Decentralized pricing of differentiated products: 
Implications for industry analysis*

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Abstract

When price setting is decentralized within a multidivisional firm and decision makers face local incentives, observed product prices are often – but not always – greater than firm-level optimal prices. The information that can be inferred from observed prices in empirical studies of differentiated product industries depends on the organizational structure of the firm. The interaction of the transfer pricing method employed by the firm and characteristics of the firm’s organizational form, such as the number of downstream divisions and the number of products sold in each division, determines the nature of the distortion to final good pricing. This paper describes when information about firm structure and transfer pricing method is particularly valuable for modeling firm behavior in industry-level analysis.

Keywords: multidivisional firms, organizational design, transfer pricing.

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1 Introduction

Many differentiated products are manufactured and sold by the multidivisional firms that, as described in Chandler (1977), dominate developed economies. In many cases, divisions within firms are treated as "profit centers" where performance evaluation is based on division profitability. Decision-making is then often decentralized to the division level primarily to create incentives for managers to exert effort\(^1\). Within this context, firms face the complex decision of how to price the goods and services that are transferred between different divisions so that decisions made with the objective of maximizing profit at the division level also serve to maximize overall firm profit. A large and long-standing literature discusses the relative merits of different transfer pricing methods. When final goods pricing is decentralized, division managers facing local incentives treat the transfer price as their effective marginal cost and choose a final goods price that is a function of the transfer price and, in the case of differentiated products, the nature of local demand and product characteristics. If the transfer price does not equal the firm-level marginal cost, the final good price chosen may well differ from the firm-level profit maximizing price\(^2\).

In his influential article on this topic, Hirshleifer (1956) concludes that transfer pricing at marginal cost is a necessary condition for the firm-level optimal outcome. Industry surveys, however, reveal that firms very rarely use marginal production cost as a basis for transfer price. Managerial accountants infer that all of the frequently observed transfer pricing methods represent a compromise at the firm level, as discussed in Zimmerman (1995). The general implication is that, in imperfectly competitive industries, distortions to final goods prices in a decentralized organization are more or less inevitable and represent the lesser of two evils when compared to the costs that are associated with centralized decision making.

Empirical models of differentiated product industries in the industrial organization literature have, for the most part, assumed firms act optimally in setting final goods prices according to some firm-level objective function. Treating the firm as the profit maximizing agent abstracts from the complexities introduced when firms are comprised of groups of individual decision makers, all operating to maximize their individual objective functions within an organizational structure. This has, of course, been a necessary simplification since information about intrafirm decision making structures is often unobserved. It may also be the case that researchers view the distortion introduced by this simplification as unaffected by the analysis of interest and hence as having no material impact on the results of counterfactual outcomes\(^3\).

The goal of this paper is to investigate how decentralized price setting affects final goods prices

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\(^1\)Recent developments in organizational theory, such as Alonso et al., (2008) and Rantakari (2008) set out conditions under which firms may choose to decentralize some aspect of decision-making. These papers also survey the prior literature on this issue.

\(^2\)Any distortion to price can be called a cost of decentralization but is not due to unobserved differences in local conditions of the type described in Alonso et al., (2008). The following sections will illustrate how distortions in final goods prices arise with local incentives even in a single downstream division, or in several different downstream divisions with identical and centrally observed local conditions.

\(^3\)Researchers often appeal to this argument when discussing the role of the retailer in setting the observed final goods prices, for example in Thomas (2008).
under the two most commonly used transfer pricing methods. These are market price based transfer pricing and full cost transfer pricing. The distortions in final goods prices are compared in each case to the firm profit maximizing price. The distortions arising with each transfer pricing scheme are shown to depend on the organizational form of the firm: whether it is a single- or multi-product firm, and whether the firm has one or several downstream divisions. The implications of the respective distortions are then explored in the context of firm conduct and horizontal merger analysis. The industry studied here is the laundry detergents industry in the UK, as discussed at greater length in Thomas (2008). A set of simulations reveals how organizational form and transfer pricing method affect what can be inferred about firm conduct from observed prices and the estimated impact of a horizontal merger on detergent prices.

The investigation begins with the simple case of a firm with one manufacturing division and one marketing division. As is standard in much of empirical industrial organization, it is assumed that the price chosen by the decision maker satisfies the first order conditions resulting from a pure-strategy Bertrand-Nash equilibrium. The decision maker setting the final goods price for this firm is the marketing division manager, who faces local incentives. The price that maximizes the marketing division’s profit is found for each transfer pricing method. As has been widely noted, market cost transfer pricing leads to double marginalization and higher final goods prices. The first surprising result presented here is that full cost transfer pricing introduces no distortion to final goods pricing in a decentralized single product, single marketing division firm, under standard price setting behavior assumptions. This is because the increase in final price that results from a portion of fixed cost being perceived as part of marginal cost by the division manager is entirely offset by the fact that reducing the final price increases quantity and lowers the per unit transfer price charged to the division for each unit.

Adding further products to the firm’s portfolio leads to a price distortion under market price transfer pricing which is likely to be lower than in the single product case. The role played by the product markup remains, but it is partially offset by the fact that demand spillovers are now less highly valued by the decision maker than when the manager captures the full markup over marginal cost from a switching customer. Under full cost transfer pricing, there is no distortion in the final price of any good. The direct effect on price of the fixed cost allocation is once more entirely offset by the reduction in per unit fixed cost through increased quantity both for the product in question and the cross-product effect for each other product.

Returning to the case of a single product firm, adding more marketing divisions - for example, other national markets - does not affect the magnitude of the price distortion under market price transfer pricing. In the case of full cost transfer pricing, however, the presence of additional mar-

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4This paper will not focus on distortions to transfer price arising from local incentives in the production division but it is briefly mentioned in section 2.

5This finding runs counter to Hirschleifer’s assertion that transfer pricing at marginal cost is necessary for firm-level profit maximization, and represents a clear advantage of full cost transfer pricing. To my knowledge, it has not been noted before in the accounting literature. Under full cost transfer pricing, the results from empirical work which incorrectly assumes prices are set to maximize firm-level profit are equivalent to the results that would be generated if decentralized decision-making were modeled explicitly.
keting divisions selling the same product does lead to a final good pricing distortion in each market. Although lowering price increases the quantity sold and hence reduces the per unit transfer price, the market manager captures only a share of this benefit. He does not internalize the fact that the transfer price in the other markets will also be lowered. Each manager is less inclined to reduce price and offset the direct effect of the share of fixed cost which is seen in the per unit transfer price. Prices are set above the firm profit maximizing price in each market. The distortion in each is greater the larger the share of total units which is sold elsewhere.

In a decentralized firm with many products, each of which is sold through a number of marketing divisions, both the transfer pricing methods considered lead to upward distortions in price due to the effects detailed in the previous two cases. Under market price transfer pricing, the final good’s price distortion is greater when the number of products for which is manager is responsible is smaller, and the distortion is independent of the number of downstream divisions. This may appear counterintuitive. For any one product, the distortion to its price is lower when another product is transferred to the same market at a higher transfer price than if the other good were transferred at marginal cost.

Under full cost transfer pricing, the final good’s price distortion is greater the smaller the share of total units for which each manager is responsible – that is, the greater the number of downstream divisions selling the same product. This is also somewhat counterintuitive. When the fixed cost of the product is shared out over a large number of downstream markets, the distortion to the price in any local market is greater than when the entire fixed cost is shared between the locally-sold units. The price distortion is independent of the number of products which enter each manager’s objective function.

The following section contains a short review of some of the literature about the choice of transfer pricing scheme in multidivisional firms. Section 3 presents the role of various transfer price methods in a single product decentralized multidivisional firm with only one downstream division. Section 4 extends the analysis to investigate how transfer pricing method interacts with organizational form to affect final goods prices. The interaction between transfer pricing method and organizational form presents a challenge to empirical researchers seeking either to test an optimality assumption or to impose an optimality assumption and then use price and quantity information to make inferences about cost. Section 5 presents an industry simulation to illustrate some potential implications of this analysis for empirical work, focusing on tests of firm conduct and horizontal merger analysis. Section 6 concludes.

### 2 A brief review of commonly used transfer pricing methods

Al-Najjar et al., (2008) describe how irrational pricing decisions arise when firms confound irrelevant costs with marginal costs. In a model of differentiated products and price competition, firms with
myopic decision makers and an initial irrational pricing bias will continue to price suboptimally over time. The aim of this paper is to discuss the implications of systematic distortions from optimal pricing within multidivisional firms which exist in equilibrium, even with perfectly rational agents, arising from the interaction of organizational form and transfer pricing methods.

A broad consensus in the management accounting literature holds that each of the widely used methods of transfer pricing in multidivisional firms presents some challenges for firm-level profit maximization. Zimmerman (1995, p.174) notes that no method dominates the others in all situations. Many studies emphasize how the firm’s choice among methods is influenced by international taxation concerns. Economists and accountants have focused on how to design a transfer pricing scheme that creates local incentives and permits accurate performance monitoring of local divisions. The local incentives in question are often concerned with effort or information revelation. For example, Holmstrom and Tirole (1991) derive the optimal transfer pricing scheme as part of a broad mechanism design problem to ensure agents reveal marginal costs accurately. There has been relatively little analysis of the impact of transfer pricing on the incentives surrounding how managers set final goods prices, the potential conflict between division profit-maximization and firm-level profit, and the implications of transfer pricing choice for industry-level outcomes.

Transfer pricing methods can be grouped into three main categories: market price based, cost based, or negotiated. Ernst and Young’s 2007-2008 Transfer Pricing Global Survey contains information about the methods used by 850 multinational enterprises in 24 countries. In this paper, the simplest versions of two commonly used methods will be analyzed. These are first, market price as transfer price and, second, full cost as the transfer price. For tangible goods, 32% of parent companies used Comparable Uncontrolled Prices, and 17% used Resale Price as a benchmark transfer price. The intention of both of these practices is to find a representative arm’s length, external, market price for the good being transferred between business divisions. 29% of the surveyed parent firms used a Cost-Plus transfer pricing method which starts with the sum of direct costs, indirect costs, and operating expenses such as selling, general, and administrative expenses when setting per unit transfer price.

The market price transfer price method relies on the presence of some external market for the product being transferred between divisions. Any intrafirm transfers of products are priced at the per unit market price in the external market. If there is an external market for the good and, importantly, if the external market is competitive, then this transfer pricing method is agreed to be efficient from the point of view of the firm. However, as noted in Baldenius and Reichelstein (2006), many intermediate product markets are imperfectly competitive. Indeed, the presence of

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6Much current practitioner debate analyzes the tax implications of different pricing methods. It was deemed the "most important tax issue for tax directors" in a recent Ernst & Young survey of MNE parent companies, and articles about litigation risk arising from international profit shifting are the most frequently observed topics on the website of the industry publication Transfer Pricing Week.

7The International Tax Institute website provides a glossary of the acronyms found in the Ernst & Young report. It can be found at: http://www.itinet.org/transferpricing/methods.htm. It is often the case that firms use a combination of these two transfer pricing methods, for example, transfer price may be set at a markup over marginal cost and a per unit fixed cost. This generates more complex pricing distortions than those laid out here.
a competitive upstream market raises more fundamental questions about the boundaries of the firm and, in particular, why the firm is vertically integrated if a competitive market exists for a stage of production. Baldenius and Reichelstein go on to examine when and how firms can use intracompany discounts to avoid the double marginalization problem generated when the upstream division produces a product for which the external price includes a markup over marginal cost. This paper examines how the inefficiency of market price transfer pricing produced by double marginalization for any given markup depends on the organizational structure of the firm.

The simplest version of the full cost transfer pricing method allocates all fixed production costs to the per unit transfer price. Zimmerman (1995) notes that one advantage of this method is that it is simple. There are no problems about how to measure an external market price and the production division has no incentive to misallocate any fixed cost to variable cost, but there is no corresponding incentive for the production division to try and minimize cost. Zimmerman comments that this method leads to sub-optimal decision making downstream since the buying unit purchases too few units. He also notes that this transfer pricing method is widespread, prompting the challenge of identifying any unrecognized benefits that outweigh the costs associated with this method. The analysis in this paper provides evidence of one benefit that, to the best of my knowledge, has not previously been discussed. Full cost accounting can lead decentralized price setters to set optimal prices in differentiated product markets, but only within certain organizational forms.

In sum, the choice of transfer pricing method in a decentralized firm is a complex and much-analyzed subject. Incentives, horizontal and vertical communication, decisions about individual manager effort, product range choice (as in Thomas (2008)), and final product price, all depend on the firm’s choices of transfer pricing and it’s organizational form. This paper takes as given that the firm has found it optimal to decentralize final good price setting. It investigates the implications of various exogenously given transfer pricing schemes for final goods prices and industry outcomes within different organizational structures. The different organizational forms studied are summarized in Figure 1.

3 A single product firm with one downstream division

In the simple case of one product shown in Figure 1(i), firm profit can be written as \( \pi = (p - c) q (p) - F \), where marginal cost is assumed to be the constant, \( c \), per unit price is \( p \) and product demand \( q \) is a function of price, \( p \), and all fixed costs are denoted by \( F \). Under the standard assumption of the existence of a pure-strategy Bertrand-Nash equilibrium in prices that are strictly positive, the optimal price from the view of the profit maximizing firm manufacturing selling a single product is, \( p \), where:

\[
p = c - q \left( \frac{dq}{dp} \right)^{-1}
\]  

The mark-up of price over marginal cost is a function of the own-price price elasticity of demand in the final-good market. If price decision making is centralized, the firm can be assumed to set price
In contrast, imagine the firm producing this product is organized as a multidivisional firm with a production division and one marketing division and decision making over price is the responsibility of the marketing division manager whose incentives are based on division profitability given the transfer pricing method in place. The downstream division manager seeks to maximize the following objective function:

$$\pi_d = (p_d - t(q(p_d))) q(p_d) - F_d$$

where $F_d$ is any fixed cost borne by the downstream division and $t$ is the per unit transfer price charged to the division. As described in section 2, under some of the most widespread transfer pricing schemes, the per unit transfer price seen as a cost by the decision maker is a decreasing function of total quantity, $q(p_d)$.

The division manager’s first order condition for division profit maximization conditional on the transfer pricing scheme is the total derivative of his objective function $\pi_d$ with respect to $p_d$. Solving this for $p_d$ gives the following division-profit maximizing price:

$$p_d = t - q_d \left( \frac{dq_d}{dp_d} \right)^{-1} + q_d \left( \frac{\partial t}{\partial q_d} \right)$$

Comparing equation 1 with equation 3 reveals that the distortion to price introduced by decentralized price setting, conditional on the transfer pricing scheme, can be decomposed into two parts. The first part of the distortion arises from the fact that the division manager faces a per unit cost, $t$, that differs from the marginal production cost, $c$. The second part of this distortion arises because the optimal markup over this cost is determined by the price elasticity of demand and the per unit transfer price elasticity with respect to quantity at the new decentralized quantity.

The choice of transfer pricing scheme determines the relative magnitude of the price distortion and the reduction in profits under decentralized decision making. Under market price transfer pricing, the product is transferred between company divisions at the external market price. Assuming the upstream market is not perfectly competitive, the external market price includes a markup, $\eta$, over marginal production cost. Under this scheme, $t = c + \eta$ and so $dt/dq_d = 0$. Substituting these terms into equation 3 gives:

$$p_d = c + \eta - q_d \left( \frac{dq_d}{dp_d} \right)^{-1}$$

The first component of the price distortion means that the decentralized price is higher than the optimal price, by a constant per unit amount, $\eta$. The less competitive the upstream external market, the greater is $\eta$ and the distortion to final good price. This is the typical double marginalization case,

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8The issue of whether this market exists and the question of the value of internalizing the stage of production is not addressed here. Also, for simplicity, it is assumed the downstream division has no buying power in external market so that $t$ is not a function of $q_d^*$ under this transfer pricing method.
the implications of which are discussed in detail in Baldenius and Reichelstein (2006) and others.\footnote{It is worth noting that the price set by a local manager is simply the price a centralized firm would set if it faced marginal costs of a constant $c + \eta$.}

The increase in price of $\eta$ may be either amplified or partially offset by the change in optimal markup due to the relative nature of demand at the centralized and decentralized quantities.

In the most straightforward version of full cost transfer pricing, the entire product-level fixed cost is allocated to the per unit transfer price. Under this method, $t = c + F/q_d$ and so $dt/dq_d = (-F/q_d^2)$. Substituting these terms into equation 3 gives the decentralized final good price – derived in the appendix – as:

$$p_d = c - q_d \left( \frac{dq_d}{dp_d} \right)^{-1} = p$$

(5)

The decentralized price is equal to the centralized price, and hence the quantities demanded in each case are equal, as are the price elasticities of demand at that quantity demanded. The price chosen by the decentralized decision maker with entirely local incentives is actually the firm profit maximizing price, and $q_d$ will equal the quantity sold in the centralized firm profit maximizing case. This is a somewhat counterintuitive finding since the manager may see a per unit cost that is very different from the actual marginal cost. The higher per unit price is completely offset by the fact that the optimal markup is a decreasing function of quantity with this transfer pricing method, an effect which leads him to set a lower price and sell more units.\footnote{Although the firm has constant marginal costs, the organizational structure of the firm leads the price-setter to price as if marginal cost were a decreasing function of quantity.} Firm-level profit is hence maximized in the decentralized price setting organizational form under this transfer pricing method.\footnote{This finding runs against the common inference made in accounting text books that full cost transfer pricing distorts the quantities sold by downstream managers. In this price-setting decentralized equilibrium, the optimal number of units is sold.}

\section{Prices set by local decision makers within more complex organizational forms}

The analysis set out in the previous section applies to a very simple organizational form. The majority of decentralized firms sell more than one product in each division and/or include several downstream divisions. In this section, the decentralized prices set by local managers in these cases are compared with firm profit maximizing prices. For simplicity, the analysis will focus on the two product and two division cases, but the findings generalize in a straightforward way to larger numbers of products and divisions. Inefficiency in final good pricing depends on the interaction of the particular transfer pricing method chosen and the organizational form.

\textbf{Decentralized decision making in a multiproduct firm}

A single price setting downstream division manager is responsible for choosing price for each of two products in the same local market as described in Figure 1(ii). The products are referred to as...
products A and B. Even if production costs are independent across products, joint price setting interacts with the firm’s choice of transfer pricing scheme in determining the final goods’ prices. In this case, the centralized firm profit maximizing price for product A would be:

$$p_A = c_A - q_A \left( \frac{d q_A}{dp_A} \right)^{-1} - (p_B - c_B) \left( \frac{d q_B}{dp_A} \right) \left( \frac{d q_A}{dp_A} \right)^{-1}$$  \hspace{1cm} (6)$$

where the last term is positive if A and B are substitutes in the local market and reflects the firm-level incentive for higher prices for each product since a share of market demand switches to the other firm product when faced with marginal price increases.

In the decentralized case, the division manager chooses $p_A$ and $p_B$ to maximize:

$$\pi_d = \sum_{j=A,B} (p_{d,j} - t_j (q_{d,j} (p_{d,j}, p_{d,-j}), q_{d,-j} (p_{d,j}, p_{d,-j}))) q_{d,j} (p_{d,j}, p_{d,-j}) - F$$  \hspace{1cm} (7)$$

where $\cdot j = B$ if $j = A$ and $\cdot j = A$ if $j = B$. The decentralized decision maker will set the price of good A, as derived in the appendix, as:

$$p_{d,A} = t_A - q_{d,A} \left( \frac{d q_{d,A}}{dp_{d,A}} \right)^{-1} - (p_{d,B} - t_B) \left( \frac{d q_{d,A}}{dp_{d,A}} \right)^{-1} + q_{A,d} \left( \frac{\partial t_A}{\partial q_{d,A}} \right) + q_{B,d} \left( \frac{\partial t_B}{\partial q_{d,A}} \right)$$  \hspace{1cm} (8)$$

If there is an external market for products A and B where the external market price includes markups of $\eta_A$ and $\eta_B$, respectively, then the transfer price of each product under the market price method is simply cost plus a fixed markup. This gives:

$$t_A = c_A + \eta_A, t_B = c_B + \eta_B$$

$$\frac{\partial t_A}{\partial q_{d,A}} = \frac{\partial t_B}{\partial q_{d,A}} = \frac{\partial t_A}{\partial q_{d,B}} = \frac{\partial t_B}{\partial q_{d,B}} = 0$$

The final goods price for product A is:

$$p_{d,A} = c_A + \eta_A - q_{d,A} \left( \frac{d q_{d,A}}{dp_{d,A}} \right)^{-1} - (p_{d,B} - c_B - \eta_B) \left( \frac{d q_{d,B}}{dp_{d,A}} \right) \left( \frac{d q_{d,A}}{dp_{d,A}} \right)^{-1}$$  \hspace{1cm} (9)$$

Comparing equation 9 with equation 6 reveals that the distortion in final price away from the firm optimum under market price transfer pricing is likely to be lower in the multiproduct case than in the single product case. Each unit is priced up by the markup over its own production cost, $\eta_A$, as in the single product case with market price transfer pricing, but there are additional cross-product effects at work here. Relative to the centralized price, the local manager has a decreased incentive to switch demand to the other product by raising price. Rather than earning $(p_B - c_B)$ on each customer
that switches to good \( B \) when good \( A \)'s price rises, he earns \( (p_{d,A} - c_B - \eta_B) < (p_B - c_B) \)\(^{12}\). On the margin, then, he is less willing than a centralized price-setter to raise the price of good \( A \). The larger the cross-price elasticity of demand between goods \( A \) and \( B \), the larger is this second effect in offsetting the upwards distortion in \( A \)'s price, \( \eta_A \), seen in the single product case\(^{13}\).

In the **full cost transfer pricing method**, the relevant terms to substitute into equation 8 are:

\[
\begin{align*}
t_A &= c_A + \frac{F_A}{q_{d,A}}, t_B = c_B + \frac{F_B}{q_{d,B}} \\
\frac{\partial t_A}{\partial q_{d,A}} &= -\frac{F_A}{q_{d,A}^2}, \frac{\partial t_B}{\partial q_{d,B}} = -\frac{F_B}{q_{d,B}^2}, \frac{\partial t_A}{\partial q_{d,B}} = \frac{\partial t_B}{\partial q_{d,A}} = 0
\end{align*}
\]

As shown in the appendix, the local decision maker will set the price of good \( A \) (and good \( B \), symmetrically) at \( p_{d,A} = p_A \). All of the terms reflecting cross-product effects cancel out and, once again, the full cost transfer pricing method generates no distortion in the price of either product. The quantities of each product sold in the market under the decentralized case are the same as in the firm-level profit maximizing outcome. Just as in the single product case, the direct effect on price of including a portion of fixed cost in transfer price is offset by the fact that the manager’s optimal markup is smaller. The effect on demand for product \( B \) when setting the price for product \( A \) work in a similar way and cancel out.

### Decentralized price setting with two downstream divisions

This subsection, represented in Figure 1(iii), will focus on a firm with one production facility manufacturing a single product and with two downstream divisions. This structure could represent a multinational firm manufacturing one product and then selling the product in two different countries. The markets are referred to as market 1 and market 2. The optimal price in market \( i \) from the point of view of the profit maximizing firm is as in section 3, that is, \( p_i = c - q_i \left( \frac{dq_i}{dp_i} \right)^{-1} \) since cross market effects play no role in determining the firm-optimal price in each market. With decentralized decision making the price for the product is determined locally. The price set in market \( i \), as in equation 3, will be:

\[
p_{d,i} = t - q_{d,i} \left( \frac{dq_{d,i}}{dp_{d,i}} \right)^{-1} + q_{d,i} \left( \frac{\partial t}{\partial q_{d,i}} \right) \tag{10}
\]

Under **market price transfer pricing**, the presence of an additional downstream division does not affect the transfer price set by the firm. The transfer price seen by each local decision maker is

\(^{12}(p_{d,B} - c_B - \eta_B) > (p_B - c_B) \Leftrightarrow (p_{d,B} - p_B) > \eta_B, \text{ and we know, through the equivalent of equation 18 for product } B \text{ that } p_{d,B} - p_B < \eta_B \text{ (unless the market demand function has unusual properties and the last four terms of equation 18 offset the negative effect of the second term.)}

\(^{13}\)This effect could be termed a source of economies of scope. Under market price transfer pricing within this organizational structure, the greater the number of products in a single division where a single manager is responsible for all final good prices, the closer the prices will be to the firm-level optimum.
\[ t = c + \eta, \text{ and again, } \frac{dt}{dq_{d,i}} = 0, \text{ so the local price set in each division is exceeds the optimal local price by the same amount as in the single-product, single-division case. The presence of another market does not affect the final goods price in market } i. \text{ Any observed local price differences across divisions are the result of varying local market conditions which determine the division-specific markup and how sensitive that markup is to quantity choices. That is, the local price distortion is independent of any firm activities in other markets under this transfer pricing method.}

In the most straightforward case of the full cost transfer pricing method, the product-level fixed cost is fully allocated across both markets. The transfer price faced in each market is 
\[ t = c + \frac{F}{q_i + q_j}, \text{ and } \frac{\partial t}{\partial q_i} = -\frac{F}{(q_i + q_j)^2}. \] 
It can be seen at once that this transfer pricing method will introduce cross-market dependencies in local price. The profit set by market 1, as derived in the appendix, is:

\[ p_{d,1} = c - q_{d,1} \left( \frac{dq_{d,1}}{dp_{d,1}} \right)^{-1} + \frac{q_{d,2} F}{(q_{d,1} + q_{d,2})^2} \] 

(11)

Unlike in the single market case with full cost transfer pricing, the increase in the per unit cost seen by the decision maker is not fully offset by the reduction in markup arising from the quantity effect on transfer price. There is a wedge between the centralized and decentralized prices which is a function of product-level fixed costs. As long as both markets sell positive quantities, this term will increase the price set in each market. In addition, the markup is affected if the price elasticity of demand differs at the centralized and decentralized quantities.

The larger the fraction of total product output sold elsewhere, the larger will be the local price distortion. This is because lowering price and raising quantity in division \( i \) reduces the transfer price for all units sold, both locally and in the other division. The greater the share of all units sold in the local division, the larger the share of this effect which is internalized by the local price-setter making him more likely to seek to increase quantity by lowering price\textsuperscript{14}.

Decentralized decision making in a multi-product, multi-division firm

The results in the previous two subsections extend quite naturally to this case. Consider a firm manufacturing two goods \( A \) and \( B \), each of which is sold in two markets \( 1 \) and \( 2 \), as set out in Figure 1(iv). The firm profit maximizing price for good \( A \) (and good \( B \), symmetrically) in each market is given in equation 6 and the decentralized division profit maximizing price for good \( A \) is given in equation 7.

In the market price transfer price method, the transfer price of each product in each market is independent of quantities. The prices set by the decentralized price setter will be as in equation

\textsuperscript{14}This part of the inefficiency introduced by decentralized decision-making is due to the fact that the centralized production facility is manufacturing only one product. If the firm were centrally manufacturing two goods, one for each market, the externality associated with reducing the per unit transfer price would be fully internalized by each division and efficient pricing in each would result.
9, that is:

\[
p_{d,A,i} = c_A + \eta_A - q_{d,A,i} \left( \frac{dq_{d,A,i}}{dp_{d,A,i}} \right)^{-1} - (p_{d,B,i} - c_B - \eta_B) \left( \frac{dq_{d,B,i}}{dp_{d,A,i}} \right) \left( \frac{dq_{d,A,i}}{dp_{d,A,i}} \right)^{-1}
\]  

(12)

As in the two product, single division case, the last term leads the manager to set price lower than the centralized case. Each customer that switches to product B is worth less to him since he generates less profit for the division. The term (partially) offsets the increase in price caused by \( \eta_A \). Once again, market price transfer pricing is less distortionary than in the single product case. This is due to the presence of two products in each market and not due to any effects resulting from the multi-market nature of the firm.

In the **full cost transfer pricing method** in market \( i \):

\[
t_A = c_A + \frac{F_A}{q_{d,A,1} + q_{d,A,2}}, \quad t_B = c_B + \frac{F_B}{q_{d,B,1} + q_{d,B,2}}
\]

\[
\frac{\partial t_A}{\partial q_{d,A,i}} = -\frac{F_A}{(q_{d,A,1} + q_{d,A,2})^2}, \quad \frac{\partial t_B}{\partial q_{d,B,i}} = -\frac{F_B}{(q_{d,B,1} + q_{d,B,2})^2}
\]

\[
\frac{\partial t_A}{\partial q_{d,B,i}} = \frac{\partial t_B}{\partial q_{d,A,i}} = 0
\]

Substituting these terms into equation 7 for market 1 gives

\[
p_{d,A,1} = c_A - q_{d,A,1} \left( \frac{dq_{d,A,1}}{dp_{d,A,1}} \right)^{-1} - (p_{d,B,1} - c_B) \left( \frac{dq_{d,B,1}}{dp_{d,A,1}} \right) \left( \frac{dq_{d,A,1}}{dp_{d,A,1}} \right)^{-1}
\]

(13)

The fourth term in equation 13 is the equivalent of the wedge term in equation 11 and arises because the local manager of market \( i \) does not internalize the effect of his marginal price reduction of good A total quantity sold and hence on the transfer price faced by the manager of the other market. The final term in equation 13 is negative and serves to partially offset the fourth term of this expression by a similar logic. If the manager of market \( i \) were to raise the price of A, he would sell more units of good B in market \( i \) reducing the transfer price of B in the other market. Again, this effect is not internalized by the local manager so he is less inclined to raise the price of A.

The prices set by decentralized decision makers in each organizational firm under different transfer pricing methods, compared to the relevant optimal price from the firm’s perspective, are summarized in table 1. The analysis extends to cases where firms sell many substitute products in each market and to when the firm has many decentralized downstream divisions.
5 Industry simulation of pricing outcomes

The analysis in the previous section has direct implications for a decentralized firm when choosing a method of transfer pricing. The magnitude of the distortion to price, and the corresponding reductions in firm profit relative to the centralized case, under each of the methods discussed above depend on the degree of competition in the upstream market, fixed costs, and factors related to the organizational structure of the firm such as the number of downstream divisions and the number of products per division. The accounting literature discusses which method is more appropriate in different contexts but spends relatively little time on how the optimal choice of transfer method interacts with the organizational form of the firm in question. This section explores some implications of price distortions arising from the interaction of organizational form and transfer price method for empirical analysis of the laundry detergents industry in the United Kingdom. Firm conduct and the impact of horizontal mergers will be analyzed in the context of this multiproduct, multimarket industry under different assumptions about the transfer pricing schemes in place.

The demand system for laundry detergent in the UK is estimated in Thomas (2008) using proprietary product-level data from the market research firm Europanel. Using a discrete choice random coefficients model, consumer demand for detergent characteristics is shown to vary across households in the UK. The typical consumer also exhibits differing relative preferences for various brands, formats, pack size and detergent price. The demand coefficients relevant to the UK are given in appendix table 1 and discussed in more detail in Thomas (2008). The market structure is simplified here so that there are 10 products on sale in the UK at any one time. Each of the major brands in the UK has one product on sale, and there are two Ariel products available in the market. Consumers can also purchase a supermarket own-brand product or a product that is not sold under one of the top brands. The products are a variety of formats – standard powder, liquids, and tablets – and either 15 washloads in pack size or 40 washloads in pack size.

For the purposes of this illustrative simulation, each product is assumed to have a per washload marginal cost of 0.2 euro. The parameters of the demand system are used to find the prices set for each product in the market under different pricing assumptions in a centralized firm and then also when the prices of Ariel products are decentralized to the UK market level and the local manager faces a per unit transfer price. The product characteristics of each product in the market are presented in the first column of table 2.

Prices resulting from a centralized, firm-level, decision

This subsection outlines how several research questions would be approached when it is assumed that the prices observed in the market are the outcome of a firm-level optimization process. One

---

15 This represents a significant simplification since, for the time period during which the demand system applied, around 180 detergent products were marketed by the top 20 detergent brands in the UK at any one time. In this interpretation of the model, each brand has one product (except Ariel, which has two). The products can be taken to represent brand averages for the top 10 brands. The non-linear solution method employed to find the prices set under each organizational form is much more efficient with fewer products.
question of interest is whether observed prices in this market reflect product-level market power, are set jointly at the brand level, or are the result of collusive behavior across firms in the industry. The approach taken to address this question is taken from Nevo (2001) which examines firm behavior in the US breakfast cereals industry. Under the assumption that pricing is centralized, the prices the firm would set can be found using equation 1 for single-product pricing, and equation 6 for brand-level pricing for the Ariel brand, where products \( A \) and \( B \) refer to the two Ariel products in the market. The prices set in a market where all firms collude can be found using an extended version of equation 6 which takes the cross-product effects of all products in the market into account:

\[
p_A = c_A - q_A \left( \frac{dq_A}{dp_A} \right)^{-1} - \sum_{j \in J \setminus A} (p_j - c_j) \left( \frac{dq_j}{dp_A} \right) \left( \frac{dq_A}{dp_A} \right)^{-1}
\]

(14)

Finding the equilibrium prices in each case involves solving a system of \( J + 1 \) non-linear equations, where a Gauss-Newton method is employed to find the root of the system\(^{16}\). Table 2 presents the price of each product in a centralized firm under each of the three pricing assumptions; single product pricing (column 1), brand-level pricing (column 3), and market collusion (column 5). The estimated markup over marginal cost is given in the column next to the price in each case. Focusing on the estimated markups for Ariel products, the market share-weighted average price increases from 0.26 to 0.28 to 0.36 as pricing behavior moves from single product to brand to collusive pricing. The market share-weighted markup over marginal cost goes from 32% to 42% to 80%.

It is more likely that a researcher observes prices rather than marginal costs when studying this market. Given the prices, the reverse of the above process will permit estimation of product-level marginal cost and markup under each of the three price setting assumptions. If prices are indeed set centrally, this process will yield correct estimates of marginal cost and markups. Given the three estimates of average markup corresponding to each price setting assumption, the researcher can then compare the estimates to the accounting statements of the firms in questions to ascertain which markup estimate matches actual markups most closely. For example, the Procter and Gamble income statement might report profitability by brand and by market. If the markup of total Ariel revenues in the UK over the cost of goods sold is closer to 40% than 30% or 80%, it can be inferred that pricing is optimal at the brand level.

Similar tools might also be used to estimate the impact on final good pricing of a horizontal merger in this industry. For example, if Ariel were to acquire the Persil product in the market which is given in row three of table 2, the change in prices in the two Ariel products and the Persil product could be estimated using a version of equation 14 which includes cross-product effects for each of the two other relevant products. If prices had originally been set at the brand level, as shown in columns 3 and 4, the impact of pricing the Persil product jointly with the two Ariel products is shown in columns 7 and 8 of table 2. The markup over marginal cost of the two Ariel products increases slightly, from an average of 42% to an average of 45%, and there is a large

---

\(^{16}\)The fsolve command in Matlab is used here and in all subsequent price and markup estimations. Starting prices are set at 0.2 per washload, equal to marginal cost.
increase in the markup over marginal cost of the Persil product from 22% to 45%. This horizontal merger is forecast to increase the market share-weighted average markup from 35% to 37%. The UK competition authorities might use this type of analysis as the basis for a decision about whether the proposed merger were anti-competitive in terms of reducing consumer surplus.

**Prices resulting from a decentralized decision under market price transfer pricing**

What if the prices of the two Ariel products were set by a UK based product manager whose compensation was related to the profitability of the brand in the UK and who faced a per unit transfer price from the production division? Following the process outlined above to assess policy questions, while appropriate for the centralized firm, leads to several potential pitfalls when the firm is decentralized. Under a market price transfer pricing method final product prices are higher than the firm-level optimal price under each price setting assumption, and using observed prices to estimate marginal costs without accounting for the transfer pricing markup leads to overestimates of marginal cost and underestimates of firm-wide markup. If the local manager sets the price of each product independently, the resulting prices are given in equation 4. If the local manager prices at the brand level then the prices observed would reflect equation 9. If the firms the market were collusive then prices would be the result of an extended version of equation 9 that includes cross-product terms for all other products in the market:

\[
p_A = c_A + \eta_A - q_A \left( \frac{dq_A}{dp_A} \right)^{-1} - \sum_{j \in J_A} (p_j - c_j - \eta_j) \left( \frac{dq_j}{dp_A} \right) \left( \frac{dq_A}{dp_A} \right)^{-1}
\]

(15)

For the purposes of this illustration, the two Ariel products are assumed to each have a transfer pricing markup of $\eta = 0.02$. The prices that would result under the three different final product pricing assumptions are given in table 3. Comparing column 1 of table 3 with column 1 of table 2, it can be seen that all product prices increase and the increase in the markup for Ariel products is particularly high, moving from a market share-weighted markup of 32% to 42%. Comparing columns 3 and 4 of table 2 with columns 5 and 6 of table 3, it can be seen that the distortion in the decentralized Ariel prices is smaller in magnitude in the brand-pricing outcome than in the single-product outcome. This is due to the distortion-offsetting effect of multiproduct pricing described in section 4. The distortion is actually larger in the case of collusive pricing. This is due to the fact that the difference in price elasticity of demand at the higher product prices and lower quantities in this outcome dominate the offsetting effect.

The presence of pricing distortions has implications for policy analysis. First, using the observed prices to estimate marginal costs without accounting for the transfer pricing markup leads to estimates that are too high by the value of $\eta$ where $\eta = 0.02$ in this case. Columns 3, 7 and 11 of table 3 present the marginal costs that would be inferred from observed prices. Markups are hence consistently underestimated. For example, the market share-weighted average Ariel markup
under brand-pricing is estimated to be 37% but the actual markup in this case is 51%. This means that researchers underestimate the degree of competitiveness in the market. A researcher observing income statement markups for Ariel of 51% might conclude that prices represent some level of collusion since brand-level pricing can justify markups of only 37%. In fact, margins of 51% are explained by brand-level pricing in the presence of a transfer price markup which is equivalent to 10% of the marginal cost.

Turning to the horizontal merger example, policy makers might take the prices observed in column 5 of table 3 and predict the effect on prices of a merger of Ariel with Persil. The demand system together with observed prices, absent allowances for transfer pricing, would yield the marginal cost estimates given in column 7. Estimating post-merger prices using the equivalent of equation 14 with cross-product effects for the Ariel and Persil products and using the marginal cost estimates in column 7 gives the price estimates presented in column 13. These post-merger prices are also predicted by a model with transfer pricing since equation 15 is equivalent to equation 14. However, if the merged entity were to apply the same decentralized decision making structure and transfer pricing method to the Persil product, the post-merger prices would be as given in column 15. There is a further increase in the price of the Persil product, driven mainly by the introduction of the double marginalization to final price. The prices of the two Ariel products are actually slightly lower than in column 13, due to the cross-product effects resulting from the price increase for Persil. In this case, competition authorities will underestimate the market level price increase resulting from the merger if they do not explicitly take into account the change in the organizational structure that determines Persil pricing.

**Prices resulting from a decentralized decision under full cost transfer pricing.**

What if the UK manager of the Ariel brand faced a per unit cost based on full cost transfer pricing? For illustrative purposes, it will be assumed that the per period fixed cost of each product is 10 million euros. If each product is priced independently then prices will be set as in equation 11, and if prices are set at the brand level then Ariel prices will be set as in equation 13, where products $A$ and $B$ refer to the two Ariel products\(^\text{17}\). Both these equations demonstrate that if the entire production quantity of each product is sold in the local market, then the price set by the decentralized price-setter is equal to the firm-level optimal price. Table 4 shows the pricing outcomes under each of these assumptions when $q_{d,2} = 0$ for the relevant products. Columns 1 and 5 show the single product and brand-level pricing outcomes, which are equal to columns 1 and 3, respectively, of table 2. Even though the decision maker does not see marginal cost when setting the local price, product-level marginal costs will be estimated correctly when assuming prices are the result of a firm-level optimization process, as shown in columns 3 and 7.

\(^{17}\)Since the number of products sold in the UK by a brand is not related to the price distortion under this transfer pricing method, the collusive outcome is not discussed here.
The analysis in section 5 sets out how pricing distortions arise under full cost transfer pricing when sales of a centrally produced product are distributed among several downstream markets. As part of the simplified illustration, it is now assumed that each Ariel product has a 25% market share of the German market. That is, the same product is sold in both the UK and Germany and the two markets share each product’s fixed cost so that their share is proportional to the share of output sold in each market. If the UK manager is pricing at the brand level, the prices he would set in this scenario are given in column 9 of table 4. The brand-level market share-weighted markup over marginal cost of Ariel products in the UK is now 44%, rather than 42% which is the markup when each product is sold only in the UK.

A researcher observing the prices in column 9 of table 4, and assuming they represent the firm-optimal prices, would estimate the marginal costs given in column 11. Once more, marginal cost estimates are overstated and product-level markups are underestimated. The researcher may then conclude that market pricing is less competitive than it actually is since the estimated markups under brand-level pricing are systematically lower than the actual markups which result from brand-level pricing in this organizational structure. This occurs only, as noted above, when products are sold in several markets and fixed costs are shared across all units.

Turning to the horizontal merger analysis, if the merged entity does not begin to sell units of Persil in other markets, the merger of the Ariel and Persil brands is forecast to increase the market share-weighted average price from 0.27 to 0.28. The product-level prices pre- and post-merger are given in columns 9 and 13 respectively. In this case, not taking account of the decentralization leads policy makers to overestimate the price impact of the merger. Using the marginal cost estimates given in column 11 that were inferred from observed prices by assuming they were the firm-optimal prices, the policy maker will forecast post-merger prices to be the prices given in column 15 of table 4.

What if the merged firm also decides to sell Persil products in Germany? It is now assumed that the Persil product has a 25% market share in Germany and the product-level fixed costs of each product are unaffected by the merger. In this case, the final goods prices set by the UK manager pricing the Ariel and Persil products together are given in column 17. The prices of the two Ariel product are lower than in the case where no Persil product was sold in Germany. This is because the UK manager earns a lower markup for each unit of Persil sold, so the marginal gain from a customer that switches from an Ariel product to the Persil product when Ariel prices rise is reduced. The price of the Persil product increases, but the market share-weighted average price is actually lower than would be forecast by policy makers starting with the overestimated marginal costs for the Ariel products. The merger will increase price levels, moving from column 9 of table 4 to column 17. However, the post-merger prices will be lower than the estimates given in column 15 which are forecast by policy makers.
**Discussion and summary**

First, it can be seen that using observed prices to make inferences about firm conduct, as represented by the markup over marginal cost, is problematic when price setting decision making is decentralized. It is no longer sufficient to use the assumption of Bertrand competition in prices as a means by which marginal costs and markups can be estimated from observed prices. A clearer specification of the decision maker’s objective function is required. The transfer pricing methodology and the organizational form are the first pieces of new information that are needed. These can then be used together to ascertain what other data is needed in order to estimate marginal costs and conduct parameters. Unless the firm uses full cost transfer pricing for a single downstream division, marginal cost and markups cannot be separately identified without additional data. If the firm uses market price transfer pricing, the external market markup over marginal cost for each product manufactured by the firm sold in the downstream market in question is required. One advantage arising from this transfer pricing method is that no information about other markets is required. In contrast, for fixed cost transfer pricing, when the firm is active in two or more markets, the fixed costs associated with each product and the equilibrium quantities sold in each market must be known in order to make inferences about conduct.

Second, the interaction of transfer price method and organizational form has implications for horizontal merger analysis. The FTC’s horizontal merger guidelines (1997 revision) set out how the agency determines whether a proposed merger is "likely substantially to lessen competition" (p.3). The focus is on market power, and whether the merged entity would find it optimal to exert increased market power, that is, increase prices. The results in this paper demonstrate another possible source of inefficiency arising from horizontal mergers. In the case of localized price setting, organizational form has a direct effect on final goods prices and the act of changing the number of products manufactured within the firm, or the number of local markets in which centrally produced products are sold, can effect prices in all markets. In addition, if the merger involves a change in transfer pricing method in either one of the merging firms, there will be further implications for post-merger prices.

These are just two examples of how the assumption that firms price optimally may lead to incorrect inferences in industry analysis. More broadly, the analysis set out in section 4 applies to many of the questions typically studied in differentiated product markets. Recent papers have discussed the role played by product differentiation in estimating firm-level productivity. Even if firm-level prices were observed, attempting to separate product differentiation from the effect of organizational form and transfer price on final goods price would require additional information.

**6 Conclusion**

One of the strengths of single-industry empirical industrial organization studies, as noted by Einav and Nevo (2006), is that researchers are able to incorporate industry-specific characteristics into
models of firm behavior in the industry. Many studies of differentiated product industries analyze the implications of imperfect competition for welfare, new product development, merger analysis, and other counterfactual situations. Most recent papers employ, or test, an assumption about price setting behavior taking as given that the firm sets prices to maximize firm-level profit. It is widely known that many differentiated product industries, such as consumer goods, are dominated by multidivisional firms where decision making about final goods pricing is decentralized to the divisional level. The assumption that local division managers price to optimize firm-level profit is often inappropriate since division managers tend to face local incentives.

Decentralized decision making with local incentives creates the need for some sort of transfer price for goods and services traded within the firm. The managerial accounting literature generally acknowledges that widely-used transfer pricing schemes represent a compromise of some sort and may lead to sub-optimal pricing outcomes. In particular, the final goods prices set in local markets can no longer be assumed to reflect marginal cost and an optimal markup over markup cost that can be estimated from the demand system alone. The extent of the distortion away from firm profit maximizing price is shown here to depend on the organizational form of the firm, the transfer pricing method in place, and the interaction of the two. Even if the decentralized firm is assumed to choose the transfer pricing scheme that minimizes the distortion given its organizational form, the nature of the distortion may confound inferences made in empirical counterfactual analysis. For example, in the context of the UK laundry detergents industry, assuming observed prices are the result of a firm-profit maximizing decision can lead to the underestimation of the extent of firm competitiveness in the market. Analyzing the implications of a horizontal merger without explicitly modeling organizational structure can lead policy makers to underestimate or overestimate the post-merger prices.

Broadly speaking, under the standard assumption of Bertrand pricing, market price transfer pricing incurs the largest distortions away from optimal price in decentralized firms where the decision maker faces incentives related to the division profitability of only one product, rather than having joint pricing responsibility for many products. Full cost transfer pricing incurs the largest distortions when centrally manufactured products are sold in many downstream divisions. The distortion under this transfer pricing method is not affected by the number of products for which a local decision maker sets prices.

The main aim of this paper is to draw attention to the potential benefit of including information about internal firm organization when designing the industry-specific model of firm behavior in empirical analysis. Internal firm organization includes the extent of decentralized decision making, the organizational structure in terms of the number of products and number of divisions, and the transfer pricing scheme employed in the firm. In sum, the organization of the firm along these dimensions influences how best to structure the study of the organization of the industry.
References


Appendix

Full cost transfer pricing in a single product, single downstream division firm.

The marketing division manager’s objective function is expressed in equation 2 as:

\[ \pi_d = (p_d - t(q(p_d)))q(p_d) - F_d \]

The first order condition for division profit maximization, conditional on the transfer pricing scheme, is the total derivative of this objective function \( \pi_d \) with respect to \( p_d \):

\[
p_d \frac{dq_d}{dp_d} + q_d - \left[ t \frac{dq_d}{dp_d} + q_d \left( \frac{\partial t}{\partial q_d} \frac{dq_d}{dp_d} \right) \right] = 0
\]

The division manager will hence choose \( p_d \) so that:

\[
p_d = t - q_d \left( \frac{dq_d}{dp_d} \right)^{-1} + q_d \left( \frac{\partial t}{\partial q_d} \frac{dq_d}{dp_d} \right) \left( \frac{dq_d}{dp_d} \right)^{-1}
\]

The distortion in price when compared to the centralized price, \( p \), is:

\[
p_d - p = t - c - q_d \left[ \left( \frac{dq_d}{dp_d} \right)^{-1} - \frac{\partial t}{\partial q_d} \right] + q \left( \frac{dq}{dp} \right)^{-1}
\]

Under market price transfer pricing, substituting equations 1 and 4 into equation 16 gives the magnitude of the price distortion as:

\[
p_d - p = \eta - q_d \left( \frac{dq_d}{dp_d} \right)^{-1} + q \left( \frac{dq}{dp} \right)^{-1}
\]

Under full cost transfer pricing, \( t = c + F/q_d \) and \( \partial t/\partial q_d = (-F/q_d^2) \), giving

\[
p_d = c + \frac{F}{q_d} - q_d \left( \frac{dq_d}{dp_d} \right)^{-1} + q_d \left( \frac{-F}{q_d^2} \right)
\]

\[
= c + \frac{F}{q_d} - q_d \left( \frac{dq_d}{dp_d} \right)^{-1} - \left( \frac{F}{q_d} \right)
\]

\[
= c - q_d \left( \frac{dq_d}{dp_d} \right)^{-1}
\]

and there is no distortion to the final good price.
Multiproduct firms in a single downstream division case

In the decentralized case, the division manager chooses $p_A$ and $p_B$ to maximize equation 7:

$$\pi_d = (p_{d,A} - t_A (q_{d,A} (p_{d,A}, p_{d,B}), q_{d,B} (p_{d,A}, p_{d,B}))) q_{d,A} (p_{d,A}, p_{d,B})$$
$$+ (p_{d,B} - t_B (q_{d,A} (p_{d,A}, p_{d,B}), q_{d,B} (p_{d,A}, p_{d,B}))) q_{d,B} (p_{d,A}, p_{d,B}) - F$$

The first order condition for product $A$ can be written

$$0 = q_{d,A} + p_{d,A} \left( \frac{dq_{d,A}}{dp_{d,A}} \right) - \left[ t_A \frac{dq_{d,A}}{dp_{d,A}} + q_{d,A} \left( \frac{\partial t_A}{\partial q_{d,A}} \frac{dq_{d,A}}{dp_{d,A}} + \frac{\partial t_A}{\partial q_{d,B}} \frac{dq_{d,B}}{dp_{d,A}} \right) \right]$$
$$+ p_{d,B} \left( \frac{dq_{d,B}}{dp_{d,A}} \right) - \left[ t_B \frac{dq_{d,B}}{dp_{d,A}} + q_{d,B} \left( \frac{\partial t_B}{\partial q_{d,A}} \frac{dq_{d,A}}{dp_{d,A}} + \frac{\partial t_B}{\partial q_{d,B}} \frac{dq_{d,B}}{dp_{d,A}} \right) \right]$$

Solving this expression for the decentralized price of product $A$ gives:

$$p_{d,A} = t_A - q_{d,A} \left( \frac{dq_{d,A}}{dp_{d,A}} \right)^{-1} - (p_{d,B} - t_B) \frac{dq_{d,B}}{dp_{d,A}} \left( \frac{dq_{d,A}}{dp_{d,A}} \right)^{-1} + q_{d,A} \left( \frac{\partial t_A}{\partial q_{d,A}} \right) + q_{d,B} \left( \frac{\partial t_B}{\partial q_{d,A}} \right)$$
$$+ q_{d,A} \left( \frac{\partial t_A}{\partial q_{d,B}} \frac{dq_{d,B}}{dp_{d,A}} \left( \frac{dq_{d,A}}{dp_{d,A}} \right)^{-1} \right) + q_{d,B} \left( \frac{\partial t_B}{\partial q_{d,B}} \frac{dq_{d,A}}{dp_{d,A}} \left( \frac{dq_{d,A}}{dp_{d,A}} \right)^{-1} \right)$$

The distortion in price under market price transfer pricing where each product has a fixed markup $\eta_A$ and $\eta_B$ respectively gives:

$$p_{d,A} - p_A = \eta_A + \eta_B \left( \frac{dq_{d,B}}{dp_{d,A}} \right) \left( \frac{dq_{d,A}}{dp_{d,A}} \right)^{-1} + q_A \left( \frac{dq_{A}}{dp_{A}} \right)^{-1} - q_{d,A} \left( \frac{dq_{d,A}}{dp_{d,A}} \right)^{-1}$$
$$- (p_{d,B} - c_B) \left( \frac{dq_{d,B}}{dp_{d,A}} \right) \left( \frac{dq_{d,A}}{dp_{d,A}} \right)^{-1} + (p_B - c_B) \left( \frac{dq_{B}}{dp_{A}} \right) \left( \frac{dq_{A}}{dp_{A}} \right)^{-1}$$

(18)

In the full cost transfer pricing case – written out here because the algebra is more complex than in the market price method – the relevant terms are:

$$t_A = c_A + \frac{F_A}{q_{d,A}}, t_B = c_B + \frac{F_B}{q_{d,B}}$$
$$\frac{\partial t_A}{\partial q_{d,A}} = -\frac{F_A}{q_{d,A}^2}, \frac{\partial t_B}{\partial q_{d,B}} = -\frac{F_B}{q_{d,B}^2}, \frac{\partial t_A}{\partial q_{d,B}} = \frac{\partial t_B}{\partial q_{d,A}} = 0$$

22
Substituting these terms into the expression for the decentralized price of product \( A \) gives:

\[
\begin{align*}
    p_{d,A} &= c_A + \frac{F_A}{q_{d,A}} - q_{d,A} \left( \frac{dq_{d,A}}{dp_{d,A}} \right)^{-1} - \left( p_{d,B} - c_B - \frac{F_B}{q_{d,B}} \right) \frac{dq_{d,B}}{dp_{d,A}} \left( \frac{dq_{d,A}}{dp_{d,A}} \right)^{-1} \\
    &+ q_{d,A} \left( -\frac{F_A}{q_{d,A}^2} \right) + q_{d,B} \left( -\frac{F_B}{q_{d,B}^2} \frac{dq_{d,A}}{dp_{d,A}} \left( \frac{dq_{d,A}}{dp_{d,A}} \right)^{-1} \right) \\
    &= c_A + \frac{F_A}{q_{d,A}} - q_{d,A} \left( \frac{dq_{d,A}}{dp_{d,A}} \right)^{-1} - \left( p_{d,B} - c_B - \frac{F_B}{q_{d,B}} \right) \frac{dq_{d,B}}{dp_{d,A}} \left( \frac{dq_{d,A}}{dp_{d,A}} \right)^{-1} \\
    &- \left( \frac{F_A}{q_{d,A}} \right) - \left( \frac{F_B}{q_{d,B}} \frac{dq_{d,B}}{dp_{d,A}} \left( \frac{dq_{d,A}}{dp_{d,A}} \right)^{-1} \right) \\
    &= c_A - q_{d,A} \left( \frac{dq_{d,A}}{dp_{d,A}} \right)^{-1} - \left( p_{d,B} - c_B \right) \frac{dq_{d,B}}{dp_{d,A}} \left( \frac{dq_{d,A}}{dp_{d,A}} \right)^{-1}
\end{align*}
\]

The distortion in price is hence:

\[
\begin{align*}
    p_{d,A} - p_A &= \eta_A + \eta_B \left( \frac{dq_{d,B}}{dp_{d,A}} \right) \left( \frac{dq_{d,A}}{dp_{d,A}} \right)^{-1} + q_A \left( \frac{dq_{A}}{dp_A} \right)^{-1} - q_{d,A} \left( \frac{dq_{d,A}}{dp_{d,A}} \right)^{-1} \\
    &- \left( p_{d,B} - c_B \right) \frac{dq_{d,B}}{dp_{d,A}} \left( \frac{dq_{d,A}}{dp_{d,A}} \right)^{-1} + \left( p_B - c_B \right) \left( \frac{dq_{B}}{dp_B} \right) \left( \frac{dq_{A}}{dp_A} \right)^{-1}
\end{align*}
\]  \( (19) \)

**Single product firms with two downstream divisions**

The first order condition in market \( i \) is given by equation 10 is:

\[
p_{d,i} = t - q_{d,i} \left( \frac{dq_{d,i}}{dp_{d,i}} \right)^{-1} + q_{d,i} \left( \frac{\partial t}{\partial q_{d,i}} \right)
\]

The relevant terms in the case of full cost transfer pricing are: \( t = c + \frac{F}{q_{d,1} + q_{d,2}} \), and \( \frac{\partial t}{\partial q_{d,i}} = \frac{-F}{(q_{d,1} + q_{d,2})^2} \). Substituting these terms into equation 10 for the price set in market 1 gives:

\[
\begin{align*}
    p_{d,1} &= c + \frac{F}{q_{d,1} + q_{d,2}} - q_{d,1} \left( \frac{dq_{d,1}}{dp_{d,1}} \right)^{-1} + q_{d,1} \left( \frac{-F}{(q_{d,1} + q_{d,2})^2} \right) \\
    &= c + \frac{F (q_{d,1} + q_{d,2}) - F q_{d,1}}{(q_{d,1} + q_{d,2})^2} - q_{d,1} \left( \frac{dq_{d,1}}{dp_{d,1}} \right)^{-1} \\
    &= c - q_{d,1} \left( \frac{dq_{d,1}}{dp_{d,1}} \right)^{-1} + \frac{q_{d,2} F}{(q_{d,1} + q_{d,2})^2}
\end{align*}
\]

The distortion away from the centralized profit maximizing price in market 1 is:

\[
    p_d - p = q_1 \left( \frac{dq_1}{dp_1} \right)^{-1} - q_{d,1} \left( \frac{dq_{d,1}}{dp_{d,1}} \right)^{-1} + \frac{q_{d,2} F}{(q_{d,1} + q_{d,2})^2}
\]  \( (20) \)

23
Multiproduct, multi-downstream division firm.

The decentralized final goods price in market $i$ for product $A$ will be as in the two products, one division case:

$$p_{d,A,i} = t_A - q_{d,A,i} \left( \frac{dq_{d,A,i}}{dp_{d,A,i}} \right)^{-1} - \left( p_{d,B,i} - t_B \right) \frac{dq_{d,B,i}}{dp_{d,A,i}} \left( \frac{dq_{d,A,i}}{dp_{d,A,i}} \right)^{-1} + q_{d,A,i} \left( \frac{\partial t_A}{\partial q_{d,A,i}} \right) + q_{d,B,i} \left( \frac{\partial t_B}{\partial q_{d,B,i}} \right) \frac{dq_{d,B,i}}{dp_{d,A,i}} + q_{d,A,i} \left( \frac{\partial t_A}{\partial q_{d,A,i}} \right)$$

(21)

As in the one product, two division case, however, cross market dependencies are introduced under the full cost transfer pricing method. In market 1, we have

$$t_A = c_A + \frac{F_A}{q_{d,A,1} + q_{d,A,2}}, t_B = c_B + \frac{F_B}{q_{d,B,1} + q_{d,B,2}}, \left( \frac{\partial t_A}{\partial q_{d,A,i}} \right) = -\frac{F_A}{(q_{d,A,1} + q_{d,A,2})^2}, \left( \frac{\partial t_B}{\partial q_{d,B,i}} \right) = -\frac{F_B}{(q_{d,B,1} + q_{d,B,2})^2}$$

$$\left( \frac{\partial t_A}{\partial q_{d,B,i}} \right) = \frac{\partial t_B}{\partial q_{d,A,i}} = 0$$

Substituting these terms into equation 21 reveals that the local decision maker will set prices so that:

$$p_{d,A,1} = t_A - q_{d,A,1} \left( \frac{dq_{d,A,1}}{dp_{d,A,1}} \right)^{-1} - \left( p_{d,B,1} - t_B \right) \frac{dq_{d,B,1}}{dp_{d,A,1}} \left( \frac{dq_{d,A,1}}{dp_{d,A,1}} \right)^{-1} + q_{d,A,1} \left( \frac{\partial t_A}{\partial q_{d,A,1}} \right) + q_{d,B,1} \left( \frac{\partial t_B}{\partial q_{d,B,1}} \right) \frac{dq_{d,B,1}}{dp_{d,A,1}} + q_{d,A,1} \left( \frac{\partial t_A}{\partial q_{d,A,1}} \right)$$

$$p_{d,A,1} = c_A + \frac{F_A}{q_{d,A,1} + q_{d,A,2}} - q_{d,A,1} \left( \frac{dq_{d,A,1}}{dp_{d,A,1}} \right)^{-1} - \left( p_{d,B,1} - c_B + \frac{F_B}{q_{d,B,1} + q_{d,B,2}} \right) \frac{dq_{d,B,1}}{dp_{d,A,1}} \left( \frac{dq_{d,A,1}}{dp_{d,A,1}} \right)^{-1} + q_{d,A,1} \left( \frac{\partial t_A}{\partial q_{d,A,1}} \right) + q_{d,B,1} \left( \frac{\partial t_B}{\partial q_{d,B,1}} \right) \frac{dq_{d,B,1}}{dp_{d,A,1}} \left( \frac{dq_{d,A,1}}{dp_{d,A,1}} \right)^{-1}$$

$$p_{d,A,1} = c_A - q_{d,A,1} \left( \frac{dq_{d,A,1}}{dp_{d,A,1}} \right)^{-1} - \left( p_{d,B,1} - c_B \right) \frac{dq_{d,B,1}}{dp_{d,A,1}} \left( \frac{dq_{d,A,1}}{dp_{d,A,1}} \right)^{-1} + \frac{F_A}{q_{d,A,1} + q_{d,A,2}} + \frac{F_B}{q_{d,B,1} + q_{d,B,2}} \frac{dq_{d,B,1}}{dp_{d,A,1}} \left( \frac{dq_{d,A,1}}{dp_{d,A,1}} \right)^{-1} - \left( \frac{q_{d,A,1} F_A}{(q_{d,A,1} + q_{d,A,2})^2} \right) - \left( \frac{q_{d,B,1} F_B}{(q_{d,B,1} + q_{d,B,2})^2} \right) \frac{dq_{d,B,1}}{dp_{d,A,1}} \left( \frac{dq_{d,A,1}}{dp_{d,A,1}} \right)^{-1}$$

24
\[ p_{d,A,1} = c_A - q_{d,A,1} \left( \frac{dq_{d,A,1}}{dp_{d,A,1}} \right)^{-1} - (p_{d,B,1} - c_B) \frac{dq_{d,B,1}}{dp_{d,A,1}} \left( \frac{dq_{d,A,1}}{dp_{d,A,1}} \right)^{-1} \]

\[ + \left( \frac{F_A q_{d,A,2}}{(q_{d,A,1} + q_{d,A,2})^2} \right) + \left( \frac{q_{d,B,1} F_B + q_{d,B,2} F_B}{(q_{d,B,1} + q_{d,B,2})^2} \right) \frac{dq_{d,B,1}}{dp_{d,A,1}} \left( \frac{dq_{d,A,1}}{dp_{d,A,1}} \right)^{-1} \]

\[ p_{d,A,1} = c_A - q_{d,A,1} \left( \frac{dq_{d,A,1}}{dp_{d,A,1}} \right)^{-1} - (p_{d,B,1} - c_B) \frac{dq_{d,B,1}}{dp_{d,A,1}} \left( \frac{dq_{d,A,1}}{dp_{d,A,1}} \right)^{-1} \]

\[ + \left( \frac{F_A q_{d,A,2}}{(q_{d,A,1} + q_{d,A,2})^2} \right) + \left( \frac{q_{d,B,1} F_B}{(q_{d,B,1} + q_{d,B,2})^2} \right) \frac{dq_{d,B,1}}{dp_{d,A,1}} \left( \frac{dq_{d,A,1}}{dp_{d,A,1}} \right)^{-1} \]

The distortion to price for product A in market 1 is given by

\[ p_{d,A,1} - p_{A,1} = q_{A,1} \left( \frac{dq_{A,1}}{dp_{A,1}} \right)^{-1} - q_{d,A,1} \left( \frac{dq_{d,A,1}}{dp_{d,A,1}} \right)^{-1} \]

\[ + (p_{B,1} - c_B) \frac{dq_{B,1}}{dp_{A,1}} \left( \frac{dq_{A,1}}{dp_{A,1}} \right)^{-1} - (p_{d,B,1} - c_B) \frac{dq_{d,B,1}}{dp_{d,A,1}} \left( \frac{dq_{d,A,1}}{dp_{d,A,1}} \right)^{-1} \]

\[ + \left( \frac{F_A q_{d,A,2}}{(q_{d,A,1} + q_{d,A,2})^2} \right) + \left( \frac{q_{d,B,2} F_B}{(q_{d,B,1} + q_{d,B,2})^2} \right) \frac{dq_{d,B,1}}{dp_{d,A,1}} \left( \frac{dq_{d,A,1}}{dp_{d,A,1}} \right)^{-1} \]
Table 1: Final goods pricing under different organizational forms and transfer pricing methods

Product $A$ price in market 1 as a function of whether there is a product $B$ and/or a market 2.

<table>
<thead>
<tr>
<th></th>
<th>Centralized price</th>
<th>Under market price transfer pricing</th>
<th>Under full cost transfer pricing</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 product, 1 division</td>
<td>1</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>2 products, 1 division</td>
<td>2</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>1 product, 2 divisions</td>
<td>1</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>2 products, 2 divisions</td>
<td>2</td>
<td>4</td>
<td>6</td>
</tr>
</tbody>
</table>

Key

1. $p = c_A - q_A \left( \frac{dq_A}{dp_A} \right)^{-1}$

2. $p = c_A - q_A \left( \frac{dq_A}{dp_A} \right)^{-1} - (p_B - c_B) \left( \frac{dq_B}{dp_A} \right) \left( \frac{dq_A}{dp_A} \right)^{-1}$

3. $p = c_A + \eta_A - q_{d, A} \left( \frac{dq_{d, A}}{dp_{d, A}} \right)^{-1}$

4. $p = c_A + \eta_A - q_{d, A} \left( \frac{dq_{d, A}}{dp_{d, A}} \right)^{-1} - (p_{d, B} - c_B - \eta_B) \left( \frac{dq_{d, B}}{dp_{d, A}} \right) \left( \frac{dq_{d, A}}{dp_{d, A}} \right)^{-1}$

5. $p = c_A - q_{d,1} \left( \frac{dq_{d,1}}{dp_{d,1}} \right)^{-1} + \frac{q_{d,2}F}{(q_{d,1} + q_{d,2})^2}$

6. $p = c_A - q_{d, A} \left( \frac{dq_{d, A}}{dp_{d, A}} \right)^{-1} - (p_{d, B} - c_B) \frac{dq_{d, B}}{dp_{d, B}} \left( \frac{dq_{d, A}}{dp_{d, A}} \right)^{-1} + \left( \frac{F_A q_{d, A,2}}{(q_{d, A,1} + q_{d, A,2})^2} \right) + \left( \frac{F_B q_{d, B,2}}{(q_{d, B,1} + q_{d, B,2})^2} \right) \frac{dq_{d, B,1}}{dp_{d, A,1}} \left( \frac{dq_{d, A,1}}{dp_{d, A,1}} \right)^{-1}$

---

The decentralized quantities, prices, and price elasticities of demand at those prices and quantities, differ across outcomes.
Table 2: Centralized price setting under different pricing assumptions

<table>
<thead>
<tr>
<th>Product Number Product Description</th>
<th>Single product pricing</th>
<th>Brand-level Pricing</th>
<th>Collusive pricing</th>
<th>Brand-level pricing if Ariel were to acquire Persil</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Price per washload, euro</td>
<td>Markup over actual marginal cost, %</td>
<td>Price per washload, euro</td>
<td>Markup over actual marginal cost, %</td>
</tr>
<tr>
<td>1 Ariel, 15 washload, tablets</td>
<td>0.2705</td>
<td>35.24</td>
<td>0.2846</td>
<td>42.31</td>
</tr>
<tr>
<td>2 Ariel, 40 washload, standard liquid</td>
<td>0.2480</td>
<td>24.02</td>
<td>0.2829</td>
<td>41.43</td>
</tr>
<tr>
<td>3 Persil, 15 washload, standard powder</td>
<td>0.2446</td>
<td>22.28</td>
<td>0.2448</td>
<td>22.40</td>
</tr>
<tr>
<td>4 Surf, 40 washload, standard powder</td>
<td>0.2417</td>
<td>20.86</td>
<td>0.2417</td>
<td>20.87</td>
</tr>
<tr>
<td>5 Bold, 15 washload, standard powder</td>
<td>0.2437</td>
<td>21.85</td>
<td>0.2438</td>
<td>21.90</td>
</tr>
<tr>
<td>6 Daz, 40 washload, standard powder</td>
<td>0.2420</td>
<td>21.02</td>
<td>0.2421</td>
<td>21.05</td>
</tr>
<tr>
<td>7 Fairy, 15 washload, standard powder</td>
<td>0.2443</td>
<td>22.17</td>
<td>0.2445</td>
<td>22.27</td>
</tr>
<tr>
<td>8 Dreft, 40 washload, standard powder</td>
<td>0.2442</td>
<td>22.12</td>
<td>0.2446</td>
<td>22.32</td>
</tr>
<tr>
<td>9 Ecover, 15 washload, standard powder</td>
<td>0.2450</td>
<td>22.50</td>
<td>0.2453</td>
<td>22.66</td>
</tr>
<tr>
<td>10 Supermarket brand, 40 washload, standard powder</td>
<td>0.2416</td>
<td>20.79</td>
<td>0.2416</td>
<td>20.79</td>
</tr>
<tr>
<td>Average Ariel products</td>
<td>0.2643</td>
<td>32.15</td>
<td>0.2842</td>
<td>42.12</td>
</tr>
<tr>
<td>Average Ariel and Persil products</td>
<td>0.2628</td>
<td>31.4</td>
<td>0.2804</td>
<td>40.2</td>
</tr>
<tr>
<td>Average Market</td>
<td>0.2579</td>
<td>28.97</td>
<td>0.2691</td>
<td>34.57</td>
</tr>
</tbody>
</table>
Table 3: Decentralized price setting under different pricing assumptions, with Market Price Transfer Pricing

<table>
<thead>
<tr>
<th>Product Number</th>
<th>Product Description</th>
<th>Single product pricing</th>
<th>Brand-level Pricing</th>
<th>Collusive pricing</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Price per washload, euro</td>
<td>Markup over actual marginal cost, %</td>
<td>Estimated marginal cost, euro</td>
</tr>
<tr>
<td>1</td>
<td>Ariel, 15 washload, tablets</td>
<td>0.2893</td>
<td>44.67</td>
<td>0.2200</td>
</tr>
<tr>
<td>2</td>
<td>Ariel, 40 washload, standard liquid</td>
<td>0.2679</td>
<td>33.96</td>
<td>0.2200</td>
</tr>
<tr>
<td>3</td>
<td>Persil, 15 washload, standard powder</td>
<td>0.2448</td>
<td>22.42</td>
<td>0.2200</td>
</tr>
<tr>
<td>4</td>
<td>Surf, 40 washload, standard powder</td>
<td>0.2418</td>
<td>20.88</td>
<td>0.2200</td>
</tr>
<tr>
<td>5</td>
<td>Bold, 15 washload, standard powder</td>
<td>0.2438</td>
<td>21.92</td>
<td>0.2200</td>
</tr>
<tr>
<td>6</td>
<td>Daz, 40 washload, standard powder</td>
<td>0.2421</td>
<td>21.07</td>
<td>0.2200</td>
</tr>
<tr>
<td>7</td>
<td>Fairy, 15 washload, standard powder</td>
<td>0.2446</td>
<td>22.29</td>
<td>0.2200</td>
</tr>
<tr>
<td>8</td>
<td>Dref, 40 washload, standard powder</td>
<td>0.2447</td>
<td>22.33</td>
<td>0.2200</td>
</tr>
<tr>
<td>9</td>
<td>Ecover, 15 washload, standard powder</td>
<td>0.2453</td>
<td>22.67</td>
<td>0.2200</td>
</tr>
<tr>
<td>10</td>
<td>Supermarket brand, 40 washload, standard powder</td>
<td>0.2416</td>
<td>20.80</td>
<td>0.2200</td>
</tr>
<tr>
<td></td>
<td>Average Ariel products</td>
<td>0.2836</td>
<td>41.81</td>
<td>0.2200</td>
</tr>
<tr>
<td></td>
<td>Average Ariel and Persil products</td>
<td>0.2788</td>
<td>39.92</td>
<td>0.2200</td>
</tr>
<tr>
<td></td>
<td>Average Market</td>
<td>0.2888</td>
<td>34.40</td>
<td>0.2200</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Product Number</th>
<th>Product Description</th>
<th>Brand-level pricing if Ariel were to acquire Persil</th>
<th>Brand-level pricing if Ariel were to acquire Persil and apply transfer pricing</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Price per washload, euro</td>
<td>Markup over actual marginal cost, %</td>
</tr>
<tr>
<td>1</td>
<td>Ariel, 15 washload, tablets</td>
<td>0.3084</td>
<td>54.20</td>
</tr>
<tr>
<td>2</td>
<td>Ariel, 40 washload, standard liquid</td>
<td>0.3066</td>
<td>53.32</td>
</tr>
<tr>
<td>3</td>
<td>Persil, 15 washload, standard powder</td>
<td>0.2839</td>
<td>41.96</td>
</tr>
<tr>
<td>4</td>
<td>Surf, 40 washload, standard powder</td>
<td>0.2419</td>
<td>20.94</td>
</tr>
<tr>
<td>5</td>
<td>Bold, 15 washload, standard powder</td>
<td>0.2441</td>
<td>22.05</td>
</tr>
<tr>
<td>6</td>
<td>Daz, 40 washload, standard powder</td>
<td>0.2423</td>
<td>21.16</td>
</tr>
<tr>
<td>7</td>
<td>Fairy, 15 washload, standard powder</td>
<td>0.2450</td>
<td>22.48</td>
</tr>
<tr>
<td>8</td>
<td>Dref, 40 washload, standard powder</td>
<td>0.2453</td>
<td>22.67</td>
</tr>
<tr>
<td>9</td>
<td>Ecover, 15 washload, standard powder</td>
<td>0.2459</td>
<td>22.94</td>
</tr>
<tr>
<td>10</td>
<td>Supermarket brand, 40 washload, standard powder</td>
<td>0.2417</td>
<td>20.84</td>
</tr>
<tr>
<td></td>
<td>Average Ariel products</td>
<td>0.308</td>
<td>54.01</td>
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<tr>
<td></td>
<td>Average Ariel and Persil products</td>
<td>0.3062</td>
<td>53.10</td>
</tr>
<tr>
<td></td>
<td>Average Market</td>
<td>0.2823</td>
<td>41.16</td>
</tr>
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</table>
### Table 4: Decentralized price setting under different pricing assumptions, with Full Cost Transfer Pricing

<table>
<thead>
<tr>
<th>Product Number</th>
<th>Product Description</th>
<th>Single product pricing</th>
<th></th>
<th></th>
<th>Brand-level Pricing</th>
<th></th>
<th></th>
<th>Brand level pricing, Ariel products sold also in Germany</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Price per washload, euro</td>
<td>Markup over actual marginal cost, %</td>
<td>Estimated marginal cost, euro</td>
<td>Estimated markup, %</td>
<td>Price per washload, euro</td>
<td>Markup over actual marginal cost, %</td>
<td>Estimated marginal cost, euro</td>
<td>Estimated markup, %</td>
<td>Price per washload, euro</td>
</tr>
<tr>
<td>1</td>
<td>Ariel, 15 washload, tablets</td>
<td>0.2705</td>
<td>35.24</td>
<td>0.2000</td>
<td>35.24</td>
<td>0.2846</td>
<td>44.31</td>
<td>0.2000</td>
<td>44.31</td>
<td>0.2883</td>
</tr>
<tr>
<td>2</td>
<td>Ariel, 40 washload, standard liquid</td>
<td>0.2480</td>
<td>24.02</td>
<td>0.2000</td>
<td>24.02</td>
<td>0.2929</td>
<td>41.43</td>
<td>0.2000</td>
<td>41.43</td>
<td>0.2884</td>
</tr>
<tr>
<td>3</td>
<td>Persil, 15 washload, standard powder</td>
<td>0.2446</td>
<td>22.28</td>
<td>0.2000</td>
<td>22.28</td>
<td>0.2448</td>
<td>22.40</td>
<td>0.2000</td>
<td>22.40</td>
<td>0.2449</td>
</tr>
<tr>
<td>4</td>
<td>Surf, 40 washload, standard powder</td>
<td>0.2417</td>
<td>20.86</td>
<td>0.2000</td>
<td>20.86</td>
<td>0.2417</td>
<td>20.87</td>
<td>0.2000</td>
<td>20.87</td>
<td>0.2418</td>
</tr>
<tr>
<td>5</td>
<td>Bold, 15 washload, standard powder</td>
<td>0.2437</td>
<td>21.85</td>
<td>0.2000</td>
<td>21.85</td>
<td>0.2438</td>
<td>21.90</td>
<td>0.2000</td>
<td>21.90</td>
<td>0.2438</td>
</tr>
<tr>
<td>6</td>
<td>Daz, 40 washload, standard powder</td>
<td>0.2420</td>
<td>21.02</td>
<td>0.2000</td>
<td>21.02</td>
<td>0.2421</td>
<td>21.05</td>
<td>0.2000</td>
<td>21.05</td>
<td>0.2421</td>
</tr>
<tr>
<td>7</td>
<td>Fairy, 15 washload, standard powder</td>
<td>0.2443</td>
<td>22.17</td>
<td>0.2000</td>
<td>22.17</td>
<td>0.2445</td>
<td>22.27</td>
<td>0.2000</td>
<td>22.27</td>
<td>0.2446</td>
</tr>
<tr>
<td>8</td>
<td>Dreft, 40 washload, standard powder</td>
<td>0.2442</td>
<td>22.12</td>
<td>0.2000</td>
<td>22.12</td>
<td>0.2446</td>
<td>22.32</td>
<td>0.2000</td>
<td>22.32</td>
<td>0.2447</td>
</tr>
<tr>
<td>9</td>
<td>Ecover, 15 washload, standard powder</td>
<td>0.2450</td>
<td>22.50</td>
<td>0.2000</td>
<td>22.50</td>
<td>0.2453</td>
<td>22.66</td>
<td>0.2000</td>
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<th>Estimated brand level pricing, Ariel products sold also in Germany, Ariel acquires Persil</th>
<th>Brand level pricing, Ariel acquires Persil and also sells Persil in Germany</th>
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<td>Price per washload, euro</td>
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<td><strong>Average Market</strong></td>
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Figure 1: Organizational Structures

A and B are the products manufactured in the upstream production division to be sold through one or two downstream marketing divisions.
Appendix Table 1: UK Demand For Laundry Detergents

The first row presents the estimated coefficient. These can be interpreted as the additional utility the average household obtains by using a detergent with this characteristic for one washload of laundry. The second row contains the standard error estimate for the coefficient given above. *** indicates the coefficient is significant at the 1% level, ** the 5% level, and * the 10% level.

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<tr>
<th>BLP Demand system estimates</th>
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<td>Persil (Lever)</td>
<td>2.63 ***</td>
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<tr>
<td>Surf (Lever)</td>
<td>1.09 ***</td>
<td>(0.17)</td>
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<tr>
<td>Ariel (P&amp;G)</td>
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<td>(0.27)</td>
</tr>
<tr>
<td>Bold (P&amp;G)</td>
<td>1.94 ***</td>
<td>(0.28)</td>
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<tr>
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<tr>
<td>Fairy (P&amp;G)</td>
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<td>(0.29)</td>
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<tr>
<td>Dref (P&amp;G)</td>
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<td>(0.57)</td>
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<td>(0.50)</td>
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<td>Liquid</td>
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<td>Tablet</td>
<td>2.40 ***</td>
<td>(0.41)</td>
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<tr>
<td>Capsule</td>
<td>3.14 ***</td>
<td>(0.51)</td>
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<td>Concentrated</td>
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