-through rate that is very close to the corresponding average that we obtain for the counterfactual duopolies. Raising the conduct parameter to .9 yields an average pass-through rate that is roughly 6 percentage points above the average we obtain under counterfactual monopoly (see Table (11)). Thus, we can conclude that any deviation from Nash-Bertrand that yields less competitive industry conduct simply amplifies the dampening of pass-through rates.

Is it reasonable, however, to expect such deviations from Nash-Bertrand play between firms? Several recent industry studies find evidence for systematic and sizable deviations from Nash-Bertrand competition between firms. Björnerstedt and Verboven (2015) find that observed effects of a merger in the Swedish market

Table 12: The Distribution of Pass-Through Rates Under Different Assumptions on Conduct

percentile	$\phi = .1$	$\phi = .25$	$\phi = .5$	$\phi = .75$	$\phi = .9$
1 st	72.7	71.8	66.0	51.3	34.8
5 th	75.6	74.1	67.8	55.3	42.1
10 th	76.9	75.0	68.8	57.1	45.2
Median	81.1	79.2	73.4	63.2	53.1
Mean	81.4	79.5	74.4	64.5	54.6
90 th	86.8	85.0	81.1	74.5	67.7
95 th	87.7	86.1	82.4	76.4	69.9
99 th	89.6	88.0	84.2	78.6	72.8

Note: All reported equilibrium pass-through rates are based on the actually observed ownership in the market. Zero entries in \mathcal{H} are replaced by the respective values of ϕ in each column to compute pre- and post-perturbation prices.

for analgesics is best rationalized when ϕ is set to .75. Ciliberto and Williams (2014) find that multi-market contact among U.S. airlines substantially softens competition and ongoing work by Miller and Weinberg (2015) indicates that an increase in the concentration of the U.S. beer brewing industry facilitates collusive play between the two biggest producers. Estimating conduct for our sample of data is beyond the scope of this paper, but these recent studies at least demonstrate that more collusive conduct than Nash-Bertrand is likely to determine equilibrium outcomes in other industries. We would therefore argue that the magnitudes that we obtain in our counterfactuals are best interpreted as a lower bound on the effect that multiproduct firms have on pass-through rates.¹⁵

¹⁵We have to keep in mind, however, that if collusion is maintained by stick-and-carrot schemes as in Green and Porter (1984), it is possible that $\phi < 0$ for a limited period of time.

7 Conclusion

We want to highlight three takeaways from our analysis. First, for our market of study, multiproduct markup setting yields a limited dampening of cost pass-through to prices. The existing literature’s abstraction from cannibalization within firm’s product portfolios and its focus on multiproduct economies of scope in price adjustment with menu costs is therefore supported by our empirical findings. Second, and notwithstanding, the dampening effect that we find is statistically highly significant and robust to a wide range of changes to our counterfactual market settings. Moreover, we also find economically large dampening of cost pass-through to prices in more concentrated market settings or in moderately concentrated markets in which firms compete less fiercely than Nash-in-prices. Third, we therefore want to emphasize the caveat that in other markets, where the substitutability among products is higher, the dampening effect is also greater. When calibrating or estimating a model of multiproduct price adjustment with menu costs in a setting of several sectors, this potential heterogeneity might play a substantial role.

8 References

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9 Appendix

9.1 First- and Second-Order Conditions

For the two firm case, the first- and second-order conditions are given as follows.

$$\begin{aligned}
 f^i &= q_i^i(p^i - c^i) + q^i &= 0 \\
 f_i^i &= q_{ii}^i(p^i - c^i) + 2q_i^i &< 0 \\
 f_j^i &= q_{ij}^i(p^i - c^i) + q_j^i &> 0 \\
 f_{c^i}^i &= -q_i^i \\
 f_{c^j}^i &= 0
 \end{aligned} \tag{21}$$

For the single firm case, the first- and second-order conditions are given as follows.

$$\begin{aligned}
 f^i &= q_i^i(p^i - c^i) + q^i + q_i^j(p^j - c^j) &= 0 \\
 f_i^i &= q_{ii}^i(p^i - c^i) + 2q_i^i + q_{ii}^j(p^j - c^j) &< 0 \\
 f_j^i &= q_{ij}^i(p^i - c^i) + q_j^i + q_i^j + q_{ij}^j(p^j - c^j) &> 0 \\
 f_{c^i}^i &= -q_i^i \\
 f_{c^j}^i &= -q_i^j
 \end{aligned} \tag{22}$$

9.2 Comparing Single- and Multiproduct Pass-Through

Here are the the calculations for own-cost pass-through. In a first step, we rearrange (5) as follows.

$$\frac{2}{4 - \frac{q_2^1 q_1^2}{q_1^1 q_2^2}} < \frac{q_2^1(q_2^1 + q_1^2)}{(q_2^1 + q_1^2)^2 - q_2^1 q_1^2} \tag{23}$$

The rhs can then be expressed in terms of $w^1 \equiv q_2^1/(q_2^1 + q_1^2)$ and $w^2 \equiv q_1^2/(q_2^1 + q_1^2)$.

$$\begin{aligned}
 \frac{q_2^1(q_2^1 + q_1^2)}{(q_2^1 + q_1^2)^2 - q_2^1 q_1^2} &= \frac{q_2^1 + q_1^2}{\frac{(q_2^1 + q_1^2)^2}{q_2^1} - q_1^2} = \frac{1}{\frac{q_2^1 + q_1^2}{q_2^1} - \frac{q_1^2}{q_2^1 + q_1^2}} \\
 &= \frac{1}{1 - w^1 w^2} = \frac{w^1}{1 - w^1 w^2} \\
 &\quad w^1
 \end{aligned} \tag{24}$$

With regards to cross-cost pass-through, dp^2/dc^1 is greater for the single-product firm than for the multiproduct firm if the following inequality holds.

$$\frac{-q_1^1 q_1^2}{4q_1^1 q_2^2 - q_2^1 q_1^2} > \frac{q_1^1 (q_2^1 - q_1^2)}{4q_1^1 q_2^2 - (q_2^1 + q_1^2)^2} \quad (25)$$

We rearrange the inequality as follows.

$$q_1^1 q_1^2 (q_2^1 + q_1^2)^2 > 4q_1^1 q_2^2 q_1^1 q_2^1$$

Dividing by $q_1^1 q_1^2$ gives the following expression.

$$(q_2^1 + q_1^2)^2 < \frac{4q_1^1 q_2^2 q_2^1}{q_1^2}$$

We make the following substitution: $q_1^2 = \gamma q_2^1$.

$$(q_2^1)^2 (1 + \gamma)^2 < \frac{4q_1^1 q_2^2}{\gamma} - (q_2^1)^2 (1 - \gamma)$$

Dividing by $(q_2^1)^2$ and using the substitution $q_1^2 = \gamma q_2^1$ gives the following result.

$$(1 + \gamma)^2 + 1 - \gamma < \frac{4q_1^1 q_2^2}{q_2^1 q_1^2}$$

We obtain the inequality reported in the main text after collecting terms and inverting both sides. The calculations for dp^1/dc^2 follow the same steps.

9.3 Firms in the Post-Merger Sample

The major change in the subsample from February 2001 to January 2003 is the merger between Carlsberg and Pripps. To obtain approval from the Swedish competition authority, the merging parties had to divest 19 beer varieties to Galatea. The bulk of these divestitures originate from Carlsberg's pre-merger portfolio. In the post-merger period, Carlsberg-Pripps is the by far largest firm with on average 50 products in its holdings and it accounts for more than 40 percent of market volume. Galatea's volume share jumps to close to 10 percent in the post-merger period. This is completely due to the divested beers. Apart from these merger-related changes, the remaining firm statistics are largely unchanged. The three medium-size producers tend to offer more foreign-brewed beers on average.

Table 13: The Firms in the Post-Merger Sample

Firm	Number of Products	Volume Share	Share of Foreign Beers	Share of Light Lagers	Share of Ales
Carlsberg-Pripps	50	41.8	50.7	83.8	2.09
Spendrups	36	20.2	34.8	87.9	5.52
Åbro	31	13.7	39.9	82.5	11.5
Kopparberg	18	6.15	11.3	95.6	0
Krönleins	16	6.90	25.0	87.2	0
Galatea	34	9.75	59.5	75.1	22.0
Bibendum	15	1.50	100	61.8	25.1

Note: The reported figures are based on the Carlsberg-Pripps post-merger sample period, which stretches from February 2001 to January 2003.

9.4 Idiosyncratic Cost Shocks

Table (14) reports equilibrium pass-through rates when we allow for idiosyncratic cost shocks. For simplicity, we simply draw the net proportional cost shock for each product that is available in August 1997 from a uniform distribution. We consider

Table 14: Product-Level Pass-Through Rates of Idiosyncratic Cost Shocks

percentile	$g_j \sim U(.10, .25)$			
	Single-Product Firms	Actual Ownership	Duopolies	Monopoly
5 th	79.60	76.50	67.27	28.00
10 th	80.63	78.09	69.10	34.21
50 th	84.22	81.93	74.61	49.44
90 th	88.26	87.54	82.68	65.08
95 th	89.39	88.79	84.56	68.16
minimum	75.15	72.05	60.36	6.19
mean	84.31	82.30	75.21	49.26
maximum	91.11	90.66	87.45	72.18
percentile	$g_j \sim U(-.25, -.10)$			
	Single-Product Firms	Actual Ownership	Duopolies	Monopoly
5 th	79.50	75.81	68.05	29.97
10 th	80.91	77.25	69.58	32.39
50 th	84.08	81.99	75.24	46.00
90 th	87.94	87.64	82.61	62.19
95 th	89.06	88.94	84.35	65.03
minimum	74.05	71.00	62.47	18.12
mean	84.11	82.19	75.62	46.65
maximum	90.77	90.00	87.23	73.16

Note: For each of the products that is available in August 1997, we draw a net proportional cost shock from the above uniform distributions. Thus, g is a vector with 198 entries. Given the pre-perturbation prices, which are identical to those reported in Table (5), we compute the post-perturbation equilibrium and the resulting product-level pass-through rates.

the cases of positive and negative cost shocks. For each case, we draw from a range between 10 and 25 percent.¹⁶ For both cases, we see that the results in the

¹⁶The cases are separated here, because of our pass-through definition. For values of $g \approx 0$, the denominator of (15) is close to zero. We can then obtain very large negative or positive pass-through rates, because of numerical rounding errors.

main text are reiterated. When moving to more concentrated market settings, the entire distribution of product-level pass-through rates shifts to the left. Quantitatively, the numbers are also very close to the those reported in the main text. Thus, the correlation of the shocks does not seem to have a substantial impact on our findings.

9.5 Bootstrapping Pass-Through Rates at the Market- and Firm-Level

We use a parametric bootstrap procedure to evaluate whether the reported point estimates in Table (6) for the differences in pass-through rates between single-product firms and the actual ownership pattern are statistically significant. Let $\hat{\theta} = (\hat{\alpha}, \hat{\beta}, \hat{\sigma})'$ denote the vector that includes our point estimates for the taste parameters and random coefficients in (11), and let $\hat{\Sigma}_\theta$ denote its asymptotic covariance matrix. We simulate 1,000 draws from the multivariate normal distribution $MVN(\hat{\theta}, \hat{\Sigma}_\theta)$. Given each draw, we solve for the structural error terms, ξ , that equate the model-implied shares with the actually observed shares. For each draw, we then re-compute pre- and post-perturbation equilibrium prices for the different counterfactuals. This gives us a distribution for the pass-through rates that are aggregated at the firm and market level, and we can therefore easily compute confidence bounds on the reported point estimates. Table (15) presents the results of this parametric bootstrapping procedure along with the point estimates reported in Table (6).

9.6 Monopoly Cost Pass-Through and The Elasticity of Demand

This subsection complements our empirical results in Robustness section 5.3. We consider a price-setting monopolist that maximizes its profits $\pi = q(p) [p - c]$. Output is a function of price. We write the familiar first-order condition as follows where η denotes the own-price elasticity of demand.

$$q \left(1 + \frac{1}{\eta} \right) - c = 0 \tag{26}$$

Totally differentiating, solving for dp/dc and rearranging, we arrive at the following expression.

$$\frac{dp}{dc} = \frac{\eta}{1 + \eta - \left(\frac{\partial\eta}{\partial p}\right) \left(\frac{p}{\eta}\right)} \quad (27)$$

This is the price-setting equivalent of equation (3') in Bulow and Pfleiderer (1983). We are interested in what happens to pass-through as the own-price elasticity tends towards $-\infty$. Given that p must be finite for demand to be strictly positive, there are three possible limits for the elasticity of the own-price elasticity (super-elasticity), which is the third term in the denominator on the right-hand side. If $\partial\eta/\partial p$ tends to $-\infty$ faster than η , the negative of the super-elasticity tends to $-\infty$. This is case 1. The second possibility is that η tends towards infinity faster than its slope with respect to price does. In that case, the super-elasticity tends towards zero. Finally, the ratio of $\partial\eta/\partial p$ and η can tend toward some finite constant K . For the latter two cases, it is clear that

$$\lim_{\eta \rightarrow -\infty} \frac{\eta}{1 + \eta - \left(\frac{\partial\eta}{\partial p}\right) \left(\frac{p}{\eta}\right)} = 1. \quad (28)$$

As demand becomes perfectly elastic, we obtain full cost pass-through. In the first case, pass-through tends to zero, because demand falls so quickly towards zero that the monopolist is unable to pass-through cost shocks. This case is inconsistent with convex demand, and is therefore ruled out by our empirical approach (BLP demand is convex).

This result therefore gives the prediction that in counterfactual market settings where own-price elasticities are higher, because prices are higher, all else equal, cost pass-through is also higher. It follows that from the two possible approaches to simulate counterfactual pass-through, the assumption of identical product-level marginal costs is the conservative choice. All else equal, the higher own-price elasticity in the more concentrated markets pushes cost-pass-through up not down and therefore works against the dampening effect emanating from multiproduct firms.

Table 15: Bootstrapped Pass-Through Rates at the Market- and Firm-Level

	Single-Product Firms	Actual Ownership	Difference
Market	83.31 [80.41,87.03]	80.54 [77.77,84.98]	2.77 ^{***} [2.31,3.81]
Carlsberg	83.22 [78.57,85.80]	79.64 [73.81,81.50]	3.58 ^{***} [3.20,5.59]
Pripps	83.83 [78.38,86.34]	80.52 [74.29,83.59]	3.31 ^{***} [2.01,4.75]
Spendrups	82.73 [77.82,85.72]	80.07 [74.47,82.82]	2.66 ^{***} [1.79,4.73]
Åbro	84.14 [79.91,86.36]	81.82 [78.02,85.28]	2.32 [*] [-.05,2.78]
Kopparberg	83.83 [78.39,85.91]	83.56 [78.66,85.78]	0.27 [-1.41,1.83]
Krönleins	81.97 [75.23,83.50]	81.62 [77.46,83.07]	0.35 [-3.16,1.42]
Galatea	87.44 [83.88,90.03]	87.42 [74.29,83.59]	0.02 [-1.40,1.89]
Bibendum	85.96 [83.27,88.96]	85.95 [84.35,90.03]	0.01 [-1.34,1.59]

Note: This table reports the bootstrapped standard errors of the figures reported in Table (6) in the main text. The last column reports the difference between pass-through rates across the two counterfactuals. For this column ^{***}, ^{**}, and ^{*} indicate statistical significance at the 99, 95 and 90 percent confidence level, respectively. Bounds of 95 percent confidence intervals are reported in square brackets. All pass-through rates are volume-weighted and reported in percent.