Multimarket Contact in Pharmaceutical Markets*

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First Version: April 20, 2007
This Version: July 15, 2007

Abstract

We analyze the effect of multimarket contact on the pricing behavior of pharmaceutical firms controlling for different levels of regulatory constraints using the IMS MIDAS database for the industry. Theoretically, under product differentiation, firms may find it profitable to allocate their market power among markets where they are operating, specifically from more collusive to more competitive ones. We present evidence for nine OECD countries suggesting the existence of a multimarket effect for more market friendly countries (U.S. and Canada) and less regulated ones (U.K., Germany, Netherlands), while the results are more unstable for highly regulated countries with some countries being consistent with the theory (France) while others contradicting it (Japan, Italy and Spain). A key result indicates that in the latter countries, price constraints are so intense, that there is little room for allocating market power. Thus equilibrium prices are expected in general to be lower in regulated countries.
JEL Classification: I18, L11, L13, L65

Keywords: Pharmaceutical prices, Multimarket Contact, Regulation

*This study was supported by an unrestricted educational grant from the Merck Company Foundation, the philanthropic arm of Merck & Co. Inc., Whitehouse Station, NJ. Partial funding was also obtained from the Spanish Ministry of Science and Technology under grant SEJ2005-08783-C04-01. We thanks MSD and IMS for providing the data and conference participants at EARIE and AES, and seminar audiences at UPF and UC3M. The helpful suggestions of Antonio Cabrales, Félix Lobo, Guillem López, Vicente Ortún, Jaume Puig, Fran Ruiz-Aliseda, and Joel Shapiro are gratefully acknowledged.

1 Introduction

Multimarket competition is defined as "a situation where firms compete with each other simultaneously in several markets" (Karnani and Wernerfelt (1985)). Scott (1982) noted that the grouping of sellers in multiple markets may create interdependence among firms in such a way that a desirable competitive process could be reduced tacitly or in a coordinated way. Scott (1982) built on the old hypothesis of the existence of "spheres of influence" by Edwards (1955). This observation proposed that firms that meet each other in several markets may have incentives to relax competition because they will recognize the interest of its rivals on some markets (their spheres of influence) and they will respect them in the expectation that their own interests will also remain unaffected. The pharmaceutical industry is a paramount example of a multimarket contact structure since several firms (particularly, large multinational corporations) coexist in a variety of product markets, either defined in therapeutical or geographical terms. Typically large pharmaceutical corporations serve a fraction of the markets, compete among themselves and compete with other smaller firms, possibly local producers. Hence, in principle the traditional view of multimarket contact that predicts higher prices in the overall industry could be applied to the pharmaceutical sector. However more interesting and relevant hypotheses can be tested from a more actual perspective.

In effect, in their seminal work Bernheim and Whinston (1990) presented a modern approach to formalize the expected effects of multimarket contacts and review the traditional approach using dynamic games. The setting of their theoretical exercise is that of a repeated competition game with discounting where firms meet in an infinite time horizon. Their relevant result for our purposes claims that under the presence of product differentiation and preeminently differences in the degrees of product differentiation among markets, the multiple market contact setting firms can find it optimal to allocate their market power across markets [Bernheim and Whinston (1990, p.19)]. As opposed to the traditional view, we may label this prediction as an strategic effect of the multimarket contact structure of an industry. Bernheim and Whinston (1990) show that this result is obtained by redistributing optimally collective market power in some markets to other markets where collusion is difficult or not possible to sustain in isolation, i.e. not considering the multimarket nature of the industry. This result states that firms may strategically give up profits -reduce prices- in markets where higher prices are easier to sustain[1] in favor of markets where collusion is difficult or less likely to arise, possibly because products are closer substitutes. The result does not require full monopolization of some markets, in fact full monopolization may not be sustainable in any market; the key is to recognize that different degrees of collusion may be observed in different markets under product differentiation. Given this result, multimarket contact collusion under product differentiation may be welfare improving because it involves increasing prices in some markets but reducing them in others[2].

[1] Ease of collusion depends on a number of factors such as the number of firms operating in the market, product homogeneity, speed of interaction, cost asymmetries, demand stability, etc.

[2] More recent theoretical developments includes Spagnolo (1999) and Matsushima (2001). The first demonstrated that for specific concavity assumptions of the firms' objective functions the traditional

The pharmaceutical industry accounts for many interesting aspects such as different levels of regulation across countries, product differentiation possibly both at the horizontal and quality levels, different degrees of competition across product markets and other institutional arrangements affecting equilibrium prices [3]. Differences in competitive levels across product markets according to Bernheim and Whinston (1990) may foster the collusive mechanism through multimarket contact. At the same time, differences among firms and across markets in terms of the perceived quality of the product by doctors, for instance, are also likely to enhance the multimarket contact mechanism to sustain collusion. Therefore, it appears that this industry satisfy the conditions for a relevant study of the effects of the external (to the individual market) multimarket industry structure as a source of price variation as reported for the heterogenous product case in Bernheim and Whinston (1990).

Although there have been serious empirical works that successfully test the traditional prediction of the multimarket contact in different industries such as those by Evans and Kessides (1994), Parker and Roller (1997), Jans and Rosembaum (1996) and Pilloff (1999), Fernández and Marín (1998) presented the first empirical assessment of the market power allocation hypothesis. Their study focused in the Spanish Hotel industry, finding relevant strategic market power allocation. We follow closely this work to implement the multimarket theory for the pharmaceutical industry case, however we take advantage of the different intensities of price regulation across OECD countries to study how the multimarket structure interacts with this particular regulatory constraint. The relevance of this analysis from a public policy point of view is out of question as we believe the design of price regulations barely takes into account how it may affect performance through structural characteristics of the industry. Therefore our aim is twofold. First we test whether optimal collusion through market power allocation can be inferred from product level data by countries, and second we study the sensibility of the result to different levels of price regulation.

The present work provides an empirical implementation of the multimarket theory for the pharmaceutical industry for nine OECD countries. Given the existing institutional differences in the pharmaceutical markets across countries the original contribution of this paper is to test the theory in the context of price regulation variation. As an extension of the results, we aim at evaluating empirically how more or less stringent price regulations is likely to affect pricing decisions through the multimarket mechanism. As mentioned in Puig-Junoy (2005), arguments regarding classic market imperfections in the pharmaceutical industry have been used by authorities to create drug price controls, however it is well known that the main concern is the level of public expenditures in pharmaceutical products, specially for health systems financed through public sources as is the case

multimarket effect will appear even if no asymmetries across markets exists. The second showed that an increasing number of multimarket contacts among competitors can solve the problem of imperfect monitoring in sustaining more collusive equilibria

[3] Some theoretical works considering these aspects of the industry includes, Cabrales (2003), Königbauer (2006) Miraldo (2007) while empirical research has been conducted by Cleanthous (2004)

of most EU experiences [See comments in Danzon (1999); Danzon and Chao (2000a,b); Puig-Junoy (2004) and Miraldo (2007)]. Thus, many different types of price regulations and other policies have been put forward by developed countries, and EU countries in particular, to alleviate the incidence of drug prices over public health expenditures. Price regulations usually do not pay attention to industry characteristics external to the market, more specifically the whole industry structure. In the pharmaceutical industry at a national level, a salient feature is the coexistence of many corporations in different products markets or *business/product lines*. Consequently, the relevant question is to investigate whether strategic behavior driven by multimarket contacts is affected by the intensity of price regulation with the ultimate objective of providing useful insights for policy evaluation.

In the context of diverse regulatory regimes, Danzon and Chao (2000b) identified different groups of countries depending on the intensity of regulation, including price regulation. From more to less regulated, the first group includes France, Italy, Japan [and Spain which was not used in Danzon and Chao (2000b)] where launch prices are regulated and afterwards are revised downwards over the drug's life cycle, and the price of new varieties is related to the price of established varieties. In addition, generic substitution by pharmacists is not allowed in France and Italy. Moreover, in the latter countries, pharmacies are paid a margin on the product price which may encourage them to sell more expensive products. The second group includes UK and Germany [and The Netherlands which also was not used in Danzon and Chao (2000b)] were corporations are free to set prices at launch but prices cannot increase later on. In addition, in both countries there is some type of upper bound to prices, implemented either through a Reference Price (Germany) or a maximum overall rate of return (UK). Consumer demand substitution is partially possible only in Germany because of the possibility of multisource drugs. Generic substitution by pharmacists is the main source of price-demand elasticity since they keep the margin between the reimbursement price and the manufacturers price. This is possible in UK, and to a lesser extent in Germany. In this second group we also include the Netherlands given its similarities with Germany in institutional terms [Danzon and Ketchman (2003)]. The third group includes US and Canada where prices are relatively free, consumers' and physicians' demands appear to be less inelastic and generic substitution on the side of the pharmacists is encouraged as a mean to promote competition. Danzon and Ketchman (2003) indicate that in the US the existing type of regulation is in fact a mild Reference Price; in any case this country is taken as a benchmark for competition analysis.

Danzon and Chao (2000a,b) estimate reduced form equations for prices on quality attributes and competition characteristics. According to their expectation, the competition variables should be significant only in less regulated markets. The empirical results suggests that regulation constraints competition.[4] The main goal of our work can be seen as

[4]Regulation can have impact on other aspect of the market such as rate of launch of new products. In this sense, Kyle (2007) examines the effect of price controls in the extent and timing of the launch of new drugs around the world and finds that regulation has a statistically and quantitatively important effect on pharmaceutical launches. Danzon et al. (2005) examine the effect of price regulation on delays in launch of new drugs. They find that countries with lower expected prices or smaller expected market

an extension of this type of analysis to account for the effects of multimarket contact on competition in order to identify additional effects of regulation on competition.[5]

Apart from the institutional constraints for business practices, the industry presents several particular characteristics that are worth noting. Previous evidence in this industry (see Berndt et al. (1999); Berndt et al. (1996); Cockburn and Anis (1998); and Suslow (1996)) suggest that marginal costs are almost irrelevant in the industry and recommend the use of a hedonic price approach. Several authors have also accounted for perceived quality when modeling the pharmaceutical industry, particularly from the likely effects of advertising and promotion over price insensitiveness. In particular, King (2000) and Windmeijer et al. (2004) conclude that brand advertising and promotion further reduces price sensitiveness of drugs. In a somehow related work, Coscelli (2000) suggests that drug consumption exhibits time dependence which implies additional price insensitiveness due to what can be understood as brand loyalty.

With respect to the effects of entry of generic products on price evolution, the empirical evidence is ambiguous. After entry of generic products, some authors (Grabowski and Vernon, 1992 and 1997, and Caves, Whinston Hurwitz, Pakes and Termin, 1991) report that brand-name prices increased relative to generic prices, while others (Wiggins and Maness, 1994) find a reduction in prices following entry. Finally, Frank and Salkever (1992 and 1997) report that brand name prices increased while generic products prices fell, producing a reduction in average prices. The latter explain the correlation between brand name prices and generics' entry through a Stakelberg price leader model, where brand name producers set prices for their products in the first stage and generic product producers set prices only after observing brand name product prices. Demand is formed by two segments: one is price insensitive and the second is price responsive. After the entry of generics price responsive buyers shift to generics and brand name firms, who are left with price insensitive consumers decide to raise their prices [6]. We will differentiate the effect of generic prices over the pricing decisions of firms considering that brand-name drugs belong to a particular (though not independent) segment of the market.

The theoretical results about competition and multimarket contact can lead to several types of tests and applications in the context of the pharmaceutical markets. As Evans and Kessides (1994) suggest: '*In empirical tests of the multimarket contact hypotheses,*

size have fewer launches and longer launch delays.

[5]Danzon and Furukawa (2003) suggest that fixed costs are distributed across countries depending on demand elasticities, so that higher prices happen to be in richer countries. This suggest that in a cross-country study specific country measures should also be included in the regression.

[6]However, this mixed evidence could also be interpreted in the context of more traditional models of competition were we take into account the existence of multimarket contact and the interaction between brand name and generic products markets. For instance, assume that ease of collusion was lower (for whatever reason) in the brand name market while it is higher in the generic products market (for instance, because of cost and brand image symmetry, that would make competition very tough in the absence of some degree of tacit collusion). Now, in the presence of multimarket contact, if the same firms operate in both markets, the emergence of the generic products market could induce an increase in brand-name product prices, while being consistent with a lower average price in the market.

appropriate definition of the market is of paramount importance.' Pharmaceutical markets are usually bounded in terms of therapeutic classes of drugs, the members of which often are therapeutic substitutes, e.g., antiulcer drugs, antidepressants, anticholesterol drugs. etc.[7] In addition, within each therapeutic class we find a large number of countries which might be regarded as independent markets on the demand side because of differences in their regulatory systems and various barriers to the mobility of drugs. Then from a geographical point of view, markets might be defined as countries and within countries a market is to be regarded either as a product line or a grouping of related product lines.

We motivate the empirical exercise by showing that it is possible to formulate, within a model with (symmetric) product differentiation, an expression for the observed prices as the equilibrium strategies of an infinite horizon game with discounting which has three separable parts: First, a function for the stage game price in equilibrium, Second, a function of the multimarket external conditions, and a function of the time preference. This formulation is comparable to that followed in Fernández and Marín (1998). For the empirical test of multimarket contact effects, we use a multicountry and multiproduct data set from the IMS MIDAS international dataset for the period 1998-2003. This dataset encompasses a large number of countries including the top ten in terms of pharmaceutical expenditures, as well as medium size and small countries. It also includes a large number of groups or anatomic classifications, and allows to study between countries variations, specially in terms of both regulatory regimes and industry structure. Provided with this data set, we select a sample of nine OECD countries, namely U.S., Canada, U.K., Netherlands, Germany, France, Japan, Italy and Spain that differ mainly in the toughness of pricing regulations but other institutional arrangements are comparable such as the compulsory need of a prescription for drug delivery. We estimate the effect of multimarket contact on prices using panel data methods which also helps us to control for a variety of effects such as idiosyncratic corporation effects and where the case requires country specific fixed effects.

Our results suggest a significant presence of the predictions of the multimarket theory for more market friendly countries (U.S. and Canada) and less regulated ones (U.K., Germany, Netherlands), in contrast, for highly regulated countries the results are more unstable with some countries being consistent (or weakly consistent) with the theory (France and Spain, the less regulated in this group) while others contradicting it (Japan and Italy, the more regulated in this group). Interestingly in all the cases where the theory seems at least weakly consistent if we omit the market power distribution effect from more collusive single markets to more competitive ones, our multimarket variable appears to deliver biased estimates. Therefore, our data and results suggests that in the pharmaceutical industry the distribution of market power is a relevant feature to explain pricing decisions. We expand further the analysis by asking about the relation between different levels of price regulation and the multimarket mechanism. We discuss on the matter of intense price regulation and suggest, in the context of the multimarket contact theory, that bringing prices close to the one shot equilibrium -there is no need to reduce prices at

[7] See Berndt et al. (1995) for a discussion.

the marginal cost- precludes the usage of market power in highly collusive markets as a mean to increase prices in more competitive lines of production. The regression analysis on this particular point suggest indeed that in the group of countries of more intense price regulation, the equilibrium prices are expected to be, in general, lower than those of the relatively free ones. That is, prices are predicted to be lower irrespective of the market specific competitive conditions. This does not mean that in highly regulated countries multimarket contact has no strategic effect, but that the effect is much less relevant than in low regulated countries. This result deserves additional analysis because affecting the performance of more competitive product markets, which are supposed to be out of the scope of strong regulatory measures, can be shown to affect future entry decision and may lead to less competition in the future.

The paper develops the streamline of analysis in the following structure: In section 2 the theoretical implications of multimarket contacts are described and discussed; we also show how observed prices can be approached from this framework. Section 3 describes the data set and the variables to be used. Next, section 4 presents the empirical specification based on the discussion of section 2 and also present the relevant aspects of the econometric methods, identification problems and solutions. Section 5 describes the results and their interpretations as well as some robustness exercises. Finally, section 6 concludes.

2 The implications of multimarket contact

It is a well known result that firms could achieve more collusive outcomes when they expect to meet and compete for an infinite number of periods. To achieve these outcomes, the firms involved must design a set of credible penalties for deviating players. For instance, if a firm decides to deviate from the collusive outcome, the penalty imposed could consist of reverting for the remainder of the game to the equilibrium strategy for the stage game, since this is also a subgame perfect equilibrium in the repeated game. In what follows we present the implications of the multimarket contact theory and a discussion of the possible effects of regulations over the collusive mechanism. We emphasize, however, the specific case of product differentiation within markets and different levels of product differentiation across markets to be in line with salient characteristics of the industry as discussed in the introduction.

2.1 Observed prices from a multimarket perspective

To simplify the analysis, assume a market k where N_k firms producing symmetrically differentiated products compete in prices and denote the equilibrium prices in the one shot game by p_i^*, $i = 1, ..., N_k$. Consider this as the stage game of an infinitely repeated game with discounting. Let p_i^m denote the price that jointly maximizes the profits of all the N_k firms in the market [8]. Now firms have the possibility of choosing from a set of alternative prices in the repeated game and tacitly support prices above the stage game

[8] With symmetric product differentiation it is expected that joint profit maximization give also a symmetric price equilibrium. See Bernheim and Whinston (1990) and Chang (1991).

outcome in the long run. Detection of any deviation from this collusive outcome will be penalized by all the members of the coalition by reverting to the stage game equilibrium from then on. This also implies that market transparency is such that rivals can easily find out whether a member of the coalition has defected or not, an assumption that has been criticized from many instances in the literature [9]. Denote by $p_i^{'}$ the price for firm i in the repeated game and assume that $p_i^{'} \in [p_i^*, p_i^m]$. $p_i^{'}$ then is selected such that it maximizes the present discounted value of the firm's expected flow of profits subject to the incentive constraint that loses implied by deviations from the collusive path are greater than the implied gains [10]:

$$\frac{\delta}{1-\delta}[\pi_i^{'} - \pi_i^*] \geq \pi_i(R_i(p_{-i}^{'}), p_{-i}^{'}) - \pi_i^{'} \tag{1}$$

where π_i^* and $\pi_i^{'}$ are firm i's profits when prices are p_i^* and $p_i^{'}$ respectively, $\pi_i(R_i(p_{-i}^{'}), p_{-i}^{'})$ are firm i's profits when all firms other that i set their collusive prices, $p_{-i}^{'}$, and firm i chooses its best response to them, $R_i(p_{-i}^{'})$, and $\delta \in (0,1)$ is the discount factor. Now, note that if p_i^m is to be supported as a sub game perfect equilibrium, then it must be the case that there is no profitable deviation from it, in other words it satisfies:

$$\frac{\delta}{1-\delta}[\pi_i^m - \pi_i^*] \geq \pi_i(R_i(p_{-i}^m), p_{-i}^m) - \pi_i^m \tag{2}$$

Where π_i^m is firm's i profits from the joint profit maximization outcome. While the left hand side of this expression depends on δ, and increases monotonically in this argument, the right hand side is independent of the discount factor. If we denote the left hand side by $F(\delta, \pi_i^m - \pi_i^*)$ the following condition is true:

$$F(0, \pi_i^m - \pi_i^*) < \pi_i(R_i(p_{-i}^m), p_{-i}^m) - \pi_i^m < F(1, \pi_i^m - \pi_i^*) \tag{3}$$

This expression implies the existence of some threshold for the discount factor, say δ^m, above which the joint profit maximization outcome is a sub game perfect equilibrium. Although other strategies may be supported in equilibrium by values above δ^m, we shall assume that firms will select the highest price π_i^m. Below δ^m, p_i^m cannot be supported and the maximum sustainable price is given by $p_i^+(\delta)$. Lets define the maximum sustainable price as a function of the discount factor by $p_i^+(\delta) = \max\{p_i \in [p_i^*, p_i^m) \mid F(\delta, \pi_i - \pi_i^*) \geq \pi_i(R_i(p_{-i}), p_{-i}) - \pi_i)\}$. Note that the condition in this function when $p_i^+ = p_i^*$ implies $F(\delta, 0) = \pi_i(R_i(p_{-i}), p_{-i}^*) - \pi_i^*) = 0$ and when $p_i^+ \to p_i^m$ implies $F(\delta, p_i^m) < \pi_i(R_i(p_{-i}), p_{-i}^m) - \pi_i^m)$; therefore if $p_i^+(\delta) > p_i^*$ it should be the case that the condition is hold with equality. To proceed with the analysis we need to make some

[9] For example a sudden reduction on a firm's sales may be an indication that one or more rivals have defected or can be just the result of a random demand shock which implies that perfect monitoring of rivals' decisions is not possible.

[10] More precisely, in a symmetric product differentiation set up $p_i^{'}$ is the price that maximizes joint profits under the constraint that loses from deviations are greater or equal than the gains from such an strategy.

monotonicity assumption on this function. Furthermore in the context of product heterogeneity, the way in which the discount factor affects the maximum sustainable price depends on the nature of product differentiation. For instance, Chang (1991) showed that in the context of symmetric horizontal product differentiation the maximum sustainable price, also known as best collusive price, has the property that $\partial p_i^+/\partial\delta > 0$ while in the case of vertical (quality) product differentiation explored by Häckner (1994) there is not a clear answer. However, it is possible to show in the context of Hackner's analysis that given a level of (non symmetric) product differentiation, the price of the high quality firm that maximizes joint profits is increasing in the discount factor. For our analysis we will adopt the plausible property that $p_i^+(\delta)$ is a monotonically increasing function. This implies the intuitive result that whenever future profits are more valuable, short run benefits from defecting are accordingly less preferred. Therefore $p_i^{'}$, the collusive price, will be a non-decreasing function of δ [11].

At any given δ, $p_i^{'}$ will depend on the same cost and demand conditions that determine p_i^*. This last fact together with assumption that $p_i^{'} \in [p_i^*, p_i^m]$ and the discussion above allows us to express $p_i^{'}$ as a separable function of the equilibrium price in the stage game and a function of the discount factor, $p_i^{'} = \Phi(\delta)\ p_i^*$, where:

$$\Phi(\delta) = \begin{cases} \frac{p_i^m}{p_i^*} & \text{if } \delta > \delta^m \\ \frac{p_i^+(\delta)}{p_i^*} & \text{if } \delta^m > \delta \end{cases}$$

Note that for sufficiently low δ ($< \delta^m$) the most collusive outcome requires $p_i^+ = p_i^*$ which readily implies $\Phi(\delta) = 1$. From there this function increases until it reaches the upper bound $\frac{p_i^m}{p_i^*}$. Once this simple analysis is expanded to allow for the realistic situation in which firms interact with their rivals in many independent markets, some interesting hypotheses on the expected strategic behavior of firms may be extracted.

To model the implications of multimarket contacts it is reasonably assumed that any firm which intends to deviate from the collusive equilibrium in any market k will face a penalty in every of the markets where it meets its market k rivals. Given that the punishment is going to spread over all the markets, when a firm decides to deviate from the collusive strategy it does so simultaneously in all the markets where it operates. Therefore, assuming that firm i is present in K independent markets, the incentive constraint under the multimarket contact hypothesis becomes:

$$\sum_{k=1}^{K} \frac{\delta_k}{1-\delta_k}[\pi_{ik}^{'} - \pi_{ik}^*] \geq \sum_{k=1}^{K} \left\{\pi_{ik}(R_{ik}(p_{-ik}^{'}), p_{-ik}^{'}) + \pi_{ik}^{'}\right\} \tag{4}$$

This condition is a pooling of the K individual market incentive constraints. Given differences in the levels of product differentiation, at any given value of δ, the maximum

[11] Bernheim and Whinston (1990) nevertheless mentions that ''Product heterogeneity within each market adds considerable complexity since the maximum sustainable price typically increases continuously as the discount factor, δ, rises''.

sustainable price may differ substantially across markets. According to Bernheim and Whinston (1990) analysis, optimality for firms involves allocating market power from markets where collusion is easier to sustain to markets where it is more difficult or not possible to sustain. Hence, from equation (4) we can extract the main implication for our purposes:

As an illustration imagine a situation in which condition (1) holds as an equality for all the markets where the firm is operating, i.e. $p_{ik}^{'} = p_{ik}^{+} < p_{ik}^{m}$ for all $k \in K$. That is full collusion is not sustainable. In this case, firms can reduce their price in a sub set of markets so that condition (1) in these markets holds now as a strict inequality. In this way firms create some slackness in a number of markets so that they can increase prices in some (or all) of the rest of the markets, violating condition (1), as long as condition (2) still holds. Along this line of argumentation, Bernheim and Whinston (1990) conclude that under product differentiation firms can find it optimal to redistribute their market power, giving up profits in some markets where the collective action is easier to coordinate in order to increase profits in other markets where their conditions does not support higher prices in equilibrium. Given the link between ease of collusion and demand responsiveness, the expected outcome of this strategy is a positive net gain for the firm.

If we change the assumptions to consider homogeneous markets and we further assume identical markets and firms' characteristics across markets, both profits and losses from deviating are multiplied by the number of markets where the firms are meeting, and the set of strategies that form a subgame perfect equilibria remains unchanged [12].

In the context of the homogeneous goods assumption, when markets differ, for example by different number of firms, or firms have market specific characteristics (have different costs), we can obtain a larger set of sustainable equilibria for each market that still includes all the equilibrium strategies available in the absence of multimarket contact. In particular, a firm can reach more collusive outcomes in some markets by violating condition (1) as long as this condition holds in other markets as a strict inequality, i.e., when $p_{ik}^{'} = p_{ik}^{m}$ for some k, and condition (2) holds for the whole set of markets where the firm operates. In this case, according to Bernheim and Whinston (1990), firms can transfer the slack of market power to other markets and increase prices in instances where collusion is difficult or not possible to sustain. Note that this transference of market power differs to the case of optimal allocation of market power in the heterogeneous products ambience. However, we might conjecture that in the presence of product differentiation as well as differences in the structure of the markets (e.g. differences in the number of firms) which seems relevant for the pharmaceutical industry, both types of effects may be combined so that different hypotheses can be jointly tested.

Turning back to our product heterogeneity assumption, given the structure of each k market and as a consequence the structure of multimarket contacts for firm i, we can

[12] This is labelled as the irrelevance result by the authors. Spagnolo (1999), however, has shown that when the objective function of the agent is strictly concave then multimarket contact can increase the ability of firms to support collusion even if no asymmetries exist between markets.

represent the firm's equilibrium price of the repeated game in market k as a function of three separable components:

$$p_{ik}^{'} = \Gamma(MMC_{ik}, \theta_k)\ \Phi(\delta_k)\ p_{ik}^{*} \tag{5}$$

where $\Gamma(MMC_{ik}, \theta_k) > 0$ measures the effect of the multimarket contacts structure given by variable MMC_{ik} and some measure of the toughness of price competition at the stage game in market k, which we denoted θ_k. In terms of the hypothesis of the strategic behavior supported by the existence of multimarket contacts, the key prediction implies that $\frac{\partial^2 \Gamma(.)}{\partial MMC_{ik} \partial \theta_k} > 0$. That is, the strategic effect of multimarket contact over the repeated game equilibrium price is expected to be increasing in the toughness of price competition. More precisely, it is expected to observe $\Gamma(MMC_{jik}) < 1$ in markets where a collusive price is easier to support (less toughness of price competition) in equilibrium and $\Gamma(MMC_{jik})$ > 1 in markets with less favorable conditions to sustain collusion.

2.2 Effects of regulation on strategic behavior

How price regulation, and different intensities of price regulation may distort the multimarket contact strategic effect is still to be answered from a theoretical point of view. However we give here some initial thoughts on the likely effects of price regulation. Theoretically price regulation reduce the ability of firms to price above marginal costs. In a model of price competition with product differentiation even if we reduce exogenously the price of only one competing variety of the market, other varieties should respond by reducing their prices too given that typically in these models, optimal price responses are strategic complements. If we conjecture that regulation will be more intense in product markets where high prices can be sustained more easily, this public policy may reduce prices in these type of markets further below to the level implied by the multimarket contact theory. Accordingly, further slackness may be created so that prices in competitive product markets could be conversely raised over the un-regulated case.

However if regulation is so intense such that prices are lowered exogenously until it reaches the stage game equilibrium price, p_i^*, no slackness is left for allocating market power to more competitive markets, therefore intuitively we would expect that stricter price regulation could lead to a reduction in prices belonging to more competitive product markets with respect to the un-regulated equilibrium. This informal discussion gives us an initial way to think about what to expect from the relation between multimarket contact and price regulation in the pharmaceutical industry.

There are many types of regulations within the pharmaceutical industry across (OECD) countries and even in a particular country many kinds of controls coexist. However, we are interested in policies aim at cost containment of public health care systems, that is policies aim at constraining pricing decisions and promoting the consumption of less expensive (alternative) drugs. Basically two types of price regulations can be identified, the application of direct price caps and the application of reference pricing systems. The latter are supposed to relax the price elasticity of demand involving the otherwise indifferent consumer into the selection of the pharmaceutical product to consume [See Danzon and

Ketchman (2003) for a discussion on such form of regulation]. As such this type of price regulation can be thought as a mild restrictive regulation.

Although we do not present a formal discussion on the likely effects of price regulations over the multimarket contact equilibrium, in particular price ceilings for drug products, the literature on the topic gives us some initial thoughts about the kinds of distortions that may affect the strategic behavior of firms in this industry. Cabrales (2003) provides a theoretical approach to the effects of price ceilings in the pharmaceutical industry using a vertical differentiation oligopolistic model. He is able to show that increasing the stringiness of regulation increases the relative market share of the branded product with respect to generic drugs, a result that is compatible with what is informally observed in practice. In a related theoretical work, Miraldo (2007) have found that Reference Pricing may actually increase equilibrium prices because the prices of reference to which drug prices are subject to are the prices observed in the past. This result is observed both for the case in which branded drugs share the market with generic drugs or when only substitutes therapies are available as a mean for competitive pressure to branded products.

From an empirical perspective, Aronson et al. (2001) studies the effect of reference price systems over well established brand name drugs. The results are mixed, showing a positive relation between price controls and brand name product market shares for some products and a negative one for others so that this version of price controls seems to increase or decrease relative market power. Likewise, Danzon and Chao (2000b) have found that countries where price regulations are more strict, such as France, Italy and Japan, price competition is in general less dynamic in contrast where prices are relatively free such as USA, Germany and UK. It seems that actually strict price regulation increases market power while mild or low regulation does not distort too heavily market outcomes. Therefore, strict price regulation could be inducing a potential increase in slack for less competitive markets and as a consequence higher prices in more competitive ones compared to the equilibrium one would observe in countries with low and mild regulation.

From this discussion we may extract two potential hypotheses, either price regulations in countries with intense controls in the industry exacerbates the strategic allocation of market power, or pricing constraints are such that no market power is left to allocate from less competitive product markets to more competitive ones.

3 Data and construction of the variables

3.1 Data set description and analysis

We use a multi-country and multi-product data set from the IMS MIDAS international dataset for the period 1998-2003[13]. This dataset encompasses a large number of countries including the top ten in terms of medicine expenditures, as well as medium size and small

[13]We dispose of information from the 4^{th} quarter of each year, apart from 2003, for which the information is provided for the 2^{nd} quarter.

countries. We restrict here the analysis to data from nine OECD countries (see Table 1 for a list of the countries and data summary). The most widely used classification for pharmaceutical products is the Anatomical Therapeutic Chemical classification or ATC code which groups medicines in different levels starting from the basic chemical entity or molecule at the bottom level. This classification provides the researcher an a priori way to approach the study of markets for drugs with the possibility of using many alternative relevant market definitions [14]. The panel structure of the data set also provides the econometrician with several sources of price variations that can be studied. This is particularly interesting for our work given that market structure and the configuration of multimarket contacts will vary across product markets, whatever their definition, and time.

As in any applied industrial organization and competition analysis, a correct market definition is crucial. The pharmaceutical industry represents, however, a complex exercise of market definition considering that shaping geographical boundaries within a country or clear mutually exclusive sets of substitute products is not straightforward. We disregard any delimitation of regional markets within a country, as it is reasonably to assume that value to cost transportation in this industry is high. In the ATC classification, the basic unit of differentiation between two products is the main chemical substance of the products, called the molecule. When two products have the same chemical substance are thought to be therapeutically equivalent. When they belong to different molecules they can be imperfect substitutes for a therapy or have no relation at all. In the current study we define a market as the set of products whose main chemical composite belongs to the same molecule. However, this definition may be too narrow based on the well known fact that different molecules can be used to treat the same medical condition. To overcome this issue, we contrast the results with a broader definition of the market: the 4-digits Anatomic Therapeutical Classification (ATC4) the molecule belongs in, however we do not present the results to save space. Table 1 (panel B) presents the distribution of corporations depending on the number of markets supplied for the set of countries considered in our sample, namely: US, Canada, Germany, UK, Netherlands, France, Italy, Japan, and Spain.

This data set is specially valuable to conduct a cross country study which is of particular interest for the industry due to the different regulatory regimes each country have designed and currently applies. Following the comprehensive study by Danzon and Chao (2000b) as well as the advice of recognized experts[15] we group the countries considered in the sample in three regulatory categories. (I) US and Canada belong to the group of more market friendly policies; (II) Germany, UK, Netherlands belong to the group of medium intensity of price regulation; and, finally, (III) France, Italy, Japan, and Spain belong the highly regulated group.

The list of variables that we construct is the following. The variable price, called *Price*,

[14]The ATC classification is supported and maintained by the World Health Organization Collaborating Centre for Drug Statistics Methodology with a base in the Norwegian Institute of Public Health.

[15]We are indebted to Guillem López (UPF) and Vicente Ortún (UPF) and Félix Lobo (UC3M) for helpful advice on this regard.

corresponds to sales revenue divided by the number of 'standard units' sold. The IMS Midas database consider these standard units as standard quantities of products considering a recommended daily dosage. We convert the computed prices to US dollars. As pointed out by several authors marginal costs are almost irrelevant in the industry [c.f. Stern (1996)]. This suggests the use of a *hedonic* approach.[16] Accordingly, in our pricing regressions we incorporate this approach and include quality variables as regressors to proxy the stage game equilibrium price. The quality variables for which we do have information and therefore we include in our regressions are as follows: The variable firm's size, *Fsize*, is constructed as total corporation sales correcting it by excluding sales of the product under analysis. *Generic* is a dummy variable which takes one if the product is a generic, and *Composite* is a dummy variable which takes the value one if the product is a combination of two or more molecules. Molecule age, *Molage*, is the time elapsed since the molecule was launched to December 31, 2003. The age distribution of molecules and products is presented in Table 1 (panel C). Competition variables related to the mark-up are also computed. These variables are: Number of generics, *Ngenerics*, is the number of generic products in each market. The Hirschmand-Herfindähl concentration index, *HHI*, is constructed using corporation sales value, with squared market shares of the corporation under analysis excluded from the index, $\widetilde{HHI}$. We construct the market share of each variety in the market, *Mshare*, and the aggregate market share of all other varieties supplied by the same corporation in each market, *Cshare*. For the regression analysis we use log transformations of *Price*, *Fsize* and *Molage*, so we value more the differences in smaller than in larger values.

A number of dummy variables are also constructed: *New* is a dummy variable equal to one if the product was launched in the previous year and zero otherwise, *Censormol* equals 1 if the molecule was launched before January 1, 1991 and zero otherwise, *Censorlag* equals one for products launched before January 1, 1991 and zero otherwise. These dummies are part of the quality variables used to capture price variation. Also a dummy variable taking 1 if the product belongs to the generic segment and 0 for branded drugs. The variable name is *Dgeneric*. Finally we also include a dummy taking 1 if the product is a composite of various molecules, *Composite*

In addition to these variables, concerns on the endogeneity of some of the regressors led us to find a way to include some additional information. The argument is that in pharmaceutical markets, product differentiation in terms of attributes is of particular relevance. However many important attributes are not observable from the econometrician point of view because are not measurable or as it is in our case are absent from our data set. The stage game price P^*_{ik} will be a function of marginal costs, usually thought to be irrelevant in the industry, and a mark-up term. This mark-up will depend on some measures of market participation such as those commented lines above. However this mark-up variables will be correlated with unobserved characteristics of the product i whose effect by definition will be located in the error term. Abusing the language of the Instrumental Variables approach to the problem, we put forward an identification assumption that the

[16] See Berndt, Cockburn and Griliches, 1996, Berndt, Pindyck and Azoulay, 1999, Cockburn and Anis, 1998, and Suslow, 1996.

independence of markets across countries gives us the possibility of using the price of other products in the same market definition in other countries to control for the unobserved effects. The argument is that this prices will be correlated with time variable and time invariant unobserved attributes of a number of products that interact with product i in market k, information that is also relevant to the firm to set prices. However these attributes of other products are not correlated with product's i own characteristics and as such helps us to control for some of the unknown price variability. The variable constructed is a global price, *Gprice*, which is the average price of the products belonging to the same market definition of i but in other countries.

In addition, and regarding the same endogeneity problem, firm specific attributes that are time invariant in the sample such as brand reputation are usually unobserved for the econometrician and can be correlated with some of the left hand side variables. For these reason we will used a fixed corporation effect approach in the regression analysis. Given its relevance for this paper, the definition and construction of variables capturing the influences of multimarket contact will be discussed in the following sub-section.

3.2 Alternative measures for multimarket contact

In the empirical literature briefly mentioned in the introduction, many different ways of defining multimarket contact have been tried. From a purely strategic point of view, there has been consensus that a contact of firm i with its rivals in the focal (or reference) market k in other markets should reflect the importance of this last contact market for the firm. This is considered in our definitions either by using market shares or concentration indexes in terms of quantities or sales as weights for each market contact. Other important general consideration is concerned to the extent to which individual price variation is explained by the firm individual multimarket contacts variation or average multimarket contact across firms within a given market. The former approach will for instance capture the effect of small prediction power of multimarket contacts because of the presence of small firms producing a very limited number of products. In contrast, the latter implies that average multimarket contacts across firms within a market will affect all the firms in this markets in the same way, no matter how many individual market contacts have each firm. We will try both specifications.

With respect to the multimarket contact variable, an instance of multimarket contact occurs, according to our definition, when a corporation i and its competitor l in the focal market k, also meet in a different market m that we will call the contact market. If an event of multimarket contact occurs we define a dummy variable $C_{il,km} = 1$, otherwise $C_{il,km} = 0$. We define first individual measures of multimarket contact. The variable, MMC, is defined:

$$MMC_{il,km} = C_{il,km}\, Y_m$$

where Y measures the corporations' interests in the contact market m. We can think of several instances for Y, such as the degree of concentration, the corporation's market share or the percentage of the corporations' operations in that market. The measure of

multimarket contact is the weighted average number of multimarket contacts with the competitors in the focal market which is calculated as follows:

$$AVMMC_{ik} = \frac{1}{(N_k - 1)} \sum_{l \neq i} \sum_{m \neq k} MMC_{il,km} \tag{6}$$

where N_k is the number of competitors in the focal market. An alternative way of defining the multimarket contact variable is to average across all the weighted contacts of every firm with its rivals in the focal market using the total number of potential pairings of the same firms. In this case the multimarket contact variable will vary across markets but remain fixed within markets. The definition will be given by:

$$AVMMC_{k} = \frac{1}{(N_k(N_k - 1))/2} \sum_{i} \sum_{l \neq i} \sum_{m \neq k} MMC_{il,km} \tag{7}$$

where $(N_k(N_k - 1))/2$ is the total number of possible pairings of the firms belonging to market k. This indicator will punish markets where a large number of firms exists in the focal market but very few interact with each other out of the focal market. Descriptive statistics for these two definitions are shown in Table 2.

4 Empirical specification and Econometric methods

In section 2 we have shown an expression for the observed price of a product considering the multimarket structure of the industry. Therefore the price for a product j of firm i in market k, denoted $p^{'}_{jik}$, can be represented as a separable function of its equilibrium price in the stage game, p^{*}_{jik}, a mark-up on this price which depends on the discount factor, δ, and a function of the degree of multimarket contact and the ease of collusion in both the focal and the contact market. Assuming linearity we consider the following log-linear specification:

$$log(p^{'}_{jikt}) = \alpha + \Omega(MMC_{ikt}, \theta_{kt}) + \Phi(\delta_i) + log(p^{*}_{jikt}) \tag{8}$$

where t denotes time, $\Omega(MMC_{ikt}, \theta_k) = \log \Gamma(MMC_{ikt}(\theta_{kt}))$, and α is a parameter. Note that the multimarket contact indicator varies across firms within a given market. In the related literature this variable is considered fixed within markets in most of the cases. This approach is based on the assumption that the complete set of contacts within a market will affect the pricing decisions of all the firms in the same amount. However we may think of small firms within a market for which multimarket contact does not explains too much variation on prices. This is the case of the pharmaceutical markets where large corporations share a given market with small producers. Allowing for a multimarket contact indicator that varies across firms helps us to factor in possible effects of the presence of local firms, in particular over the ability of firms to coordinate. The log of the stage game equilibrium price is specified as:

$$\log(p^{*}_{jikt}) = X^{1'}_{jikt}\beta_1 + X^{2'}_{jik}\beta_2 + Z^{1'}_{kt}\gamma_1 + Z^{2'}_{k}\gamma_2 + \eta_{1i} + v_{jikt} \tag{9}$$

where the Xs and Zs are vectors of respectively time-variant and time-invariant variables concerning product j of firm i on one hand, and market k on the other, that potentially affect the stage game equilibrium prices through different meaningful ways, β, and γ are the corresponding parameter vectors, η_{1i} is a firm fixed effect and v_{jikt} contains unobserved elements for the econometrician. Given the product differentiation nature of pharmaceutical markets we can interpret the pricing equation as a function of variables affecting marginal costs (which are usually thought to be negligible in this industry) and the product's mark-up such as observed attributes that are fixed or vary through time. From a structural point of view these attributes will affect the firm's and specific product market shares. At the same time, the fixed effect is included to control for elements of vertical (quality) product differentiation which are one of the most highlighted peculiarities of this industry. The v_{jikt} can be regarded as that information on attributes that are not observed by the econometrician but firm's do take into account when taking their pricing decisions. To complete the specification, we use the following expression for the discount factor function:

$$\Phi(\delta_{jikct}) = \eta_{2i} + \lambda_t \tag{10}$$

That is, taking advantage of the panel structure of the data, we proxy the discount factor by an specific firm effect η_{2i}, and λ_t, a time specific factor. After replacing these expressions in the above equation we obtain:

$$log(p^{'}_{jikt}) = \alpha + \Omega(MMC_{ikt}, \theta_k) + X^{1'}_{jikt}\beta_1 + X^{2'}_{jik}\beta_2 + Z^{1'}_{kt}\gamma_1 + Z^{2'}_{k}\gamma_2 + \eta_i + \lambda_t + v_{jikt} \tag{11}$$

where $\eta_i = \eta_{1i} + \eta_{2i}$.

In some of the related works reviewed [e.g. Evans and Kessides (1994)] there is some important industry specific features that call for controlling for market fixed effects which are absent in our specification. The need for including market effects should be supported by relevant structural characteristics. For example, in the airline industry, a market defined as a route has important structural characteristics such as market specific fixed costs. In our case we do not believe similar structural conditions are of relevance for the pharmaceutical markets, which are in this case defined as product markets [17]. However we are in fact identifying the effects of important time-invariant product and market features in the industry through the inclusion of the X^2_{jik} and Z^2_k vectors respectively.

We estimate equation (11) country by country using a Within Groups panel data method, where the firms' specific heterogeneity effect ν_i are accounted for. Some of the left hand side variables are potentially endogenous, mainly because they can be directly influenced by unobserved attributes of the product in the stage game price equations. For instance, as we will see in the next sub-section, different market shares definitions are incorporated as regressors. For these reason we adopt the identifying assumption that product markets are conditionally independent across time and countries and the global price variable

[17] Nonetheless we estimated an alternative specification with market fixed effects which showed to be much less significative than our present specification.

is used so as to control for time varying unobserved features. In addition we use the panel data structure of the data and variables that are thought to be endogenous to the disturbances are lagged one period in an attempt to further avoid inconsistent estimators.

Table A: Variable Names and Definitions

Variable	Definition
Price_{jikt}	Price in USD of product j belonging to firm i
Priceg_{jikt}	Global Price in USD for product j belonging to firm i
Fsize_{jikt}	Quantity size of firm i in certain country excluding quantity sales of product j
New_{jikt}	Binary variable, taking 1 if product j was launched in the previous year
Dgeneric_{jik}	Binary variable, taking 1 if product j is a generic
Composite_{jik}	Binary variable, taking 1 if product j is a compound of molecules
$\widetilde{HHI}_{jikt}$	Herfindahl-Hirschman Index for market k excluding product j's share
MShare_{jikt}	Market share of product j in market k
CShare_{jikt}	Corporation share in market k excluding product j's share
Censorlag_{jik}	Binary variable, taking 1 if product j was launch date is censored in the sample
Ngenerics_{kt}	Number of generic products in market k
Molage_{k}	Time elapsed up to 2003 since molecule (market) k was launched
Censormol_{k}	Binary variable, taking 1 if molecule age is censored in the sample
AVMMC_{ikt}	Weighted average multimarket contact variable for firm i in market k
AVMMC_{kt}	Alternative weighted average multimarket contact variable in market k

4.1 Variables and multimarket contact definition

To sum up, the different groups of variables included in the panel data regression are as follows. Variables that vary across products and time are: the corrected Firm's size variable, in order to proxy firm's brand image that spills over all its products, a dummy variable indicating if the product was launched in the previous year to proxy for entry lag disadvantages, the corrected Herfindähl-Hirschman index, the product's market share

and other products' joint market share; a variable that varies across products but is time invariant is the dummy indicating if the product was launched before January 1, 1991. [18]. Likewise, variables that varies across markets and time are: the molecule age to proxy for inverse efficiency, and the number of generic products in the market; a variable that varies across markets but is time invariant is the dummy indicating whether the age of the molecule is left censored in January 1, 1991. Firm's size and molecule age are included in logs in order to give more weight to differences in small vales than in large values.

Among the competition variables we include the number of generics and the Herfindähl-Hirschman concentration index. Both variables are potentially endogenous, accordingly the former is lagged one period and the latter is corrected excluding the squared market share of the product under analysis. We also include the market shares of the product under analysis and of other drugs of the same corporation in the market, since we would expect that higher sales lead to higher prices. Again both variables could be regarded as endogenous and we lag them one period.

For the purposes of this paper, the most important independent variable is the one describing multimarket contact. Provided with this measure of multimarket contact, we consider two different specifications for $\Omega(MMC_{ikt})$. Firstly,

$$(A.1) \qquad \Omega(MMC_{ikt}) = \alpha_1 \; AVMMC_{ikt}$$

which is independent of the characteristics of the focal market. This specification can allow us to test the sign and significance of the effect that the variable measuring multimarket contact has on prices in average terms. A positive and significant sign for α_1 would be consistent with the traditional view on multimarket contact, but it could also be measuring the effects of omitted variables highly related to multimarket contact, such as the establishment size.

Secondly,

$$(A.2) \qquad \Omega(MMC_{ikt}, \theta_{kt}) = \alpha(\theta_{kt}) \; AVMMC_{ikt}$$

where the assumption in (A.1) is now relaxed allowing for heterogeneity of the multimarket contact effect across markets. The effect of a specific contact in market k can be stated as a function of the ease of collusion in the market, θ_k in a way which represents the transfer of market power from one market to others. We use the variable HHI_k, to measure ease of collusion adopting the result of most dynamic oligopoly models by which the higher the market concentration the more collusive the output of the repeated game. Following a specification by Cabrales (1995) also used by Fernández and Marín (1998), we specify $\alpha(\theta(HHI_{kt}))$ as

$$\alpha(\theta(HHI_{kt})) = \alpha_1 + \alpha_2 \; HHI_{kt}$$

Therefore, we can rewrite (A.2) as

[18]The launch date information we have is left censored at this particular date.

$$(A.2b) \qquad \Omega(MMC_{ikt}, \theta(HHI_{kt})) = \alpha_1 \; AVMMC_{ikt} + \alpha_2 \; HHI_{kt} \; AVMMC_{ikt}$$

According to Bernheim and Whinston (1990), we expect to observe $\alpha_1 > 0$, which means that in markets with little capacity of collusion, i.e., low HHI_k, MMC has a positive effect on prices. This effect has to decrease as the ease of collusion, measured by HHI_k, increases, i.e., we expect $\alpha_2 < 0$. Additionally, the theory predicts that $\alpha(\theta_{kt})$ is to be equal to zero for a value of HHI_k between the minimum and the maximum values in our set of observations. Summing up, the effect of multimarket contact is expected to be greater in absolute terms if the variable measuring the ease of collusion in the focal market, HHI_k, is among either the largest or the smallest in the sample, being positive in markets with very low values for HHI_k and negative in markets with very high values for HHI_k. The analysis is invariant to the alternative definition of multimarket contacts where the variable MMC is the average of the sum of the weighted contacts of each firm in the focal market and as such is invariant within markets.

5 Results and interpretation

5.1 Results from baseline specifications

Tables 3 to 5 present the set of basic results, running a regression of Log (Price) on the set of quality and competition characteristics as well as multimarket contact variables explained above and when the market is defined as the molecule and the multimarket variables are firm specific (as defined in 6). In these and other tables the results are shown with the countries grouped from the more market friendly ones to the more heavily regulated in prices. The regressions in all cases include time trends and fixed effects at the corporation level. Accordingly, the t-statistics shown in parenthesis are computed with robust standard errors clustering the observations by corporations. Table 2 does not include multimarket contact variables. Its purpose is to show to what extent the remaining variables explain prices in the different countries and the type of consequences that the omission of relevant structural variables entails. It can be seen that variables New, $Fsize$, $Priceg$, $Composite$ and $Molage$ have the expected signs in all the cases, however not significant in very few of them. Firm size, $Fsize$, is highly significant, indicating that large corporations enjoy higher prices either because its products are of higher quality or perceived as such. $Molage$ has a negative impact showing that the prices fall with the life-cycle of the molecule. The *composite* dummy has mixing results. For example, for the US has a negative effect while for Germany is positive. However, $Censormol$ which is expected also to have a negative effect appear to be with the wrong sign but with weak significance in most cases. These variables proxy molecule efficiency since new molecules are expected to improve upon previously existing molecules. New is also negative, indicating that new products launched in an existing market suffer from some late entry disadvantage.

Consistently, $Censorlag$ is positive in most cases, showing that products launched in

the market before January 1991 maintain higher prices than those launched later within the same market. For three countries where regulation is more stringent, this variable appears with positive sign. The latter may be indicating that old products which are likely to belong to large corporations suffer from price regulation. In most cases however the variable is not significantly different from zero. Regarding generics we find that the price of generics are, with the exception of Canada, significantly lower than other prices. Results for the number of generics are somewhat mixing. As explained in the introduction, the presence of generics on a market does not mean that brand name products will reduce their prices. The evidence presented by the specialized literature is mixed. In some cases, the presence of generics will have the impact of concentrating brand name products over the inelastic portion of the demand which will then increase the price of these products. Hence, the expected sign of the number of generics will be positive. In our results this is the case of US, Germany, Netherlands, UK –the strongest effect, and France. On the other hand, the number of generics or generic competition, will reduce prices for everyone whenever, for instance, the quality of the existing products is not necessarily perceived to be high enough. In our results this seems to be the case of Canada alone. Note finally, that the effect of the number of generics is negligible in the more regulated countries (Italy, Japan, and Spain).

The HHI concentration index, $\widetilde{HHI}$, is not significant and in some cases appear with the wrong sign. For the market share of the product, $Mshare$, and of other corporation's products in the same market, $Cshare$, the expected signs are observed except for the particular cases of Canada, France and Spain. These variables are lagged before including them in the regressions for obvious potential endogeneity problems. Also, for the majority of less regulated countries, $Mshare$ is significant while $Cshare$ is not, and taking Japan as an exception, these variables are not significant for highly regulated countries. The unintuitive results for the signs of the variables proxying competition may be due to inconsistent estimators because of the omission of variables that are related to market power in the dynamic game. These is expected to be true for Canada where prices are expected to be highly market based while in Spain and France the inclusion of the omitted variables may not solve the question because of interactions with particular regulatory arrangements.

From these first set of results interesting preliminary conclusions can be drawn. First, it appears that most attributes and quality characteristics explains a reasonable portion of price variations which is robust across countries. This suggest that different degrees of regulation does not distorts the effects of these attributes. The only attribute that seems to have a different effect with respect to the level of regulation is $Censorlag$, although the significance of the variable is in general poor. With respect to variables controlling competition, apart from the number of generics, although not significant in many cases at least the signs appear correct for most less regulated countries, excluding Canada.

Table 4 presents the results of the same regressions after including the average multimarket contact variable, AVMMC. All other coefficients remain fairly stable and AVMMC is positive and significant for Canada and less evident for the UK, it is not significant for

the rest of the countries excluding France where it is negative and significant.

Table 5 allows for the possibility of a differentiated effect of AVMMC on prices depending on the concentration of the reference market, that proxies ease of collusion. According to the theory, in presence of multimarket contact, prices are expected to fall in markets where it is easier to reach collusive outcomes whilst they are expected to increase where it is more difficult to collude. This means that the coefficient for AVMMC, α_1, is expected to be positive and the coefficient for AVMMC*HHI , α_2,is expected to be negative, with the latter larger in absolute value than the former. The results for the less regulated countries plus France are strongly consistent with the theory except for the UK, i.e., both coefficients are significant, have the expected signs and $|\alpha_2| > \alpha_1$, for US, Canada, Germany the Netherlands and France (see figure 1). In addition, the coefficients are weakly consistent, e.g., have the expected signs but either one or both of them are not significant, for UK and Spain. Only for the case of Italy the coefficients contradict the theory in both cases and for Japan the sign of α_2 is incorrect. In addition, after controlling for these effects, the coefficients associated to $\widetilde{HHI}$, $Mshare$ and $Cshare$ appear with the correct sign with the first two groups of countries however not significant in some cases. For the heavily regulated countries still nonintuitive signs remains with the vast majority being not significant.

As noted in the previous section, for the countries where the theory is supported it is possible to find a threshold for the concentration index below which the equilibrium price is affected positively and above which it is reduced through the multimarket contact mechanism. We show these thresholds graphically in figure 1 at the end of the document. It can be seen that for the less regulated countries, this level of concentration is above 0.8. The result then suggest that the multimarket contact mechanism of market power redistribution is predicted to function at very high levels of concentration, which in turns suggest that the creation of some market power slack is possible only at substantially low levels of competition.

5.2 Sensibility analysis: MMC and Market definitions

We perform two different exercises to test for the sensibility of the results. On one hand we change the definition of the multimarket variables MMC to allow only for changes of average multimarket contacts in explaining price variation. To this end we use the mutimarket variable computed as in the second definition in section 3.2. On the other hand, we broaden the definition of a relevant market and consider the four-digit grouping of the ATC classification or ATC4. Accordingly, a market is defined as the group of molecules or chemical substances that belongs to the same chemical, pharmacological and therapeutical set. For space reasons we do not show the entire set of outputs, only a brief report on the effects of changing the MMC variable definition [The complete set of results for both exercises is available upon request.

Table B present a comparison between the baseline results for the MMC effects with

those using the alternative definition for the MMC variable.[19] Perhaps the only change worth to notice is that of the increase of the effect of MMC variables both in size and significance for some countries. As shown in the summary Table B, both α_1 and $|\alpha_2|$ increases substantially (in absolute value) for the US, the Netherlands and the UK, decrease substantially for Canada and France, while remaining almost unchanged for the rest of the countries. The explanation for these results seems to be purely statistical. Given the sign of effect of multimarket contacts in the market, if changing the definition reduces the variability of the $AVMMC$ regressors when averaging within markets, the size of this effect may increase in absolute value.

Table B: Marginal effects of MMC variables by definition
(Robust T-statistics in parenthesis)

Def./Variable	**US**	**CAN**	**GER**	**NETH**	**UK**	**FRA**	**ITA**	**JAP**	**SP**
Definition 1									
$\text{AVMMC}_{ik,t-1}$	0.066	0.134	0.028	0.030	0.068	0.031	-0.022	0.002	0.119
	(2.43)	(5.39)	(2.91)	(1.87)	(1.02)	(3.02)	(-0.28)	(0.04)	(1.02)
$\text{AVMMC}_{ik,t-1}$*	-0.092	-0.173	-0.030	-0.027	-0.043	-0.090	0.111	0.003	-0.293
$\widetilde{HHI}_{k,t-1}$	(-2.96)	(-6.33)	(-3.71)	(-1.46)	(-0.44)	(-4.13)	(0.78)	(0.04)	(-0.99)
elasticity	.0167	.0783	.0565	.0604	.0242	-.074	.0136	.0040	.0280
(at sample means)	(0.70)	(1.82)	(2.03)	(1.95)	(2.0)	(2.92)	(0.71)	(0.173)	(0.67)
Definition 2									
$AVMMC_{kt-1}$	0.081	0.072	0.022	0.184	0.110	0.010	-0.003	-0.013	0.023
	(4.96)	(6.31)	(5.64)	(3.95)	(1.49)	(1.17)	(-0.13)	(-0.40)	(0.22)
$AVMMC_{kt-1}$*	-0.099	-0.115	-0.020	-0.186	-0.100	-0.023	0.028	0.030	-0.093
$\widetilde{HHI}_{kt-1}$	(-3.25)	(-6.32)	(-3.16)	(-3.22)	(-1.00)	(-1.30)	(0.54)	(0.80)	(-0.38)
elasticity	.0426	-.0057	.0826	.0830	.0218	-.0193	.0076	.0056	-.0209
(at sample means)	(2.43)	(0.10)	(4.18)	(4.17)	(2.77)	(0.95)	(1.19)	(0.316)	(0.65)

Table B also presents a comparison of the country specific implicit sample mean price elasticity to the number of contacts. In the case of results for MMC definition 1, the sample means elasticity is positive for low and medium regulated countries (being the US an exception) and non-significant or negative for strong regulated countries. Similar (but more significant in some cases) are the results when considering MMC definition 2, although in this case the sample means price elasticity to the number of contacts is significant for the US and non-significant in Canada. Even more illustrative is Figure 2, which shows the profile of the elasticity of the price to the number of contacts by HHI quantile (for each of the quantiles considered, the number of contacts is evaluated at sample means). For all the low and medium regulated countries the elasticity is relatively high for low values of the concentration index and decreases with the degree of concentration. For the US and Canada, the elasticity turns negative for degrees of concentration above

[19]No remarkable changes appear to occur either on the variables controlling for firm and market characteristics and those controlling for competitive elements not including the MMC variables.

0.75 and 0.80 respectively, which are well above the respective country specific average concentration indexes (0.585 and 0.636 respectively). Alternatively, for Germany, the Netherlands and UK the elasticity remains positive for practically all the potential values of the concentration index. For strong regulated countries the evidence is mixing. In any case, we want to stress that for France and Spain (the two strong regulated countries in which the effect of the number of contact goes in accordance with the theory), the degree of concentration from which the elasticity turns negative is clearly below the country specific average concentration indexes (0.63 and 0.61 respectively).

With respect to the alternative market definition, in general, the results (not shown) of broadening the market definition appear to affect both the size and significance of the hypotheses derived from the multimarket contact theory to the point of rejecting them from the data in most cases. Curiously, the results for Italy that before rejected the theory, now seem to fit in it very well. As a very preliminary conclusion, the results as it could be expected are very sensitive to changes on the side of the market definition. However, changing from a molecule definition to an ATC4 definition may be a too difficult condition to satisfy for the theory. A more rigorous analysis should require small variation in the definition of a relevant market, perhaps including specific molecules that are closer substitutes to each other. At this point the information available does not allow us for these type of exercises nevertheless it is an important item in the future research agenda.

5.3 A first extension on the regulatory effects

In subsection 2.2 we have discussed informally the likely effects of price regulation over the effect of multimarket contact. We conjectured that if price regulation constrain prices in more collusive markets such that no slackness in the incentive constraint of firms is left to be used in more competitive markets, then equilibrium prices should be lower in general in more regulated countries.

In Table 6 we present the results for pooled sample regressions. In addition to the usual set of regressors, whose results are shown in columns (1) to (3) of the aforementioned table, we consider interacting the following the variables $Ngenerics$, $AVMMC$ and $AVMMC * \widetilde{HHI}$ with a dummy, $Dreg$, which takes the value one if the the observation pertains to one of the four highly regulated countries in the sample. Likewise we control for corporation $\times$ country specific effects to account for idiosyncratic elements at this level, and year dummies. All the specifications are able to explain a great deal of the variability of prices within and across countries.

The results in columns (1) to (3) show that the significant quality variables are not affected by the omission of the MMC variables. On the other hand, it appears the effect of the competition variables ($\widetilde{HHI}$, $Mshare$ and $Cshare$, and, to a lesser extent, $ngenerics$) are inconsistently estimated when no controls for the MMC structure are considered. The marginal effects for $AVMMC$ and $AVMMC * \widetilde{HHI}$ are significant and consistent with the prediction that the latter (-0.051) should be greater than the former (0.43) in absolute value. Jointly they imply that the effect of multimarket contact on

prices turns negative only for values of the concentration index above 0.84. At sample means, they also imply a 3.2 percent elasticity of prices to the number of contacts.

Columns (4) to (6) contains the analogue results to columns in (1) to (3) with the addition of the interactions of respectively $Ngenerics$, $AVMMC$ and $AVMMC * \widetilde{HHI}$ with a dummy representing the strong regulated countries in sample (France, Italy, Japan, and Spain). When comparing columns (1) to (3) with columns (3) to (6), with the sole exception of $Ngenerics$ whose coefficient gets reduced by a third, all the significant quality and competition regressors remain fairly stable. Moreover, as in columns (1) to (3), the omission of the MMC variables produce biased estimates of the competition variables. Finally, the coefficients of the multimarket contact variables increase (in absolute terms) by 10 percent (from 0.43 to 0.48 and from -0.051 to -0.055). These coefficients imply, at sample means, a 4.8 percent average elasticity of prices to the number of contacts for low and medium regulated countries.

Figure 3 presents the surface or contour plot of the price elasticity by combination of (average) number of contacts and Herfindähl index for low and medium regulated countries. Each level curve describes the combinations of number of contacts and concentration index which lead to the same value of the elasticity. The price elasticity is positive for all values of the Herfindähl index below a number close to 0.9 and it increases with the number of contacts and it decreases with the concentration index.

With respect to the interaction between the multimarket contact variables and the number of generics with the regulation dummy we obtain the following findings. Firstly, the interaction with the number of generics is positive and significant, thereby indicating that the number of generics in a molecule increases more the price in the strong regulated countries than in medium or low regulated countries. Secondly, the direct effect of the interaction of the regulatory dummy with the multimarket contact variable is negative and significant. Thirdly, the effect of the strategic multimarket contact variable, that is the effect $AVMMC * \widetilde{HHI}$, is marginally negative but insignificant[20]. Jointly, they imply that the elasticity of prices to the number of contacts in regulated countries is -2.8 percent.

Figure 4 presents the same concept as in Figure 3 but now for the strongly regulated countries. The elasticity of the price to the number of contacts turns in this case negative for all values of the Herfindähl index above 0.3, however the price elasticity for low levels of concentration show positive but much lower figures than those of the low regulation case. As in the case of low regulated countries the price elasticity increases with the number of (average) contacts and decreases with the concentration index.

These results suggest that for countries where price regulations are intense there exists a multimarket effect which delivers lower equilibrium prices in all the product markets irrespective of their degree of competition, as measured by the corresponding concentration index. We interpret this result as an indication that price regulation in the more

[20]When France is removed from the group of highly regulated countries the coefficient turns positive but still insignificant.

regulated countries are intense enough to reduce the instances in which some slackness in the incentive constraint in more collusive markets can be used to increase prices in more competitive ones. Therefore, coupling the empirical results with the theoretical discussion in section 2.2, the data appear to support the hypothesis that intense price regulation is bad for the multimarket contact equilibrium and seems to reject the alternative that intense price regulation exacerbates the strategic effect of market power allocation.

6 Concluding remarks

The theoretical literature of dynamic oligopoly models have proposed some interesting results from the situation in which firms contact with their rivals in several markets. A traditional view predicts the *Mutual Forbearance Hypothesis* by which firms may increase the set of collusive equilibria because of repeated interactions in many independent markets. Furthermore, when appropriate incentive constraints permits, multimarket contact may also promote the re-distribution of market power from markets with easier conditions for collusion to markets where colluding is more difficult. The first hypothesis has been successfully studied for several industries such as the US's industries of cement, cellular communications, airline services, banking and others while studies for Europe have been conducted for the Banking industry and the Spanish hotel industry, the latter been also approached considering the re-distribution of market power. We expand on this empirical literature by considering the effects of the multimarket structure in the pharmaceutical industry using panel data for nine countries of the OECD. The cross country nature of the data allow us to control for a very important feature of the industry which is the different degrees of regulation and in particular price controls. We perform panel data regressions for specifications in which we incorporate several important issues such as the relevance of quality variables in the industry, the importance of corporation fixed effects to control for quality product differentiation, and an instrumental variables argument to control for possible endogeneity of variables related to the competitive environment. The multimarket structure is also part of the specification in such a way that provides a simple relation between the contacts and the ease of collusion across markets to test both the traditional and the more strategically based hypotheses predicted by the theory. The baseline model appears to fit the hypotheses of multimarket contact reasonably well for the case of less regulated markets while for those countries where price regulation is more intense the results are more unstable. This suggest, as intuitively expected, that in more regulated markets there are some existing distortions that are interacting with market forces.

Given the above result we ask ourselves about the likely effect of price regulation over the multimarket contact mechanism. To answer that question we propose to pool the countries' sub-samples and interact the multimarket variables with an indicator variable for heavily regulated countries. We took this route based on the observation that in general the marginal effects of the quality variables and some competition variables does not change too widely across countries in the sample. The results suggest that price interventions in more concentrated markets induces a reduction in prices also in more competitive

-less regulated- markets. The theoretical justification for this result, although not formally shown, is related to the fact that price regulation may be so intense that little market power is left to be allocated to more competitive product markets. This result is of paramount importance for policy making. Since price controls and related regulatory systems barely take into account the structure of the industry and its peculiarities, our work could be of great interest to empirically predict undesirable effects of public interventions in this particular case. For instance, reducing prices in more competitive markets compared to the prevailing level in the un-regulated case may discourage entry and may have a negative dynamic effect in the development of the industry. Projecting this idea onto the debate of imposing further price restrictions in current less regulated countries [See a brief discussion in Santere and Vernon (2005)], our result provides an alternative explanation for the observation that in highly regulated markets entry is less likely, both of innovative products and alternative varieties of an existing drug. [c.f. Danzon et al. (2005) and Kyle (2007)].

Possible extensions of this analysis include specializing for specific product markets such as those for anti-ulcer or anti-hypertensive drugs. Focusing on specific cases will help to model in a more precise fashion features such as horizontal product and vertical product differentiation, precise definitions of price regulations on their strategic effects so that more structure could be given to the analysis. Likewise, one could also use as a starting point the idea of defining specific countries as different markets of the same industry structure much in the way states of the US are considered. For example, contacts among firms across EU countries could also be a dimension to study.

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A Figures and Tables

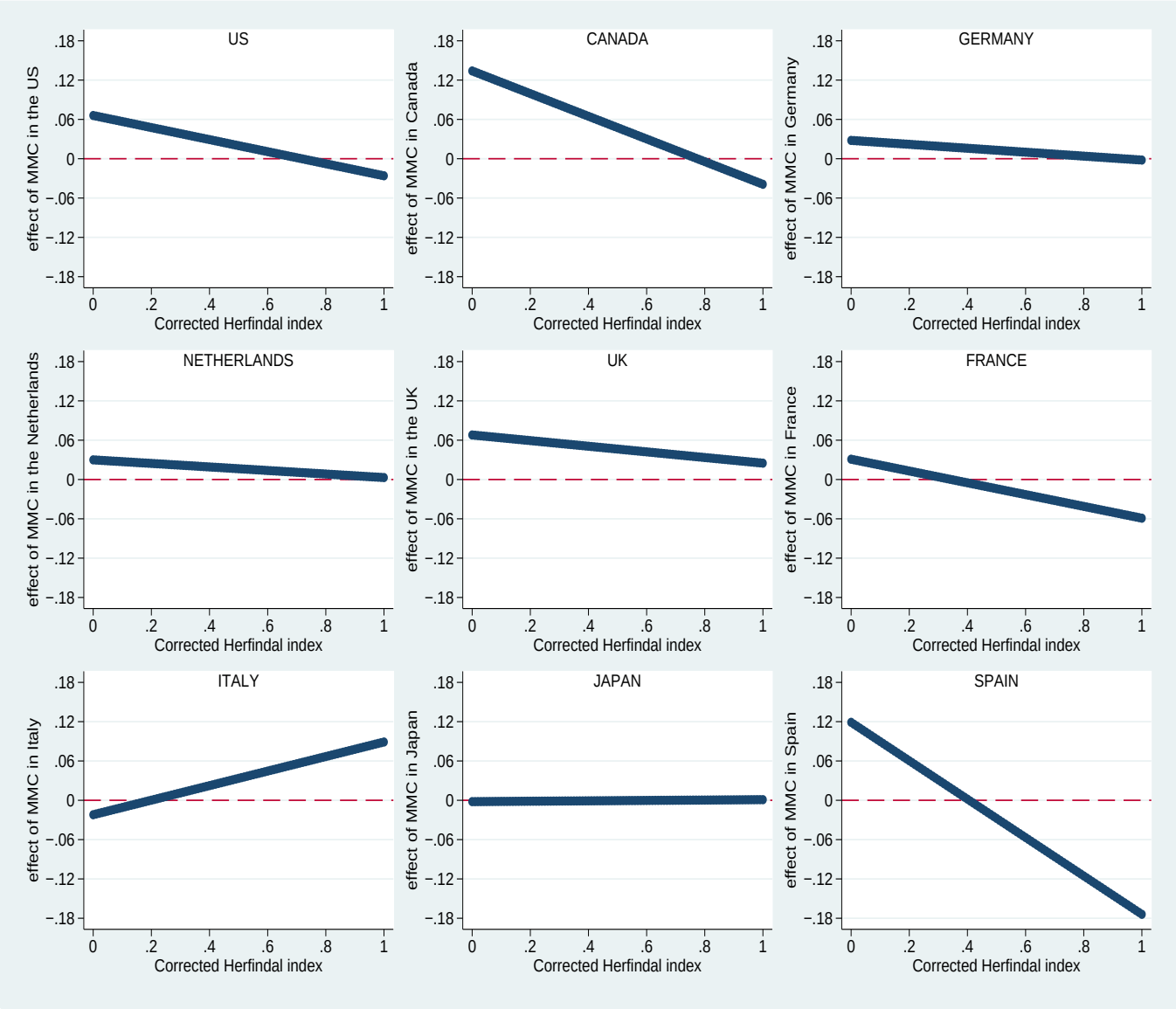

Figure 1: Effect of multimarket contact in selected markets. Market definition: molecule.

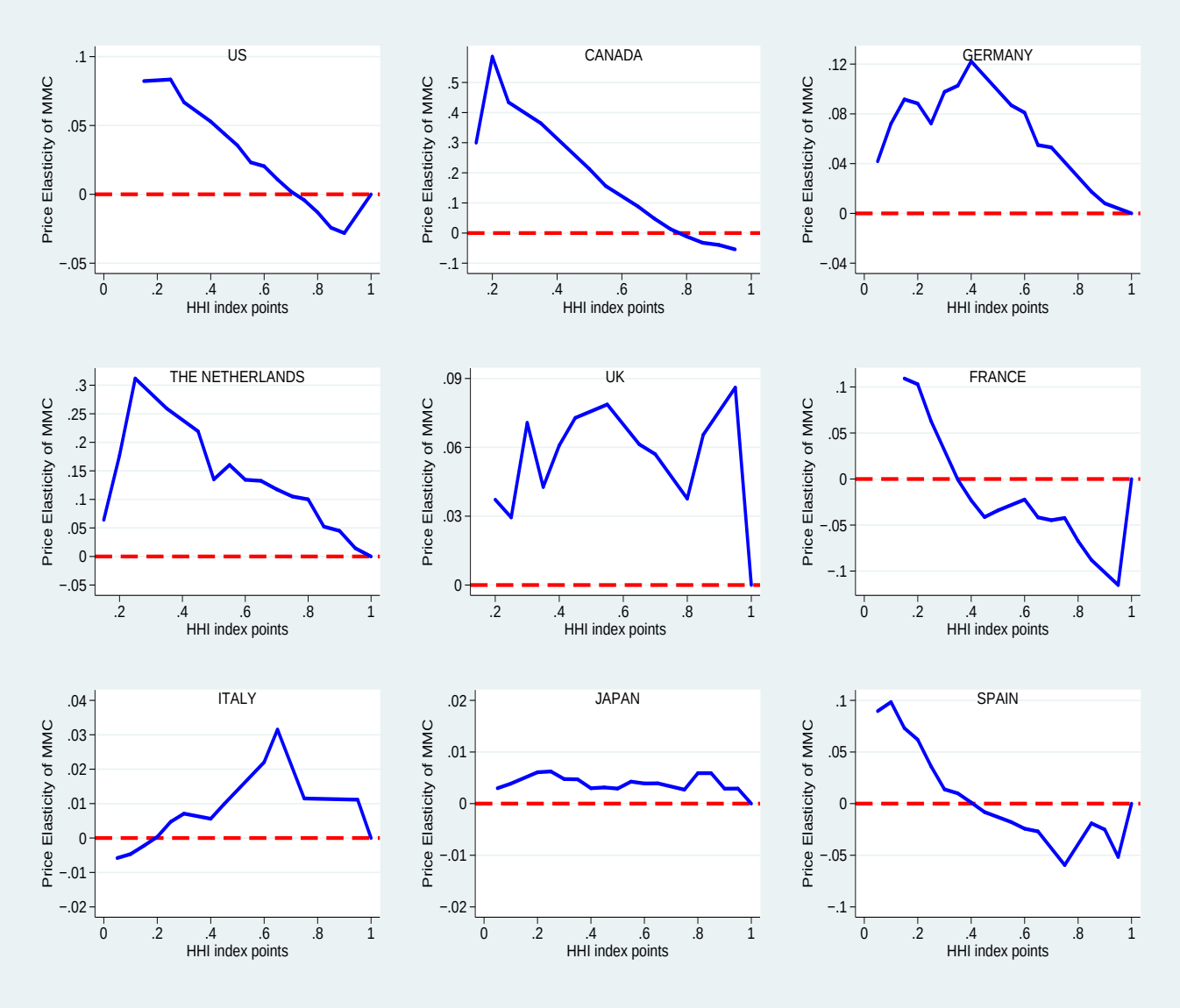

Figure 2: Estimated Price elasticities at the average MMC means by HHI-quintile. note: for each HHI-quintile the number of contacts has been set to the sample average.

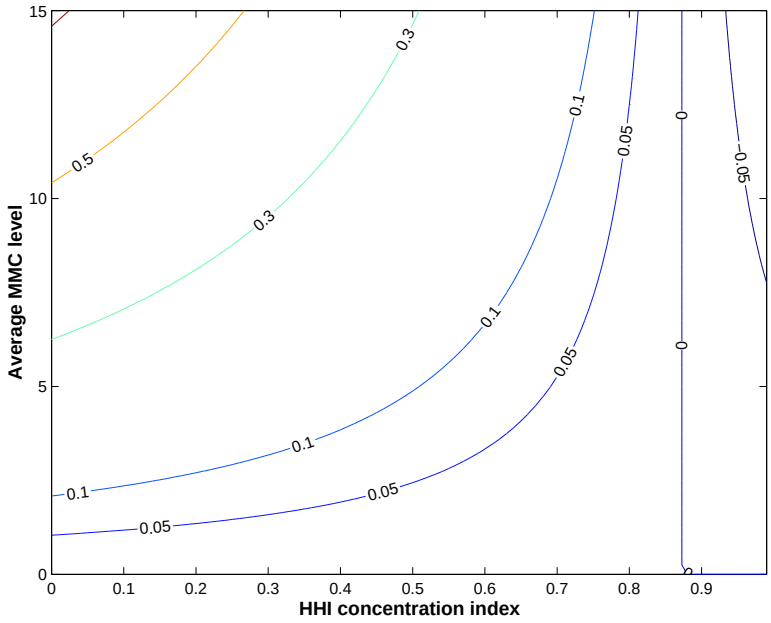

Figure 3: Estimated price elasticities to multimarket structure for low and medium regulated countries.

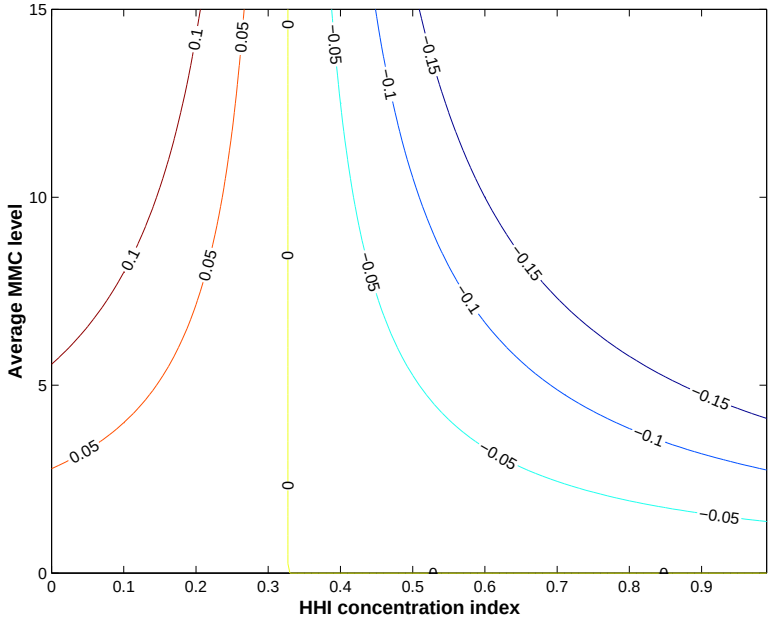

Figure 4: Estimated Price elasticities to multimarket structure for highly regulated countries

Table 1: Descriptive statistics

Panel A: Summary statistics by country

Type	country	No. markets molec. (A)	No. markets ATC4	No. corp.	No. products (C)	molecule HHI mean	molecule HHI median	ATC4 HHI mean	ATC4 HHI median
I	Canada	867	213	160	2552	.159	.080	.23	.148
	US	1574	264	621	7170	.531	.492	.167	.093
II	Germany	1874	261	587	6985	.514	.451	.152	.082
	Nether	421	146	87	1148	.668	.764	.365	.246
	UK	618	189	147	1143	.663	.830	.377	.283
III	France	782	214	164	1929	.569	.500	.254	.191
	Italy	726	215	253	1992	.533	.499	.265	.179
	Japan	674	181	174	2401	.508	.435	.253	.163
	Spain	660	220	179	1693	.523	.496	.295	.205

Panel B: Distribution of corporations by country

Type	country	1	2-4	5-9	10-14	15-20	21+	Total
I	Canada	48	30	30	15	4	33	160
	US	232	178	91	26	22	72	621
II	Germany	208	141	94	46	32	66	587
	Nether	18	28	14	9	5	13	87
	UK	49	45	25	7	8	13	147
III	France	54	46	30	10	5	19	164
	Italy	65	81	49	30	11	17	253
	Japan	32	32	43	20	19	28	174
	Spain	43	45	36	22	15	18	179

Panel C: Distribution of molecule age by country

Type	country	1	1-2	3-4	4-7	7-10	11+	Total
I	Canada	17	107	104	247	309	83	867
	US	17	190	246	418	405	298	1,574
II	Germany	45	338	218	423	512	338	1,874
	Nether	12	64	67	132	100	46	421
	UK	17	93	104	212	130	62	618
III	France	24	94	126	294	151	93	782
	Italy	16	96	136	264	143	71	726
	Japan	8	104	123	191	171	77	674
	Spain	22	106	119	215	127	71	660

Table 2: **Summary of Statistics for Alternative MMC definitions**

Country	**MMC Def.**	**mean**	**S.D.**	**N**	**min**	**max**
Canada	$AVMMC_i$	3.267787	4.539079	7306	0	23.31294
	$AVMMC_k$	5.03172	5.816102	7306	0	43.06461
US	$AVMMC_i$	1.376322	1.887178	15519	0	21.28824
	$AVMMC_k$	1.845514	2.593831	15519	0	30.93439
Germany	$AVMMC_i$	4.390942	7.594441	17365	0	43.61862
	$AVMMC_k$	6.930001	9.209209	17365	0	74.30422
Nether	$AVMMC_i$	6.304839	8.160128	2621	0	41.54391
	$AVMMC_k$	1.910695	2.200827	2621	0	16.65326
UK	$AVMMC_i$	.7167481	1.819917	3077	0	14.53169
	$AVMMC_k$	.7099619	1.704774	3077	0	15.96973
France	$AVMMC_i$	2.893824	4.328823	5799	0	19.00629
	$AVMMC_k$	4.305282	6.236178	5799	0	77.77623
Italy	$AVMMC_i$	.307457	.5662813	5760	0	4.732938
	$AVMMC_k$	.5597214	1.792093	5760	0	25.99545
Japan	$AVMMC_i$	1.098841	1.572164	5350	0	13.53323
	$AVMMC_k$	1.580326	5.534312	5350	0	51.27918
Spain	$AVMMC_i$	.4650383	.7450629	5075	0	4.525763
	$AVMMC_k$	.6174125	1.139168	5075	0	10.482

Note:
Subindex i refers to a definition that varies across corporations, while subindex k to a definition that varies across markets

Table 3: Regression results by country. Independent variable Log (Price_t). Corporation fixed effects. Without controlling for multimarket contact. Market definition: molecule (Robust Standard Errors by Corporation Clusters)

Variable	**US**	**CAN**	**GER**	**NETH**	**UK**	**FRA**	**ITA**	**JAP**	**SP**
New_{t-1}	-0.067	-0.320	-0.221	-0.236	-0.309	-0.161	-0.187	-0.190	-0.160
	(-1.39)	(-4.91)	(-7.14)	(-3.50)	(-6.53)	(-3.71)	(-4.69)	(-4.09)	(-3.45)
Fsize_{t-1}	0.240	0.286	0.220	0.114	0.213	0.171	0.161	0.318	0.160
	(15.21)	(11.22)	(14.95)	(5.01)	(11.34)	(8.63)	(7.92)	(13.33)	(7.52)
Molage_t	-0.437	-0.267	-0.166	-0.114	-0.247	-0.195	-0.142	-0.103	-0.324
	(-6.71)	(-3.08)	(-4.49)	(-1.78)	(-2.34)	(-2.88)	(-2.57)	(-1.49)	(-4.73)
Censormol_t	-0.009	0.036	0.112	0.057	-0.413	-0.065	0.161	0.091	0.166
	(-0.12)	(0.33)	(2.05)	(0.55)	(-2.16)	(-0.34)	(1.44)	(0.41)	(1.04)
Censorlag_t	0.429	0.070	0.020	0.100	1.033	0.500	-0.209	-0.412	-0.097
	(2.09)	(0.17)	(0.20)	(0.90)	(2.99)	(2.00)	(-0.68)	(-0.89)	(-0.32)
Dgeneric	-0.319	0.068	-0.060	-0.182	-0.726	-0.406	-0.206	-0.023	-0.396
	(-3.23)	(0.47)	(-0.92)	(-1.34)	(-3.26)	(-3.46)	(-2.38)	(-0.17)	(-4.12)
Composite	-0.155	-0.133	0.085	-0.042	-0.184	0.100	0.094	-0.025	-0.089
	(-1.96)	(-1.87)	(1.96)	(-0.60)	(-1.58)	(1.44)	(1.71)	(-0.24)	(-1.35)
Ngenerics_t	0.011	-0.047	0.008	0.029	0.129	0.048	0.002	0.023	0.003
	(2.05)	(-3.47)	(4.06)	(1.94)	(4.54)	(5.26)	(0.29)	(1.17)	(0.56)
Priceg_{t-1}	0.538	0.528	0.652	0.856	0.600	0.672	0.685	0.594	0.690
	(15.31)	(14.30)	(21.11)	(29.07)	(16.73)	(18.77)	(21.73)	(21.69)	(18.72)
Dpriceg_{t-1}	-1.205	-1.372	-1.565	-1.263	-1.068	-1.632	-1.148	-0.503	-0.831
	(-7.98)	(-8.22)	(-13.81)	(-1.99)	(-5.76)	(-7.65)	(-6.64)	(-1.99)	(-4.05)
$\widetilde{HHI}_{t-1}$	0.228	-1.024	-0.136	0.122	0.425	0.206	0.390	0.184	-0.780
	(1.89)	(-4.23)	(-1.32)	(0.69)	(2.03)	(1.03)	(3.17)	(1.30)	(-4.77)
Mshare_{t-1}	0.720	-0.473	0.455	0.388	0.510	0.632	0.162	0.509	-0.567
	(5.31)	(-1.85)	(5.64)	(2.12)	(2.25)	(3.94)	(1.47)	(3.21)	(-4.69)
Cshare_{t-1}	0.425	-0.742	0.008	0.111	0.312	0.242	0.354	-0.108	-0.375
	(1.87)	(-2.67)	(0.04)	(0.36)	(0.99)	(0.87)	(2.52)	(-0.24)	(-1.49)
Cons	1.850	0.829	-0.107	0.104	0.795	-0.024	0.189	-2.141	2.114
	(3.41)	(1.06)	(-0.36)	(0.18)	(0.77)	(-0.04)	(0.40)	(-3.57)	(3.87)
N	15519	7306	17365	2621	3077	5799	5760	5350	5075
$R^2 - within$	0.496	0.571	0.679	0.829	0.641	0.629	0.711	0.743	0.674
$R^2 - between$	0.723	0.762	0.771	0.856	0.775	0.807	0.792	0.893	0.638
$R^2 - overall$	0.641	0.647	0.731	0.854	0.711	0.716	0.750	0.791	0.720
F	112.26	209.75	405.56	521.81	77.15	141.58	129.62	203.44	175.11

Table 4: Regression results by country. Independent variable Log (Price$_t$). Corporation fixed effects. Linear average multimarket contact control. Market definition: molecule (Robust Standard Errors by Corporation Clusters)

Variable	**US**	**CAN**	**GER**	**NETH**	**UK**	**FRA**	**ITA**	**JAP**	**SP**
New$_{t-1}$	-0.066	-0.308	-0.218	-0.242	-0.320	-0.164	-0.185	-0.190	-0.161
	(-1.35)	(-4.64)	(-7.11)	(-3.55)	(-6.62)	(-3.75)	(-4.60)	(-4.08)	(-3.43)
Fsize$_{t-1}$	0.240	0.292	0.221	0.114	0.214	0.171	0.162	0.318	0.160
	(15.32)	(11.17)	(15.13)	(5.02)	(11.42)	(8.65)	(8.00)	(13.35)	(7.54)
Molage$_t$	-0.434	-0.210	-0.153	-0.114	-0.234	-0.203	-0.136	-0.102	-0.326
	(-6.72)	(-2.41)	(-4.16)	(-1.80)	(-2.21)	(-2.93)	(-2.48)	(-1.48)	(-4.76)
Censormol$_t$	-0.010	0.016	0.118	0.080	-0.394	-0.064	0.157	0.086	0.162
	(-0.13)	(0.17)	(2.17)	(0.76)	(-2.07)	(-0.34)	(1.43)	(0.37)	(1.00)
Censorlag$_t$	0.430	0.056	0.023	0.090	1.003	0.504	-0.210	-0.407	-0.093
	(2.09)	(0.13)	(0.23)	(0.82)	(2.93)	(2.01)	(-0.69)	(-0.87)	(-0.31)
Generic	-0.326	0.081	-0.070	-0.185	-0.741	-0.392	-0.213	-0.024	-0.391
	(-3.51)	(0.58)	(-1.12)	(-1.36)	(-3.31)	(-3.21)	(-2.37)	(-0.18)	(-4.16)
Composite	-0.156	-0.122	0.084	-0.047	-0.189	0.101	0.088	-0.026	-0.086
	(-1.98)	(-1.79)	(1.93)	(-0.67)	(-1.63)	(1.45)	(1.51)	(-0.25)	(-1.33)
Ngenerics$_t$	0.011	-0.039	0.009	0.029	0.126	0.049	0.001	0.023	0.003
	(2.06)	(-2.94)	(4.23)	(1.95)	(4.66)	(5.41)	(0.28)	(1.19)	(0.61)
Priceg$_{t-1}$	0.539	0.525	0.651	0.857	0.601	0.672	0.685	0.594	0.690
	(15.30)	(14.23)	(21.11)	(29.02)	(16.69)	(18.86)	(21.77)	(21.71)	(18.78)
Dpriceg$_{t-1}$	-1.199	-1.354	-1.566	-1.264	-1.060	-1.631	-1.142	-0.502	-0.832
	(-7.98)	(-8.19)	(-13.80)	(-1.99)	(-5.67)	(-7.64)	(-6.63)	(-1.99)	(-4.09)
$\widetilde{HHI}_{t-1}$	0.230	-0.891	-0.123	0.173	0.408	0.198	0.389	0.188	-0.784
	(1.90)	(-3.80)	(-1.16)	(0.93)	(1.94)	(0.99)	(3.15)	(1.34)	(-4.70)
Mshare$_{t-1}$	0.728	-0.287	0.483	0.425	0.543	0.613	0.175	0.514	-0.579
	(5.65)	(-1.17)	(5.75)	(2.25)	(2.40)	(3.79)	(1.58)	(3.41)	(-4.39)
Cshare$_{t-1}$	0.432	-0.596	0.008	0.150	0.341	0.225	0.362	-0.102	-0.384
	(1.92)	(-2.27)	(0.04)	(0.48)	(1.09)	(0.79)	(2.56)	(-0.22)	(-1.51)
AVMMC$_{t-1}$	0.009	0.037	0.010	0.012	0.037	-0.007	0.035	0.004	-0.022
	(0.53)	(2.46)	(1.55)	(2.11)	(2.85)	(-1.22)	(0.59)	(0.14)	(-0.34)
Cons	1.811	0.109	-0.258	0.031	0.659	0.054	0.126	-2.154	2.133
	(3.38)	(0.14)	(-0.85)	(0.05)	(0.63)	(0.09)	(0.27)	(-3.61)	(3.91)
N	15519	7306	17365	2621	3077	5799	5760	5350	5075
$R^2 - within$	0.496	0.575	0.679	0.829	0.642	0.629	0.711	0.743	0.674
$R^2 - between$	0.722	0.745	0.769	0.856	0.774	0.808	0.791	0.892	0.639
$R^2 - overall$	0.639	0.627	0.729	0.855	0.708	0.717	0.750	0.790	0.720
F	106.10	218.85	397.00	472.81	90.25	133.56	129.36	197.89	166.66

Table 5: Regression results by country. Independent variable Log (Price$_t$). Corporation fixed effects. The effect of the MMC depends on concentration. Market definition: molecule (Robust Standard Errors by Corporation Clusters)

Variable	**US**	**CAN**	**GER**	**NETH**	**UK**	**FRA**	**ITA**	**JAP**	**SP**
New$_{t-1}$	-0.063	-0.275	-0.221	-0.250	-0.318	-0.154	-0.186	-0.190	-0.153
	(-1.30)	(-4.50)	(-7.38)	(-3.73)	(-6.72)	(-3.36)	(-4.65)	(-4.05)	(-3.39)
Fsize$_{t-1}$	0.241	0.298	0.222	0.116	0.214	0.171	0.162	0.318	0.160
	(15.46)	(11.44)	(15.52)	(5.17)	(11.46)	(8.70)	(8.02)	(13.34)	(7.63)
Molage$_t$	-0.414	-0.155	-0.148	-0.113	-0.233	-0.182	-0.137	-0.102	-0.322
	(-6.28)	(-1.92)	(-4.04)	(-1.79)	(-2.24)	(-2.58)	(-2.47)	(-1.51)	(-4.71)
Censormol$_t$	-0.011	-0.056	0.132	0.080	-0.377	-0.084	0.158	0.084	0.174
	(-0.15)	(-0.56)	(2.38)	(0.74)	(-1.91)	(-0.46)	(1.45)	(0.36)	(1.10)
Censorlag$_t$	0.424	0.037	0.010	0.085	0.989	0.503	-0.210	-0.405	-0.107
	(2.07)	(0.08)	(0.10)	(0.76)	(2.90)	(2.05)	(-0.69)	(-0.87)	(-0.36)
Generic	-0.334	0.070	-0.080	-0.181	-0.742	-0.393	-0.211	-0.024	-0.396
	(-3.62)	(0.50)	(-1.30)	(-1.32)	(-3.30)	(-3.15)	(-2.36)	(-0.18)	(-4.14)
Composite	-0.158	-0.122	0.080	-0.052	-0.189	0.090	0.089	-0.026	-0.091
	(-2.00)	(-1.89)	(1.85)	(-0.74)	(-1.63)	(1.32)	(1.53)	(-0.25)	(-1.42)
Ngenerics$_t$	0.011	-0.025	0.010	0.029	0.127	0.048	0.002	0.023	0.001
	(2.04)	(-2.07)	(4.69)	(2.00)	(4.84)	(5.56)	(0.34)	(1.19)	(0.28)
Priceg$_{t-1}$	0.538	0.520	0.649	0.855	0.602	0.668	0.684	0.594	0.692
	(15.28)	(14.45)	(21.40)	(29.28)	(16.65)	(18.70)	(21.77)	(21.80)	(18.99)
Dpriceg$_{t-1}$	-1.217	-1.401	-1.576	-1.253	-1.062	-1.637	-1.139	-0.502	-0.840
	(-8.08)	(-8.47)	(-13.95)	(-1.99)	(-5.66)	(-7.67)	(-6.62)	(-1.99)	(-4.20)
$\widetilde{HHI}_{t-1}$	0.405	-0.155	0.036	0.436	0.475	0.519	0.355	0.184	-0.640
	(2.83)	(-0.55)	(0.26)	(1.24)	(1.81)	(2.13)	(2.41)	(0.92)	(-3.10)
Mshare$_{t-1}$	0.868	0.285	0.574	0.573	0.593	0.813	0.154	0.512	-0.496
	(6.01)	(1.05)	(6.60)	(2.28)	(2.58)	(4.35)	(1.25)	(3.02)	(-3.63)
Cshare$_{t-1}$	0.561	-0.046	0.085	0.294	0.392	0.426	0.338	-0.105	-0.302
	(2.40)	(-0.16)	(0.41)	(0.79)	(1.18)	(1.48)	(2.24)	(-0.22)	(-1.17)
AVMMC$_{t-1}$	0.066	0.134	0.028	0.030	0.068	0.031	-0.022	0.002	0.119
	(2.43)	(5.39)	(2.91)	(1.87)	(1.02)	(3.02)	(-0.28)	(0.04)	(1.02)
AVMMC$_{t-1}$*	-0.092	-0.173	-0.030	-0.027	-0.043	-0.090	0.111	0.003	-0.293
HHI_{t-1}	(-2.96)	(-6.33)	(-3.71)	(-1.46)	(-0.44)	(-4.13)	(0.78)	(0.04)	(-0.99)
Cons	1.527	-0.864	-0.377	-0.139	0.600	-0.287	0.155	-2.149	2.033
	(2.75)	(-1.21)	(-1.18)	(-0.23)	(0.62)	(-0.44)	(0.32)	(-3.61)	(3.66)
N	15519	7306	17365	2621	3077	5799	5760	5350	5075
$R^2 - within$	0.497	0.583	0.680	0.830	0.642	0.631	0.711	0.743	0.675
$R^2 - between$	0.720	0.751	0.768	0.858	0.772	0.808	0.792	0.892	0.635
$R^2 - overall$	0.637	0.629	0.727	0.855	0.708	0.718	0.750	0.790	0.719
F	109.94	245.26	399.39	740.76	85.01	128.95	127.20	197.11	160.83

Table 6: Regression results for the pooled sample. Independent variable Log (Price$_t$). Corporation × Country fixed effects. Market definition: Molecule (Robust Standard Errors by Country/Corporation Cluster)

Variable	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Fsize$_{t-1}$	0.223	0.224	0.225	0.223	0.224	0.224
	(28.99)	(29.10)	(29.28)	(28.97)	(29.05)	(29.20)
New$_{t-1}$	-0.184	-0.182	-0.182	-0.185	-0.184	-0.184
	(-9.65)	(-9.59)	(-9.65)	(-9.66)	(-9.69)	(-9.75)
Molage$_t$	-0.230	-0.220	-0.213	-0.231	-0.225	-0.219
	(-9.54)	(-9.26)	(-8.96)	(-9.55)	(-9.43)	(-9.16)
Censormol$_t$	0.012	0.016	0.023	0.008	0.012	0.019
	(0.28)	(0.38)	(0.54)	(0.18)	(0.28)	(0.44)
Censorlag$_t$	0.195	0.197	0.177	0.198	0.203	0.183
	(2.65)	(2.68)	(2.41)	(2.69)	(2.75)	(2.48)
Generic	-0.203	-0.213	-0.220	-0.203	-0.210	-0.215
	(-4.56)	(-4.87)	(-5.01)	(-4.57)	(-4.79)	(-4.94)
Composite	-0.044	-0.045	-0.047	-0.047	-0.047	-0.049
	(-1.52)	(-1.56)	(-1.60)	(-1.61)	(-1.62)	(-1.68)
Ngenerics$_t$	0.008	0.008	0.009	0.006	0.006	0.006
	(3.65)	(3.89)	(4.21)	(2.41)	(2.50)	(2.60)
Priceg$_{t-1}$	0.621	0.621	0.619	0.621	0.620	0.618
	(44.01)	(44.05)	(44.09)	(44.02)	(43.92)	(43.86)
Dpriceg$_{t-1}$	-1.214	-1.211	-1.223	-1.216	-1.212	-1.225
	(-17.9)	(-17.9)	(-18.1)	(-18.0)	(-17.9)	(-18.1)
$\widetilde{HHI}_{t-1}$	-0.045	-0.031	0.123	-0.031	-0.022	0.150
	(-0.78)	(-0.53)	(1.88)	(-0.53)	(-0.38)	(2.25)
Mshare$_{t-1}$	0.312	0.340	0.442	0.324	0.342	0.453
	(5.53)	(6.03)	(7.45)	(5.62)	(5.93)	(7.45)
Cshare$_{t-1}$	0.108	0.127	0.222	0.119	0.129	0.235
	(1.13)	(1.34)	(2.31)	(1.25)	(1.35)	(2.41)
AVMMC$_{t-1}$		0.014	0.043		0.016	0.048
		(2.62)	(5.07)		(2.58)	(4.73)
AVMMC$_{t-1}$ $*HHI_{t-1}$			-0.051			-0.055
			(-5.96)			(-5.64)
Dreg$_t$*Ngenerics$_t$				0.010	0.012	0.014
				(2.39)	(2.91)	(3.30)
Dreg$_t$*AVMMC$_{t-1}$					-0.026	-0.030
					(-2.75)	(-2.25)
Dreg$_t$*AVMMC$_{t-1}$ $*HHI_{t-1}$						-0.013
						(-0.71)
Cons	0.416	0.300	0.151	0.420	0.340	0.185
	(2.01)	(1.45)	(0.72)	(2.03)	(1.66)	(0.89)
N	67872	67872	67872	67872	67872	67872
$R^2 - within$	0.616	0.616	0.617	0.616	0.617	0.618
$R^2 - between$	0.733	0.731	0.730	0.733	0.732	0.731
$R^2 - overall$	0.685	0.682	0.680	0.686	0.684	0.682
F	751.73	729.21	757.71	721.92	670.53	677.35