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Summary

The main purpose of the first two chapters of this dissertation is to characterize the impact of mergers on firms' incentives to collude, and to propose and evaluate the accuracy of different tools designed to assess the magnitude of coordinated effects. In addition, the third chapter empirically assesses the impact of a merger between two large retailers in the Chilean gasoline market, and evaluates the effectiveness of gas stations divestitures as a tool to mitigate a potential anticompetitive increase in prices.

In **Chapter 1** (joint with Marc Ivaldi), titled *"Assessment of Post-merger Coordinated Effects: Characterization by Simulations,"* I examine the link between horizontal mergers and firms' incentives to engage in collusion, and offer a novel approach for assessing the change in the merged firm's critical discount factor (i.e., the minimum value of the discount factor that makes collusion profitable for a given firm). Results suggest that a merger can be used as a commitment device to increase the incentives to collude of merging parties, and depending on the characteristics of each merger, either diversion ratios or cross-price elasticities can be used as assessment tools.

In a similar vein, in **Chapter 2** (joint with Marc Ivaldi), titled *"Parallel Accommodating Conduct: Evaluating the Performance of the Coordinated Price Pressure Index,"* I study the performance of an index proposed by Moresi et al. (2011), which aims at measuring the impact of mergers on firms incentives to engage in tacit coordination to increase prices. This chapter also introduces two alternative indexes that require a larger set of information. Results suggest that the CPPI index only displays a fair performance, and show that both alternative indexes outperform the original one in terms of predicting mergers that result in a significant anticompetitive effect.

Finally, in **Chapter 3,** titled *"Effectiveness of Merger Remedies: The Case of Chilean Gasoline Retail Markets,"* I empirically assess the impact of a merger between two large retailers in the Chilean gasoline retail market and evaluate the effectiveness of gas stations divestitures as post-merger remedies. Results suggest a modest but significant effect of the merger on prices, and show that in certain cases the divestitures were indeed effective in mitigating this anticompetitive effect.

Résumé

L'objectif principal des deux premiers chapitres de cette thèse est de caractériser l'impact des fusions sur les incitations des entreprises à la collusion, et d'évaluer la précision des différents outils conçus pour mesurer des effets coordonnés afin de proposer des outils plus adaptés. De plus, le troisième chapitre évalue empiriquement l'impact d'une fusion entre deux grandes entreprises de commerce de détail de carburant au Chili et évalue l'efficacité des cessions d'actifs (dans ce cas, des stations-service) comme outil pour atténuer les effets d'une potentielle augmentation anticoncurrentielle des prix.

Dans le **Chapitre 1** (co-écrit avec Marc Ivaldi), intitulé « *Évaluation des effets coordonnés post-fusion : caractérisation par simulations* », j'examine le lien entre les fusions horizontales et les incitations des entreprises à la collusion, et je propose une nouvelle approche pour évaluer le changement du « facteur d'actualisation seuil » des entreprises fusionnées (c'est-à-dire, la valeur minimale du facteur d'actualisation en dessous duquel les entreprises sont incitées à dévier). Les résultats suggèrent qu'une fusion peut être utilisée comme un dispositif d'engagement à la collusion par les entreprises fusionnées, et qu'en fonction des caractéristiques de chaque fusion, soit des ratios de diversion (c'est-à-dire, la proportion des pertes des ventes ou de détournement de clientèle en cas d'augmentation des prix) ou soit des élasticités-prix croisées de la demande peuvent être utilisés comme outils d'évaluation.

De même, dans le **Chapitre 2** (co-écrit avec Marc Ivaldi), intitulé « *Conduite parallèle accommodante : évaluation de performance de l'indice CPPI* », j'étudie la performance d'un indice proposé par Moresi et al. (2011), qui a comme objectif principal d'évaluer l'impact des fusions sur les incitations des entreprises à une coordination tacite pour augmenter les prix. Ce chapitre présente deux indices alternatifs qui nécessitent plus d'informations pour leur mise en œuvre. Les résultats suggèrent que l'indice CPPI affiche une performance acceptable, et que les deux indices alternatifs sont plus performants en termes de prédiction des fusions conduisant a un effet anticoncurrentiel significatif.

Enfin, au **Chapitre 3**, intitulé « *Efficacité des engagements : le cas des marchés de détail de carburant au Chili* », j'évalue empiriquement l'impact d'une fusion entre deux grandes entreprises sur le marché chilien de détail de carburant et j'évalue l'efficacité des cessions d'actifs (dans ce cas, des stations-service) comme principaux engagements post-fusion. Les résultats suggèrent un effet modeste mais significatif de la fusion sur les prix, et montrent que, dans certains cas, les cessions d'actifs étaient en effet efficaces pour atténuer l'effet anticoncurrentiel de las hausses des prix.

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Many thanks to Aldo Gonzalez, who back in Chile, gave me the opportunity to be his teaching and research assistant, and later on lecturer of an undergraduate Industrial Organization class at the University of Chile. In many ways, Aldo has had a great impact in my life, he was the one who introduced me to the world of Competition Policy, and was the one who encouraged me to come to Toulouse in the first place.

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Introduction

There are two stylized facts that make the study of coordinated effects of mergers a very relevant topic for research. First, every year we observe several mergers in many different countries and across very heterogeneous industries and sectors. Notably, from the mergers that are actually reviewed by competition authorities, almost all of them are finally approved.[1] Second, the empirical evidence has shown a significant effect of cartels in raising prices faced by intermediaries and final consumers, which inefficiently reduces trade and consumers' surplus.[2] Yet, there is no consensus among practitioners on which is the best way to assess the link between both: mergers and firms' incentives to collude.

In this context, in **Chapter 1** (joint with Marc Ivaldi), titled *"Assessment of Post-merger Coordinated Effects: Characterization by Simulations,"* I examine the link between horizontal mergers and firms' incentives to engage in collusion. The main results show that a merger increases the incentives of the merged firm to collude, but weaken the incentives of non-merging parties, with the former effect being stronger. In addition, this chapter offers a novel approach for assessing the change in the merged firm's critical discount factor (i.e. the minimum value of the discount factor that makes collusion profitable). On the one hand, in the case of a merger between two symmetric firms (in terms of payoffs), the competition assessment should rely on screening tools able to capture the size of the pricing externalities existent among the merging parties' brands (for instance, diversion ratios). On the other hand, for certain mergers involving two asymmetric firms (in terms of payoffs), the magnitude of coordinated effects is directly related to the degree of pre-merger asymmetry of the merging parties in terms of their incentives to collude.

In a similar vein, in **Chapter 2** (joint with Marc Ivaldi), titled *"Parallel Accommodating Conduct: Evaluating the Performance of the Coordinated Price Pressure Index,"* I study the performance of an index proposed by Moresi et al. (2011), which aims at measuring the impact of mergers on firms incentives to engage in a specific type of tacit coordination to increase prices. The results suggest a fair performance of the index, but only in mergers involving firms with low diversion ratios among the products offered by them. Furthermore, this chapter introduces two alternative indexes that require a larger set of information, namely: the diversion ratios between the merging parties' products, their own-price elasticities and margins. Results show that these alternative indexes outperform the original one in

[1] See for instance, the statistics of merger cases reviewed by the European Commission, available in the following link: http://ec.europa.eu/competition/mergers/statistics.pdf
[2] For instance, Ivaldi et al. (2014) show that cartels in developing countries reduce production in the concerned markets by 15% on average.

terms of predicting mergers with a significant anticompetitive impact on firms' incentives to coordinate. However, the percentage of cases displaying a Type II Error is still not negligible.

Recently, policymakers have shown concern regarding the lack of ex-post impact evaluation of interventions carried out by regulators and competition authorities, especially in developing countries.[3] In particular, in the field of merger control the most common way of intervention is the implementation of post-merger remedies. These include rules regulating the way firms should behave (i.e., behavioral remedies) and/or deeper changes in the structure of markets (i.e., structural remedies). In this setting, the divestiture of assets in concentrated markets has emerged as the most popular remedy, mainly for two reasons: (i) it is relatively easy to implement and monitor, and (ii) because it potentially allows for entry, which is in theory the main source of mitigation of most anticompetitive concerns. Nevertheless, very little is known regarding the actual effectiveness of these types of policies, and the conditions under which they are more useful.

In relation to this topic, in **Chapter 3,** titled *"Effectiveness of Merger Remedies: The Case of Chilean Gasoline Retail Markets,"* I empirically assess the impact of a merger between two large retailers in the Chilean gasoline retail market and evaluate the effectiveness of gas stations divestitures in certain local markets as a tool to mitigate any potential anticompetitive effects. Initially, this merger was blocked by the Chilean Competition Tribunal, which considered that divestitures and the entry of small brands in concentrated local markets would not be an effective remedy. The Tribunal reasoning was based on the fact that small brands would face important disadvantages vis-à-vis larger competitors, due to their impossibility to reach a minimum scale of operation that would allow them to benefit from economies of scale and scope in the supply of inputs (i.e., mainly transport networks to supply retail outlets with gasoline).

The identification strategy relies on the fact that a merger between two national retail networks should be independent of previous characteristics of different small local markets. Using a novel dataset released by the Chilean government, I use geographical-information software to identify characteristics of local markets and implement a reduced-form difference-in-difference approach to capture the impact of the merger and divestitures on prices. Results suggest a modest but significant effect of the merger on prices, and show that divestitures were indeed effective in mitigating this anticompetitive effect. However, this latter result only holds for gas stations located within 2 Km. radiuses from the divested outlets.

[3] See for instance the findings of an OECD report titled "Competition and Market Studies in Latin America (2015)," available in the following link: http://www.oecd.org/daf/competition/competition-and-market-studies-in-latin-america2015.pdf

Chapter 1:

Assessment of Post-merger Coordinated Effects: Characterization by Simulations

Joint with

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Assessment of Post-merger Coordinated Effects: Characterization by Simulations*

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Abstract

This paper aims at evaluating the coordinated effects of horizontal mergers by simulating their impact on firms' critical discount factors. We consider a random coefficient model on the demand side and heterogeneous price-setting firms on the supply side. Results suggest that mergers strengthen the incentives to collude of the merged firm, but weaken the incentives of non-merging parties, with the former effect being stronger. To assess the magnitudes of these effects, we introduce the concepts of Asymmetry in Payoffs and Change in Payoffs effects, which allow us to identify appropriate screening tools according to the relative pre-merger payoffs of merging parties.

Keywords Collusion - Coordinated Effects - Critical Discount Factor - Merger Simulation

JEL classification K21 L41

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Simulation code The original versions of the code and protocol used in this paper were created by Jérôme Foncel, researcher at the University of Lille in France.

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1. Introduction

The coordinated effects that could be induced by a merger are defined as the increase in the incentives for merging parties (insiders) and non-merging parties (outsiders) to explicitly or tacitly collude. Two types of effects can be identified in the literature. First, with fewer firms in the market, a merger could lessen the costs of coordinating and monitoring a cartel.[1] Second, as the merged firm internalizes the pricing externalities among its brands, its pricing incentives are modified, which in turn affects firms' payoffs and induces a change in their incentives to collude.[2]

So far, the competition authorities' assessment of coordinated effects has mainly focused on the first type of effects. Notably, the 2004 European Horizontal Merger Guidelines (EHMG) establishes four conditions for the presence of coordinated effects, that is to say: 1) the ability to reach a common understanding of the terms of coordination; 2) the ability to monitor potential deviations; 3) the existence of deterrent mechanisms; and 4), the presence of external sustainability. To our understanding, all these steps refer to structural characteristics of markets and/or the nature of the interactions between competitors.[3,4] While these elements are indeed crucial for an assessment of coordinated effects, none of them explicitly considers the impact of mergers on firms' pricing behavior.[5]

In this vein, our aim here is to characterize the risks of coordinated effects that are driven by the internalization of pricing externalities among the merging parties' brands, taking as given the four preceding conditions. To do so, we use a simulation setting with a demand specified according to a random coefficient discrete choice model and a supply side composed by heterogeneous single-product firms that compete in prices. Using a large set of simulated markets, we measure the impact of a merger

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[1] Ivaldi, Jullien, Rey, Seabright and Tirole (2003), identify a list of relevant market characteristics that may affect the sustainability of collusion

[2] Davis (2006) evaluates the impact of a merger on firms' collusion and defection payoffs. A simulation approach is used, considering a setting of price competition with differentiated products and linear demands.

[3] See Paragraph 41 of the European Horizontal Merger Guidelines (2004), which contains the necessary conditions for coordination to be sustainable.

[4] See Aigner *et al*. (2006) for a review of the evolution of coordinated effects' assessment within the EU

[5] For a detailed analysis of European Commission decisions involving coordinated effects' assessments, refer to the following papers. (i) Aigner *et al*. (2006), for the *Sony/BMG* and *Impala* cases, show how the Commission used data on prices in order to search for evidence of coordination in the past. In addition, the qualitative analysis mainly focuses on product heterogeneity and market transparency. (ii) In Amelio *et al*. (2009), for the *ABF/GBI Business* case, it is explained that the Commission identified some structural changes in the market that would make (tacit) collusion easier to implement, monitor and sustain. Among the critical factors are: the decrease in the number of competitors, the enhancement of market transparency, more effective punishment of deviations, the reduction of incentives to deviate and the increase of competitors' symmetry. (iii) Finally, Motta (2000), for *the Airtours/First Choise* case, explains that the Commission applied the concept of joint dominance and argued that the merger would increase the risk of collusion on capacities.

on firms' payoffs under three different competition scenarios: one period static Nash-equilibrium, perfect-collusion, and defection from collusion.

Unlike case studies, a simulation approach has the major advantage of allowing for the characterization of risks of coordinated effects under heterogeneous demand and supply conditions. Furthermore, this approach provides a large set of simulated markets, which can be relied upon to identify the economic conditions driving the effects of a merger. In particular, each simulated market is built from the combination of four elements: 1) a set of N consumers; 2) an indirect utility function with random coefficients; 3) a set of single-product firms with heterogeneous marginal costs, who compete in prices; and 4), products with differentiated quality attributes. In each simulation, the number of consumers and firms is kept constant. However, for each market, consumer preferences, firm marginal costs and product characteristics are randomly drawn from a set of chosen distributions.

The simplest setting of repeated interaction under the traditional grim-trigger strategies is used to model collusion.[6] A given firm is willing to collude only when the present value of its collusion payoffs is higher than the present value of its most profitable defection strategy. The Critical Discount Factor (hereinafter CRDF) is then defined as the minimum discount factor that makes collusion profitable. The change in coordination incentives induced by a merger is measured by the variation in the value of the CRDF.

A merger has two different effects on merging parties' incentives to collude. First, the asymmetry among merging parties in terms of their relative payoffs affects the post-merger CRDF. Specifically, the CRDF of the merged firm is relatively closer to the pre-merger CRDF of the larger merging party. The reason is that the payoffs of the larger merging party have more weight on the post-merger decision to collude. It is what we define as the Asymmetry in Payoffs (AP) effect. Second, since the merging parties internalize the negative externality among their brands that stems from the undercutting of prices, they charge higher equilibrium prices and become less aggressive when deviating from collusion prices.[7] This effect —which we define as Change in Payoffs (CP) effect— increases the merged firm equilibrium payoffs, but decreases its deviation payoffs. In other words, on the one hand, the CP effect makes collusion less profitable, while, on the other hand, it increases firms' incentives to collude. Thus, the direction and magnitude of the CP effect depends on which of these forces dominates. Regarding the impact of the merger on outsider firms, the merger only increases their

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[6] A given firm sets the collusive price, if and only if, all the other firms set the collusive price in the previous periods. Any defection from collusion triggers retaliation by rival firms, which consists of playing the one-period static Nash equilibrium during all the subsequent periods. See Friedman (1971).

[7] This result is also supported by Brito *et al.* (2013). Performing a merger simulation analysis with data from the U.S. wet shaving industry, the authors find that merging parties' defection prices are indeed increased after the merger.

equilibrium payoffs. This makes the defection strategy more profitable for outsider firms, and therefore, decreases their incentives to collude.

The simulation results suggest that the impact of the merger on the merging parties' incentives to deviate is significantly stronger than its impact on equilibrium payoffs. Thus, a merger can be used as a commitment device to increase the incentives to coordinate of the merged firm. The results also suggest that, while the impact on the merged firm's CRDF can be substantial after the merger, the impact on outsiders' CRDFs is moderate. Moreover, through a set of sensitivity analyses, we draw some interesting conclusions regarding the impact of efficiency gains and higher product differentiation on firms' CRDFs. For instance, the results suggest that the presence of efficiency gains tends to reinforce the impact of the merger on firms' CRDFs (i.e., by increasing the incentives for insiders to collude and by lowering the incentives for outsiders to collude).[8]

In addition, we offer a novel approach for assessing the change in the merged firm's CRDF. On the one hand, in the case of a merger between two symmetric firms (in terms of payoffs), the magnitude of the change is mainly driven by the CP effect. Thus, for these types of mergers, the assessment should rely on screening tools able to capture the size of the pricing externality. On the other hand, in certain mergers involving two asymmetric firms (in terms of payoffs), the magnitude of the change is mainly driven by the AP effect.[9] Consequently, in this scenario, the magnitude of the change is directly related to the degree of pre-merger asymmetry between the merging parties, in terms of their incentives to collude.

This paper is related to a strand of economic literature that studies how mergers affect firms' incentives to collude via the use of simulation techniques. For instance, Davis and Huse (2010) present the first empirical merger simulation model in a differentiated product market to study coordinated effects. They focus on the merger between Hewlett Packard and Compaq in the network server market. Their results show that the CRDF of insiders would decrease after a merger, while the CRDF of outsiders would increase. Similarly, Brito *et al.* (2013) simulate the coordinated effects of mergers and partial horizontal acquisitions in the wet shaving industry. The study finds that both partial and full acquisitions generate a decrease in the CRDF of acquiring firms while increasing the CRDFs of the

[8] Nevertheless, there is a non-negligible percentage of simulated cases where the efficiency gains actually offset the impact of the merger on non-merging parties. Thus, an interesting research venue would be to explore the direction of the effect for these specific cases.

[9] We define two types of mergers between asymmetric firms, namely, (i) when the larger firm has the higher incentives to collude and (ii), when the larger firm has the lower incentives to collude. This distinction is important as it is shown that only mergers from the former type have the potential to generate a significant impact on firms' CRDFs.

remaining firms in the market. Consistent with our results, both Davis and Huse (2010) and Brito *et al.* (2013) find that the effect on insiders is considerably stronger than on outsiders.[10]

Note that our results are indeed consistent with the findings of previous empirical papers. However, we contribute to the literature in three additional ways. First, our simulation approach allows us to test the robustness of the results for a broad range of consumer and firm characteristics. Second, to the best of our knowledge, this is the first paper that incorporates the impact of efficiency gains and product differentiation with the coordinated effects of mergers. Third, we provide useful guidelines for the assessment of coordinated effects. In particular, it is shown that the magnitude of change in CRDF can be measured by existing screening tools.

Finally, it is important to highlight that the results derived here are to be interpreted only qualitatively. An empirical verification of the main conclusions is certainly an interesting venue for future empirical research.

The rest of the paper is organized as follows. Section 2 introduces the model of demand and supply, and the simple collusion scheme proposed to characterize the coordinated effects of a merger. Section 3 summarizes the basic characteristics of the simulation setting. Section 4 contains the main simulation results and develops a set of sensitivity analyses. Section 5 describes how the assessment of coordinated effects can be related to the AP and CP effects. Lastly, Section 6 presents our main conclusions.

2. The model

2.1 Discrete choice model with random coefficients

Closely following the methodology proposed by Berry (1994) and Berry, Levinsohn, and Pakes (1995), we assume that consumer choices are expressed by means of a model of demand with random coefficients. The main advantage of this model is that it encompasses much more realistic patterns of own-price and cross-price elasticities between different products and firms.[11]

[10] Table C.1 in Appendix C summarizes the main results from these papers.

[11] As explained by Nevo (2000), in contrast to a simple Logit demand model where substitution between products is driven completely by market shares, a random coefficient model of demand yields cross-price elasticities that are larger for products that are closer substitutes in terms of their characteristics. Moreover, this methodology has been widely used in the field of empirical industrial organization and competition economics in order to measure the competitive effects of mergers.

Specifically, we consider a set of N consumers, who buy at most one unit of a product j. Preferences are represented by a random utility model, where product j provides the following level of (indirect) utility to consumer n:

$$U_{j,n} = \beta_{1,n}\, x_{1,j} + \beta_{2,n}\, x_{2,j} - \alpha_n p_j + \varepsilon_{j,n}, \tag{1}$$

where $x_{1,j}$ and $x_{2,j}$ represent product characteristics that determine the quality of product j, p_j is the price of product j and $\varepsilon_{j,n}$ is an idiosyncratic term related to both: products and individuals.[12] We assume that the characteristic $x_{1,j}$ is drawn from a continuous random variable with distribution F_{x_1}, while the second characteristic $x_{2,j}$ is assumed to be discrete, taking values 0 or 1, according to the discrete distribution F_{x_2}. Moreover, note that all the parameters are specific to each individual: $\beta_{1.n} = \beta_1 + \tilde{\beta}_{1,n}$, $\beta_{2.n} = \beta_2 + \tilde{\beta}_{2,n}$, and $\alpha_n = \alpha + \tilde{\alpha}_n$, where $\tilde{\beta}_{1,n}$, $\tilde{\beta}_{2,n}$ and $\tilde{\alpha}_n$ are random variables that follow known distributions $F_{\tilde{\beta}_1}$, $F_{\tilde{\beta}_2}$ and $F_{\tilde{\alpha}}$, respectively. Having both continuous and discrete quality attributes renders the model more general, and allows us to capture a broader range of preferences.[13]

In addition, consumers face an outside option, which provides them the level of utility:

$$U_{0,n} = x_0 + \tilde{x}_{0,n} + \varepsilon_{0,n}, \tag{2}$$

where the term denoted by $\tilde{x}_{0,n}$ is drawn from a continuous random variable, with distribution $F_{\tilde{x}_0}$.

Thus, for a given vector of prices p, and assuming independence between consumer idiosyncrasies for product characteristics and the error term, the market share of product j is given by the following expression:

$$s_j(p) = \int_{A_j} dF(\tilde{\beta}_1, \tilde{\beta}_2, \tilde{\alpha}, \tilde{x}_0, \varepsilon) = \int_{A_j} dF(\tilde{\beta}_1)\, dF(\tilde{\beta}_2) dF(\tilde{\alpha}) dF(\tilde{x}_0) dF(\varepsilon), \tag{3}$$

[12] Note that this indirect utility function can be derived from a quasi-linear utility function. It does not contain income explicitly, because when consumers compare between different products ($U_{j,n} \gtreqless U_{k,n}$), the income variable vanishes. As explained by Nevo (2000), the quasi-linear assumption is only reasonable for some products. For instance, it would not be an adequate assumption for the car market, where wealth effects can play a role in consumers' decisions.

[13] In particular, Grigolon and Verboven (2014) highlight the importance of accounting for discrete sources of market segmentation not captured by continuous product characteristics. For instance, in the car market it is crucial to account for consumer heterogeneity regarding the domestic or foreign origin of products. Because it is more general, this specification allows for more reliable estimates of market definition.

with $A_j = \{(\tilde{\beta}_1, \tilde{\beta}_2, \tilde{\alpha}, \tilde{x}_0, \varepsilon) \mid U_{j,n} \geq U_{l,n}\}$, for all $l \neq j$, denoting the set of consumers that choose product j. Finally, we assume that the error term ε is distributed according to a Type I extreme-value distribution.[14]

2.2 The supply side

We consider M single-product firms. The profit function takes the simple following form:

$$\Pi_i = (p_i - c_i)s_i(p)N, \tag{4}$$

where p_i, c_i and s_i are the price, the constant marginal cost and the market share of product i, respectively. The variable p is the vector of prices of all the brands in the market, and N is the number of potential consumers. Firms have complete information regarding the parameters β_1, β_2 and α, and the distributions of the random parameters are assumed to be common knowledge.

Firms' marginal costs are assumed to have the following form:

$$c_j = \exp(\gamma_1 x_{1,j} + \gamma_2 x_{2,j} + \omega_j), \tag{5}$$

where $\gamma_1 > 0$ and $\gamma_2 > 0$ ensure that products with higher quality are more costly to produce. In addition, there is a firm-specific cost component ω_j, which introduces heterogeneity across firms.

2.3 A simple collusion scheme

The baseline model considers an infinitely repeated price competition game among heterogeneous single-product firms, where collusion sustainability is evaluated under the traditional grim-trigger strategies. The present value of the current and future flow of collusion profits has to be higher than the current defection profits plus the present value of the future flow of Nash equilibrium payoffs. Thus, collusion is sustainable at period t_0 only if the following condition is satisfied for every i:

$$\sum_{t=t_0}^{\infty} \delta_i^{t-t_0} \Pi_{i,t}^{C} \geq \Pi_{i,t_0}^{D} + \sum_{t=t_0+1}^{\infty} \delta_i^{t-t_0} \Pi_{i,t}^{N} \; . \tag{6}$$

[14] Hence, integrating-out the error term gives rise to the well-known Logit probabilities (or market shares). For further details see Nevo (2000).

The variables $\Pi_{i,t}^{C}$, $\Pi_{i,t}^{D}$ and $\Pi_{i,t}^{N}$ are the collusion payoffs, the deviation payoffs and the Nash (or equilibrium payoffs) of the static one period game, respectively. The variable δ_i is the discount factor. Under what we call perfect-collusion, the collusion profits are obtained by finding the vector of prices that maximizes the expected joint-profits of all the firms in the market.[15] The deviation profit is obtained by maximizing the expected profit of a given firm, taking prices of rivals as given and set at the collusion level. Finally, the equilibrium payoffs are obtained by computing the one-shot Nash equilibrium in prices.

It is assumed that consumer preferences, product characteristics and firm marginal costs do not change over time, which ensures that the stage-game played by firms is identical in every period. Therefore, for a given vector of prices, the expected payoffs are time independent. Then the previous equation can be simplified to:

$$\frac{\Pi_i^C}{(1-\delta_i)} \geq \Pi_i^D + \frac{\delta_i \Pi_i^N}{(1-\delta_i)}. \quad (7)$$

Rearranging terms we obtain the minimum value of the discount factor δ_i^* that satisfies this condition.

Definition: *The Critical Discount Factor (CRDF) of Firm i is the lowest discount factor for which Firm i has an incentive to collude. It is given by:*

$$\delta_i^* = \frac{\Pi_i^D - \Pi_i^C}{\Pi_i^D - \Pi_i^N}. \quad (8)$$

Under this setting, every firm in the market faces a different CRDF, which is determined by the specific characteristics of each firm and its interactions with consumers and competitors (i.e., demand elasticities, marginal costs and product characteristics). A lower CRDF implies a larger set of discount factors for which collusion is profitable. Therefore, a decrease (resp., an increase) in the CRDF is interpreted as an increase (resp., a decrease) in incentives to collude.

It is important to stress that many collusive equilibria exist. Indeed, for a given combination of discount factors, there are multiple combinations of supra-competitive prices that can be sustained under grim-trigger strategies. In this paper, we focus on the collusive vector of prices that maximizes the joint-profits of firms mainly for two reasons. First, this approach has so far been adopted by the empirical industrial organization literature; and second, since it focuses on a particular equilibrium, it

[15] The joint-profit maximization vector of prices is obtained by solving: $\Pi^{JPM} = max_{p_1,\dots,p_M} \sum_{i=1}^{M} \Pi_i(p_1, \dots, p_M)$, where, as before, the term M corresponds to the total number of firms in the market, and "JPM" stands for joint-profit maximization.

renders tractable a rather complex problem. Consequently, it seems natural to select a model that would allow us to verify the empirical results from the literature.

An alternative approach to studying coordinated effects is followed by Sabbatini (2015) who considers an equilibrium where firms share collusion gains fairly. In this situation, all firms have the same CRDF, and the assessment of coordinated effects is made by studying the impact of a merger on the set of collusion profits that can be achieved through a regime of fair distribution of gains.[16] In other words, the assessment focuses on the tension between maximization of joint-profits and their fair distribution. One of Sabbatini's motivations to focus on the distributive issues of cartels rather than on joint-profit maximization is that the perfect-collusion scheme may become unfeasible under the presence of important asymmetries among firms.

2.4 The impact of a merger on firms' prices and payoffs

Intuitively, when two firms merge, they internalize the externalities that their pricing decisions have on one another's profits. This fact has two implications for the merged firm's payoffs: (i) the merger generates an increase in prices and payoffs under the one-shot Nash equilibrium, and (ii) the internalization of the pricing externality makes the merged firm less aggressive when (potentially) undercutting collusion prices, which in turn induces a negative change in deviation payoffs compared to collusion payoffs.[17]

We express these ideas through a set of propositions. First, Proposition 1 shows that the post-merger equilibrium prices of merging parties are higher after the merger. Moreover, the corollaries of Proposition 1 suggest that the payoffs of merging parties and non-merging parties are also increased (or at least unchanged). Next, Proposition 2 states that deviation prices are always lower than or equal to collusion prices. Finally, Proposition 3 derives the conditions under which the post-merger deviation prices are higher, and its corollary suggests that merging parties' deviation payoffs are lowered.

Proposition 1: *Consider a merger between Firms i and j. The post-merger equilibrium prices $p_i^{N,post}$ and $p_j^{N,post}$ are higher than or equal to the pre-merger equilibrium prices $p_i^{N,pre}$ and $p_j^{N,pre}$, respectively.*

See proof in Appendix A.

[16] The assessment relies on the concept of Balance Temptation Equilibrium introduced by Friedman (1971).

[17] Note that perfect-collusion prices and payoffs are independent of the ownership of the firms in the market. For this reason, in the rest of the paper, we omit the superscripts "post" and "pre" when referring to collusion prices and payoffs. (For further details concerning the computation of prices and payoffs, see Appendix A)

Corollary 1: *The post-merger equilibrium payoffs of the merged firm are higher than or equal to the aggregate pre-merger equilibrium payoffs of Firms i and j.*

Corollary 2: *The post-merger equilibrium payoffs of non-merging parties are higher than or equal to their pre-merger equilibrium payoffs.*

Proposition 1 illustrates the idea that the internalization of pricing externalities results in higher post-merger equilibrium prices for the merging parties. In particular, an increase in the price of one merging party generates divested sales that are partially captured by the other merging party. This latter effect incentivizes merging parties to raise prices.

Corollary 1 relies on the fact that the merged firm has the option to set the pre-merger equilibrium prices of Firms i and j. It is only profitable to modify these prices when they result in higher post-merger equilibrium payoffs. Corollary 2 is based on the fact that if the merged firm raises its equilibrium prices, a fraction of divested sales is captured by non-merging parties, which increases their post-merger payoffs. In addition, as prices are strategic complements, outsiders may also find it profitable to modify their own prices, thereby further increasing their post-merger equilibrium payoffs.

Proposition 2: *For every Firm k, its pre-merger and post-merger deviation prices $p_k^{D,pre}$ and $p_k^{D,post}$ are lower than or equal to its perfect-collusion price p_k^C.*

See proof in Appendix A.

Proposition 3: *Consider a merger between Firms i and j. If the post-merger deviation price of Firm j belongs to the interval $[p_j^{D,pre}, p_j^C]$, and the pricing externality that Firm j exerts on Firm i is stronger than the marginal effect of p_i on $\Pi_i(p_i^{D,pre}, p_j^{D,post}, p_{-i,j}^C)$, then the post-merger deviation price of Firm i is higher than its pre-merger deviation price.*

See proof in Appendix A.

Corollary: *If $p_i^{D,post} > p_i^{D,pre}$, then the post-merger deviation payoff of Firm i, i.e., $\Pi_i(p_i^{D,post}, p_j^{D,post}, p_{-i,j}^C)$, is lower than its pre-merger deviation payoff, i.e., $\Pi_i(p_i^{D,pre}, p_{-i}^C)$.*

Proposition 3 formalizes the idea that, after a merger, the merging parties are less aggressive when potentially undercutting collusion prices. Specifically, the pricing externality that merging parties exert on one another prevents them from setting deviation prices that are too low. Moreover, the corollary stems from the fact that the price p_i that maximizes $\Pi_i(p_i, p_j^{D,post}, p_{-i,j}^C)$ is lower than $p_i^{D,pre}$. (For further details, see the proof of Proposition 3 in Appendix A.) This implies that the aggregate post-merger deviation payoffs of Firms i and j are lower compared to their aggregate collusion payoffs. (i.e., $\frac{\Pi_i(p_i^{D,post},p_j^{D,post},p_{-i,j}^C)+\Pi_j(p_i^{D,post},p_j^{D,post},p_{-i,j}^C)}{\Pi_i^C+\Pi_j^C} \leq \frac{\Pi_i(p_i^{D,pre},p_{-i}^C)+\Pi_j(p_j^{D,pre},p_{-j,}^C)}{\Pi_i^C+\Pi_j^C}$).

2.5 Asymmetry in payoffs and change in payoffs effects

We focus on the difference between the CRDF of the merged firm and the CRDF of the merging party with lower incentives to collude, which we define as the Overall Effect of the merger.

Definition: *Let $\delta_{i,j}^{*,post}$ be the CRDF of the merged firm, i.e.,*

$$\delta_{i,j}^{*,post} = \frac{(\Pi_i^{D,post}+\Pi_j^{D,post})-(\Pi_i^C+\Pi_j^C)}{(\Pi_i^{D,post}+\Pi_j^{D,post})-(\Pi_i^{N,post}+\Pi_j^{N,post})}, \tag{9}$$

and let $\delta_i^{*,pre}$ and $\delta_j^{*,pre}$ be the pre-merger CRDFs of the merging parties, which are given by:

$$\delta_i^{*,pre} = \frac{\Pi_i^{D,pre}-\Pi_i^C}{\Pi_i^{D,pre}-\Pi_i^{N,pre}} \qquad and \qquad \delta_j^{*,pre} = \frac{\Pi_j^{D,pre}-\Pi_j^C}{\Pi_j^{D,pre}-\Pi_j^{N,pre}}. \tag{10}$$

Then, the Overall Effect of a merger between Firms i and j is defined as follows:

$$OE_{i,j} = \delta_{i,j}^{*,post} - max\{\delta_i^{*,pre}, \delta_j^{*,pre}\}. \tag{11}$$

The superscripts "post" and "pre" stand for the post-merger and pre-merger periods, respectively. Equation (9) shows how the CRDF of the merged firm is influenced by the payoffs of both merging parties. The purpose of the Overall Effect is to measure how the incentives to collude of the merger firm compare with the incentives to collude of the merging party with lower pre-merger incentives to collude. Thus, a negative value of the Overall Effect can be interpreted as an increase of the merged firm's incentives to collude with respect to the merging party with a higher CRDF (i.e., the highest CRDF in Equation 10).

We study now the role played by two different effects: the asymmetry in firms' pre-merger payoffs and the internalization of the pricing externality. Separating these effects should help reach a better understanding of the magnitudes of coordinated effects. Let us name them.

The Asymmetry in Payoffs (AP) effect describes situations in which the brand with relatively larger payoffs weights more heavily on the resulting CRDF of the merged firm, thus having a higher influence on its incentives to collude. For instance, if a large multinational firm acquires a small local competitor, then we would expect the resulting merged firm's CRDF to be relatively closer to the one of the larger firm.

The sign and magnitude of ***the Change in Payoffs (CP) effect*** is the result of two opposite forces triggered by a merger. As explained in Section 2.4, on the one hand, higher equilibrium payoffs increase the merged firm's CRDF while, on the other hand, lower deviation payoffs decrease the merged firm CRDF.

In order to measure the magnitude of the AP and CP effects, we define the following variable:

$$\delta_{i,j}^{AP} = \frac{\left(\Pi_i^{D,pre}+\Pi_j^{D,pre}\right)-\left(\Pi_i^{C}+\Pi_j^{C}\right)}{\left(\Pi_i^{D,pre}+\Pi_j^{D,pre}\right)-\left(\Pi_i^{N,pre}+\Pi_j^{N,pre}\right)}. \tag{12}$$

Note that $\delta_{i,j}^{AP}$ is just the CRDF of the merged firm, but without incorporating any change in payoffs due to the merger. Adding and subtracting $\delta_{i,j}^{AP}$ from Equation (11) yields the following decomposition of the Overall Effect into the CP and AP effects:

$$OE_{i,j} = \underbrace{(\delta_{i,j}^{*,post} - \delta_{i,j}^{AP})}_{CP\ effect} + \underbrace{(\delta_{i,j}^{AP} - max\{\delta_i^{*,pre}, \delta_j^{*,pre}\})}_{AP\ effect}. \tag{13}$$

This formula shows that, in the extreme case where a merger does not modify the merging parties' payoffs, the Overall Effect is exactly equivalent to the AP effect. By contrast, in the case of a merger between two perfectly symmetric firms (i.e., identical CRDFs), the Overall Effect is completely driven by the CP effect.[18]

2.6 Non-merging parties

As suggested by the Corollary 2 of Proposition 1, the only change induced by the merger for non-merging parties is the increase in their equilibrium payoffs. It should be always the case that $\Pi_i^{N,post} \geq \Pi_i^{N,pre}$ for every i belonging to the group of non-merging parties.

[18] By replacing each of the CRDFs in Equation (13) by their definitions in Equations (9), (10) and (12), it is straightforward to show that, in this case, the second term on the right hand side of Equation (13) vanishes.

Thus, for non-merging parties, the variation in their CRDFs is always higher than (or equal to) zero, that is, $\delta_i^{*,post} = \frac{\Pi_i^D - \Pi_i^C}{\Pi_i^D - \Pi_i^{N,post}} \geq \frac{\Pi_i^D - \Pi_i^C}{\Pi_i^D - \Pi_i^{N,pre}} = \delta_i^{*,pre}$. Note that in this case, we also omit the superscripts "post" and "pre" from deviation payoffs.

3. Simulations

The simulation setting. We simulate 3,000 markets with 10,000 consumers each, using 12 different calibrations of the demand model. In all, we have 36,000 simulated markets.[19] The different calibrations vary in terms of three different dimensions: the underlying distributions of continuous characteristics of products, the underlying distribution of consumers' mean valuations for these continuous characteristics, and the underlying distribution of consumers' mean sensitivities to prices.[20]

The underlying structural parameters and the distributions of random coefficients are chosen in a way that the resulting distributions of pre-merger own-price and cross-price elasticities are "realistic," in the sense that their values are similar to real elasticity estimates from previous studies. Knittel and Metaxoglou (2014) made a selection of empirical articles using BLP-type models for the estimation of random coefficient Logit demands.[21] We identify relevant reference values or intervals for own-price and cross-price elasticities.[22] As Table B.1 in Appendix B exhibits, own-price elasticities are in general lower than 5. However, there is an important degree of variation across industries or even across brands within the same industry.[23] There are also empirical papers reporting higher values for own-price elasticities.[24] The same high degree of dispersion can be found on cross-price elasticity estimates, but their values are consistently lower than 0.4.

The supply side. We construct the supply side, assuming competition between five single-product firms, with heterogeneous but constant marginal costs for each firm and market. This number

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[19] A high number of consumers is necessary in order to get smooth market share functions. For instance, in the extreme case of having only one representative consumer, he/she would choose his/her preferred product, and the resulting market shares would be 100% for this product, and 0% for all the other products in the market. In addition, the representative consumer's preferred choice could be constant for a wide range of prices, making the market shares unresponsive to price changes. It could also be possible to find a combination of prices for which the representative consumer modifies his/her preferred choice, thus drastically changing the market share of his/her previous choice from 100% to 0% (and the market share of his/her new choice from 0% to 100%). Therefore, the existence of a high number of consumers ensures the absence of these types of discontinuities.

[20] The details can be found in Appendix B.

[21] These articles have been published in leading general interest journals and the top industrial organization journals.

[22] Considering only the subset of papers that provide explicit values for own-price and/or cross-price elasticities.

[23] For instance, Armantier and Richard (2008) identify a mean own-price elasticity of 2.22 among airline groups in the U.S. market. The difference among groups can be significant, ranging from 1.540 to 2.785.

[24] For instance, Bonnet and Dubois (2010) report an average own-price elasticity of 9.97 within the bottled water market in France (simple average across retailers and brands listed on the Table 6 of their article).

of firms seems appropriate, considering that, in general, cases raising coordinated effects concerns involve a low number of competitors, as documented by Petit (2010).[25]

In the case of firms offering heterogeneous products and competing in prices, the vector of prices that maximizes the joint-profits of firms (perfect-collusion) could potentially generate a situation where a firm faces a lower payoff as opposed to the non-collusive outcome. For instance, in a perfect-collusion scheme, it may be optimal to allocate a high market share to the firm with the lowest marginal cost, at the expense of high-cost firms. Consequently, since we are not allowing for side payments across competitors—therefore "winners" cannot compensate "losers"—the perfect-collusion scheme may become unfeasible, as it may not satisfy the basic participation constraint of every firm in the market.[26]

The game. Without loss of generality, we simulate the impact of a merger between Firms 1 and 2, on the values of the CRDFs for every firm in the market. The timing of the game can be summarized as follows:

1) Nature draws the underlying consumer preference parameters and firms' cost components.
2) Nature draws the product characteristics.
3) Conditional on prices, firms can compute expected market shares.
4) The one-shot Nash equilibrium on prices is solved.
5) Consumers observe prices and product characteristics and eventually make their choice.
6) In the case of collusion, steps 4) and 5) are repeated, but solving for the vector of prices that maximizes the joint-profits of firms.
7) In the case of deviation by Firm i, steps 4) and 5) are repeated, the price that maximizes the expected profit of Firm i is computed by taking other competitors' prices (set at the collusion level) as given.

The simulated sample. As stated before, the main advantage of a simulation approach is that it allows us to study the impact of a merger in different markets, with heterogeneous consumer preferences, firms' marginal costs and product characteristics. Most of the simulated price elasticities in this paper coincide with those found in the literature. For example, a high fraction of own-price elasticities are lower than 5 and a high fraction of cross-price elasticities are lower than 0.4. However, higher and more extreme values of both variables are also covered by the simulated sample.[27]

[25] The author lists all the European Commission cases involving remedies for coordinated effects concerns and shows that in all of them the number of firms is lower than five.

[26] This is indeed the main criticism made by Sabbatini (2015) to the joint-profit maximization approach. See the last paragraph of Section 2.3 above.

[27] Figure B.1 in Appendix B displays the simulated empirical distributions of own-price and cross-price elasticities for the different calibrations of the demand model.

Note that for different reasons, slightly less than 16,000 observations are not considered. First, 11.96% of the sample is dropped because while computing equilibrium prices, the fixed-point algorithm used to solve the system of first-order conditions does not converge to a solution.[28] Second, 13.48% of the sample is excluded because at least one of the pre-merger market shares is equal to zero.[29] Third, an additional 9.66% of the sample is excluded because at least one of the own-price and/or cross-price elasticities has unrealistic extreme value.[30] Fourth, 7.86% of the sample is not considered because the perfect-collusion scheme is unfeasible prior to the merger.[31] Finally, 0.62% of the sample is dropped because of other reasons.[32]

4. Coordinated effects' characterization

By definition, collusion is sustainable only if, for every Firm i, the condition $\delta_i \geq \delta_i^*$ is satisfied. For this reason we study the impact of a merger on the values of post-merger CRDFs, for every firm in the market. We consider a decrease (an increase, resp.) in the value of a given firm post-merger CRDF, as an increase (a decrease, resp.) in its incentives to collude. In this section, we focus on the impact of the merger on firms' payoffs and on the Overall Effect as defined in Section 2.5.

4.1 The impact of the merger on firms' payoffs

Table 1 displays the resulting price and payoff changes induced by the merger on merging (insiders) and non-merging parties (outsiders). For every scenario (Nash and deviation), the table exhibits the percentage of cases from the sample with a strictly positive or negative change in payoffs. In addition, it displays a comparison between the absolute variations in deviation payoffs with respect to Nash

[28] As documented by Knittel and Metaxoglou (2014), BLP-type models are highly non-linear, which can raise the issue of non-convergence. Thus, the rate of convergence can be sensitive to the selection of specific parameters of the simulation design. For instance, in our setting, by increasing the maximum number of iterations to 2,000 (instead of 200), the fixed-pint algorithm reaches convergence on an extra 1.15% of the cases. However, this comes at the expense of considerably longer computation time.

[29] A priori this is not a problem; however, given that our purpose is to compare results across different markets, the number of competitors should be fixed. In addition, it does not make sense to estimate the impact of a merger when one (or both) of the merging parties has a market share equal to zero (recall that regardless of the market, we simulate a merger between Firms 1 and 2).

[30] The aim is to keep realistic values for own-price and cross-price elasticities. The own-price elasticity threshold is defined as follows: $\bar{\eta} = max\{\bar{\eta}_{ii}\}$. Where $\bar{\eta}_{ii}$ stands for the 99th percentile value of the own-price elasticity of Firm i. While the threshold for cross-price elasticities is defined as:: $\bar{\zeta} = max\{\bar{\zeta}_{ij}\}$. Where $\bar{\zeta}_{ij}$ stands for the 99th percentile value of the cross-price elasticity between Firms i and j (for all i and j, with $i \neq j$).

[31] At least one of the firms' perfect-collusion profits is lower than its pre-merger Nash profits. However, in all these cases, the joint-collusion profits are higher than the joint-equilibrium profits.

[32] The details of the dropped observations can be found in Table B.4 in Appendix B.

payoffs. The purpose is to verify whether the results are consistent with the propositions in Section 2.4, and to obtain an idea of which effect is dominant on the post-merger CRDF of the merged firm.

As stated in Propositions 1 and 3, the merged firm should have an incentive to raise prices after the merger. Indeed, the simulation results confirm this prediction as both equilibrium and deviation prices are raised after the merger. (See rows 1 and 3 in Table 1.) It means that the merged firm gets higher profits under the Nash scenario but lower per-product deviation profits. (See rows 2 and 4 in Table 1.)[33] This latter result is also consistent with the corollaries of Propositions 1 and 3.

However, the most interesting result is that the negative variation in deviation payoffs is in absolute terms higher than the positive variation in Nash payoffs. (See row 5 in Table 1.) Intuitively, the reason is that, while firms' profits increase dramatically when they deviate from the collusion prices, the post-merger change in Nash payoffs is moderate. Therefore, a similar change in prices would have an asymmetric impact on payoffs.

Finally, as expected from Corollary 2 of Proposition 1, the merger has a positive impact on outsiders' equilibrium payoffs. (See row 2 in Table 1.)

Table 1 - Impact of the merger on firms' prices and payoffs

Scenario		Variable	Insiders	Outsiders
Nash	(1)	% of cases $\Delta P^N > 0$	99.99%	90.79%
	(2)	% of cases $\Delta \Pi^N > 0$	100%	99.93%
		Interpretation	Anti-collusive	Anti-collusive
Deviation	(3)	% of cases $\Delta P^D > 0$	99.99%	No effect
	(4)	% of cases $\Delta \Pi^D < 0$	100%	No effect
		Interpretation	Pro-collusive	No effect
Comparison	(5)	% of cases $\lvert \Delta \Pi^D \rvert > \Delta \Pi^N$	99.98%	N/A
		Prediction	Pro-collusive	Anti-collusive
		Observations	40,378	60,567

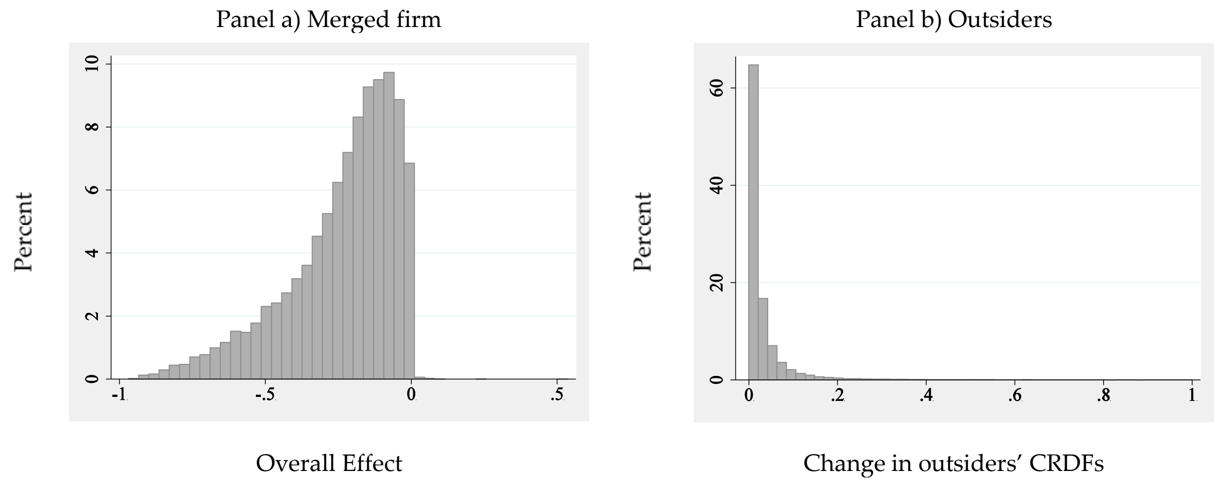
4.2 Post-merger discount factor variation

Figure 1 displays histograms of the CRDF variations of the merged firm (Overall Effect) and of outsiders. The first interesting result is that, in 99.81% of the cases, the Overall Effect for the merged

[33] These results are in line with what has been found by Brito *et al.* (2013). Indeed, the results of their counterfactual merger simulations applied to the wet-shaving industry in the U.S. suggest that both post-merger Nash and deviation prices are higher after the merger.

firm is negative.[34] In other words, the coordination incentives of the merged firm are strengthened. In addition, as expected, the CRDF of non-merging parties increases in 99.79% of the cases.[35] Nevertheless, the magnitude of this change is substantially lower than the impact of the merger on the merged firm. Indeed, the absolute change in the merged firm CRDF is higher than the change in outsiders' CRDFs in 97.41% of the sample.[36]

Figure 1 – Impact of the merger on firms' CRDFs



(*)For the sake of exposition, the graph only displays changes lower than 1

4.3 Sensitivity analysis

In this section, we conduct a set of sensitivity analyses based on the key exogenous parameters of our simulation setting. In particular, we evaluate how the results from section 4.2 are modified according to: (i) the introduction of efficiency gains (i.e., an exogenous shock on c_j), (ii) a higher degree of product differentiation (i.e., an exogenous shock on $x_{1,j}$) and, (iii) a higher consumers' mean sensitivity to price (i.e. an exogenous shock on α).

[34] There are 38 cases with a positive change in the CRDF. However, in 11 of these cases the variation is positive because post-merger collusion becomes unfeasible for the merged firm. This also explains the outlier value of 0.54. From the remaining cases, in 75% of them the positive change is lower than 0.012 and in 95% of them the change is lower than 0.056.

[35] There are 43 cases with a negative change in the CRDF. However, in all these cases the change is lower than 0.0002 in absolute value.

[36] Without considering the 0.19% of cases where the merged firm CRDF has a positive change and the 0.21% of cases where at least one of the outsiders CRDF has a negative change.

4.3.1 Introducing efficiency gains

A merger that generates efficiency gains—which in turn reduce marginal costs of production—allows the merging parties to price their products more aggressively. This effect increases the payoffs that the merged firm receives under every possible scenario (i.e., Nash, collusion and deviation).[37] Again, the impact on the merged firm CRDF is ambiguous. On the one hand, higher collusion payoffs make coordination more attractive, which in turn induces a negative variation on its CRDF. On the other hand, higher deviation and Nash payoffs make collusion more difficult to sustain, inducing a positive change in the post-merger CRDF. Regarding the non-merging parties, efficiency gains generate exactly the opposite effects on payoffs than those of merging parties.[38] Therefore, the direction of the resulting impact of efficiency gains, on both insiders and outsiders, depends on which of these effects dominates.

The simulations are repeated using the same set of calibrations, this time assuming that the merger generates efficiency gains that reduce the marginal costs of the merging parties. Two levels of efficiency gains are computed: (i) the exact amount necessary to mitigate the unilateral effects of the merger (low efficiency gains in Figure 2);[39] (ii) twice this amount (high efficiency gains in Figure 2).[40] Figure 2 displays histograms with the additional variation on firms' post-merger CRDFs induced by efficiency gains.

In general, the results suggest that, under the presence of efficiency gains, both the negative variation in the merged firm CRDF and the positive variation in outsiders' CRDFs tend to be reinforced with respect to the results shown in Section 4.2. Indeed, in the case of the merged firm, the efficiency gains induce an additional negative variation in the CRDF in 97.72% of the sample (for both levels of efficiency gains).[41] Regarding the case of outsiders, the additional variation is positive on 90.7% and 91.56% of the cases with low and high efficiency gains, respectively.

[37] Note that with different marginal costs, the vector of prices that maximizes the joint-profits also changes. We adopt the assumption that, after the realization of efficiency gains, the vector of collusive prices adjusts accordingly. This modifies the payoffs of merging parties and non-merging parties under both the collusion and deviation scenarios.

[38] Outsiders have lower payoffs under every possible scenario. Lower collusion profits make coordination less attractive for outsiders, while lower deviation and lower Nash payoffs make coordination more attractive for them. The resulting impact depends on which of these effects dominates.

[39] The level of efficiency gains that ensures that the vector of Nash equilibrium prices is the same before and after the merger.

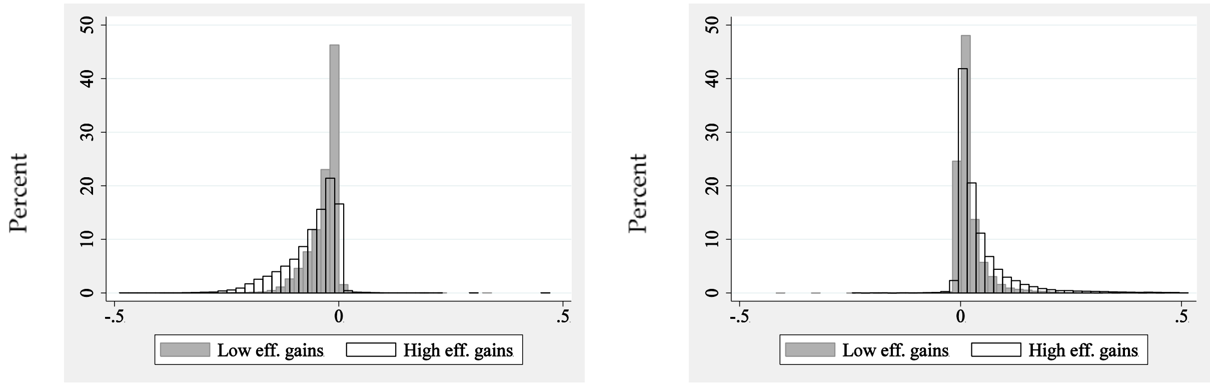
[40] We apply a similar list of criteria to the ones used in Section 3 to drop observations from the samples with efficiency gains. Thus, when merging the three databases (the original one and the ones with efficiency gains), 1,177 additional observations are lost. The main reason is that, when simulating efficiency gains, there is a higher number of markets in which the algorithm solving for equilibrium prices does not converge (after 200 iterations).

[41] This result is due to the fact that, for almost every market, the increase in collusion payoffs (pro-collusive effect) dominates over the increase in Nash payoffs (anti-collusive effect). For further details, see Table C.2 in Appendix C.

Note, however, that the percentage of cases in which the efficiency gains induce a negative variation in outsiders' CRDFs is not negligible, although the magnitudes are small.[42] This result is due to the fact that the decrease in deviation payoffs sometimes dominates the decrease in collusion payoffs. For further details, see Table C.2 in Appendix C.

Figure 2 – Impact of efficiency gains on firms' CRDFs (*)

Panel a) Merged firm | Panel b) Outsiders



Additional CRDF change | Additional CRDF change

(*) For the sake of exposition, the graphs only display changes within the interval [-0.5, 0.5].

4.3.2 Product differentiation

As it has been hinted in the literature, the impact of the degree of product differentiation is ambiguous.[43] In particular, higher product differentiation reduces the profits that firms obtain from undercutting collusion prices (pro-collusive effect). Yet, this differentiation also limits the intensity of competition under the punishment phase (anti-collusive effect). In addition, the degree of product differentiation also has an impact on the vector of perfect-collusion prices, which in turn modifies firms' optimal deviation strategies. Thus, all these factors simultaneously influence the direction of the final impact.

In this section, we focus on the degree of product differentiation in the product sold by the merging party j. Specifically, we look at the difference between $x_{1,j}$ (i.e., the continuous characteristic of the product sold by the merging party j), and the average continuous characteristic of the rest of

[42] In particular, in 95% of the cases with a negative change in CRDF, the magnitude is in absolute value lower than 0.015.

[43] For further details see Ivaldi *et al.* (2003).

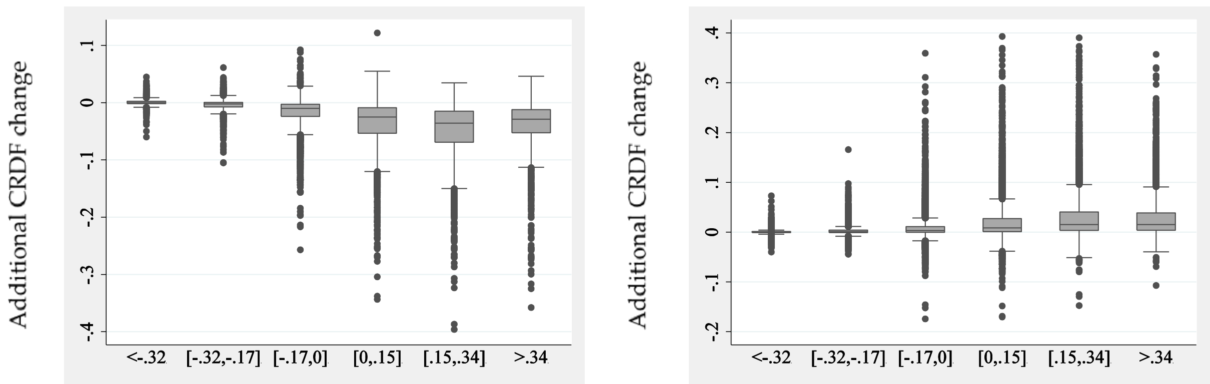
products in the market (i.e., $\frac{1}{4}\sum_{i\neq j} x_{1,i}$).[44] Then, in order to measure the impact of product differentiation on post-merger CRDFs, we simulate an exogenous 10% increase in $x_{1,j}$.[45]

Figure 3 contains two box-graphs that display the resulting relationship between the pre-merger degree of product differentiation of the merging party j, and the additional change in post-merger CRDF induced by the exogenous increase in $x_{1,j}$. First, in the scenario where $x_{1,j}$ is higher than the average continuous characteristic of other brands in the market (i.e., a value higher than 0 in the x-axis), higher product differentiation is mostly associated with a decrease in the merged firm CRDF (in 96.35% of the sample), and with an increase of outsiders' CRDFs (in 85.2% of the sample). Second, in the scenario where $x_{1,j}$ is lower than the average continuous characteristic of other brands in the market (i.e., a value lower than 0 in the x-axis), the effect of lower product differentiation is ambiguous and the magnitudes are considerably lower than in the previous scenario.[46]

Thus, at least for the case of a merging party with a high continuous attribute, the impact of higher product differentiation is similar to the impact of efficiency gains. (See Tables C.2 and C.3 in Appendix C.)

Figure 3 – Impact of product differentiation on firms' CRDFs (*)

Panel a) Merged firm (**) (***) Panel b) Outsiders (**) (***)



$x_{1,1}$ difference $x_{1,1}$ difference

(*) For the sake of exposition, the graphs only display changes within the interval [-0.4, 0.4].
(**) The term "x11 difference" stands for the pre-merger difference between $x_{1,1}$ and the average continuous characteristic from the rest of the products in the market.
(***) The thresholds displayed in the x-axis are delimited by the 10th, 25th, 50th, 75th and 90th percentile values.

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[44] For the purpose of the sensitivity analysis, we choose Firm 1 as the merging party j.
[45] When merging both databases (the original one and the one with higher values of $x_{1,j}$), 726 observations are lost. The reason is that, after applying the criteria to clean both datasets (specified in Table B.4 in Appendix B), the observations dropped in each of them do not perfectly match.
[46] In this scenario we refer to lower product differentiation because the exogenous increase of the continuous characteristic of product j makes it more similar to the average product in the market.

4.3.3 Consumers' mean price sensitivity

The impact of a higher α should be threefold. First, a higher α should make competition fiercer, thus increasing firms' incentives to engage in collusion. Second, it should make deviations more profitable, because consumers become more responsive to price cuts. Third, since consumers are more sensitive to price, firms' collusion profits should be reduced. Therefore, the direction of the resulting impact should be ambiguous.[47]

We introduce a 10% exogenous shock on α in every simulated market.[48] Its impact on firms' CRDFs is negative in 56.42% and 60.65% of cases, for the merged firm and outsiders, respectively. (See Figure C.1 in Appendix C.)[49] Consequently, it is not possible to draw precise conclusions regarding the impact of α on post-merger CRDFs.[50]

5. Understanding the magnitude of coordinated effects

In this section we provide a general guide for understanding the interaction of the Asymmetry in Payoffs (AP) and Change in Payoffs (CP) effects, which is important for assessing the magnitude of change in the merged firm CRDF. On the one hand, in the case of a merger between two symmetric firms in terms of pre-merger payoffs, the internalization of the pricing externality is what mainly drives the Overall Effect. On the other hand, in the case of a merger between asymmetric firms in terms of pre-merger payoffs, what matters for assessment purposes is the magnitude of the AP effect.

[47] In parallel, we conduct a sensitivity analysis regarding consumers' mean valuation for the continuous characteristic (i.e., the parameter β_1), which can be also interpreted as a change in α. Indeed, a lower β_1 should make price competition fiercer (equivalent to an increase in α). The reason is that now consumers care relatively less about quality (in relation to price). Therefore, the impact of β_1 on firms' incentives to collude should also be ambiguous.

[48] When merging both databases (the original one and the one with higher values of α), 1,075 observations are lost. The main reason is that, in the modified dataset, there is a higher number of markets where at least one of the market shares is equal to zero.

[49] In addition, note that the directions of the impact on insiders and outsiders are not correlated.

[50] As anticipated in Footnote 47, the exogenous increase in β_1 has an ambiguous impact on firms' incentives to collude. In particular, its impact on firms' CRDFs is negative for the merged firm and outsiders, in 41.46% and 31.59% of the cases in the sample, respectively.

5.1 The merged firm

5.1.1 A merger between two symmetric firms

In this section, we consider symmetric merging parties in terms of their pre-merger equilibrium payoffs. For these types of mergers, the magnitude of the Overall Effect should be mostly explained by the CP effect. In this situation, a natural indicator to capture the size of the pricing externality between two brands that are imperfect substitutes is given by the diversion ratio, i.e., the proportion of sales that are divested from one brand to another as a result of a raise in prices. Practitioners typically use this tool for several purposes, including the assessment of unilateral effects, the measurement of the degree of substitutability between two brands, and the definition of relevant markets.[51,52] In addition, some recent literature suggests that diversion ratios can be used to establish indices that quantify firms' incentives to coordinate prices.[53]

In the simulated sample, merging parties are identified as symmetric when the pre-merger ratio between the equilibrium payoffs of the larger and smaller merging parties is close to one. Note that in the rest of the paper, every time we distinguish between larger and smaller merging parties, we refer to their relative sizes in terms of pre-merger equilibrium payoffs, unless we explicitly state something different. Panel a) of Figure 4a displays the histogram of the Overall Effect for these symmetric firms, distinguishing mergers with low and high values of the pre-merger diversion ratios. Observe that, as expected, mergers with higher diversion ratios have on average a stronger impact on the change in CRDF.

In addition, Panel b) contains a bar-graph that displays the fraction of the Overall Effect that is explained by both AP (i.e., the dark gray fraction of each bar in the graph) and CP (i.e., the light-gray fraction of each bar in the graph) effects, for each simulated market (displayed in ascending order with respect to the magnitude of the Overall Effect). As anticipated, in these types of mergers, most of the change is due to the CP effect. Furthermore, note that when the degree of payoff asymmetry is higher,

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[51] According to the 2004 European Horizontal Merger Guidelines, the unilateral effects (or non-coordinated effects) of a merger are defined as follows: *"A merger may significantly impede effective competition in a market by removing important competitive constraints on one or more sellers, who consequently have increased market power."* (See Paragraph 24.)

[52] See for instance the report "Diversion ratios: why does it matter where customers go if a shop is closed?" published by Oxera. Available at: http://www.oxera.com/getmedia/12fcf7e5-4496-4e7f-bc79-a36457c92f1f/Diversion-ratios-(updated)_1.pdf.aspx?ext=.pdf

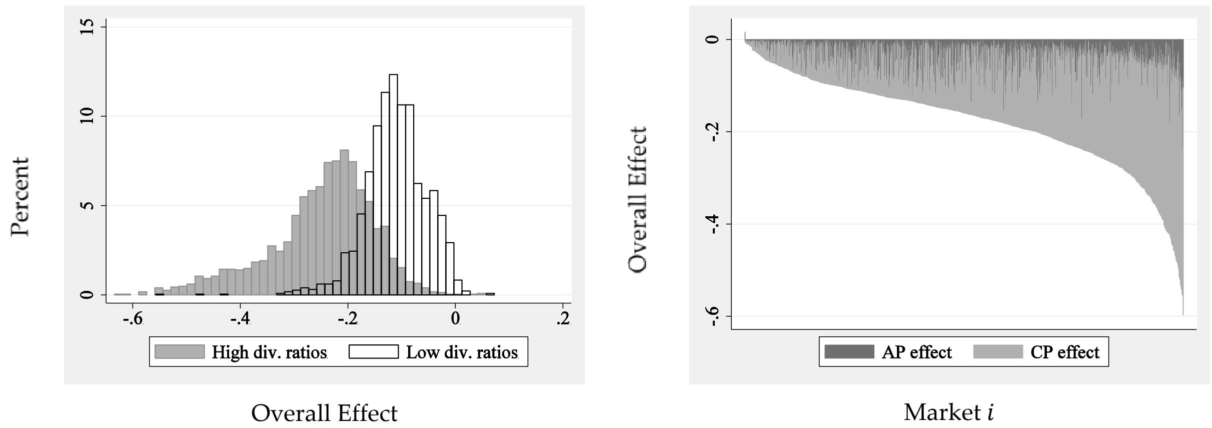
[53] See Moresi *et al.* (2011 and 2015). The CPPI and cGUPPI indexes measure the incentives of firms to engage in specific kinds of parallel accommodating conduct.

the magnitude of the Overall Effect that is due to the CP effect still can be deduced by the pre-merger diversion ratios between the merged firm's products. (See Panel a) of Figure C.2 in Appendix C.)

Figure 4a – The magnitude of $\Delta CRDF$ (Merged firm) – Very symmetric equilibrium payoffs (*)

Panel a) Post-merger Overall Effect and pre-merger diversion ratios (**)

Panel b) Post-merger AP and CP effects



(*) The ratio of pre-merger equilibrium payoffs is lower than the 25th percentile value (very symmetric firms).
(**) Where "High diversion ratios" ("Low diversion ratios") stand for markets in which the pre-merger diversion ratios between merging parties' products are both higher (lower) than their 50th percentile value.

Finally, it is interesting to evaluate how the magnitudes of the Overall Effect are related to pre-merger own-price elasticities. Traditionally, the competition assessment of the effects of a merger involves the definition of a relevant market, which is closely related to the study of firms' own-price elasticities.[54] In particular, high own-price elasticities would reflect the presence of intense competition from rival firms and/or the possibility to define a broad relevant market. Under these conditions, a merger would raise less anticompetitive concerns.

Figure 4b contains histograms that display the Overall Effect of the merger, distinguishing mergers with low and high own-price elasticities of the merging parties' products. The results clearly suggest that the magnitude of the Overall Effect is not related to the pre-merger own-price elasticities. The reason is that this variable is not a good predictor of the impact of the merger on firms' payoffs. For instance, Figure C.3 in Appendix C displays histograms of the change in firms' equilibrium and deviation payoffs, distinguishing merging parties with high and low own-price elasticities, and merging

[54] For instance, the merger guidelines published in 2006 by the International Competition Network, institution that gathers many competition authorities from around the world; suggest market definition as the first step of a merger assessment. Document available in the following link: http://www.internationalcompetitionnetwork.org/uploads/library/doc321.pdf

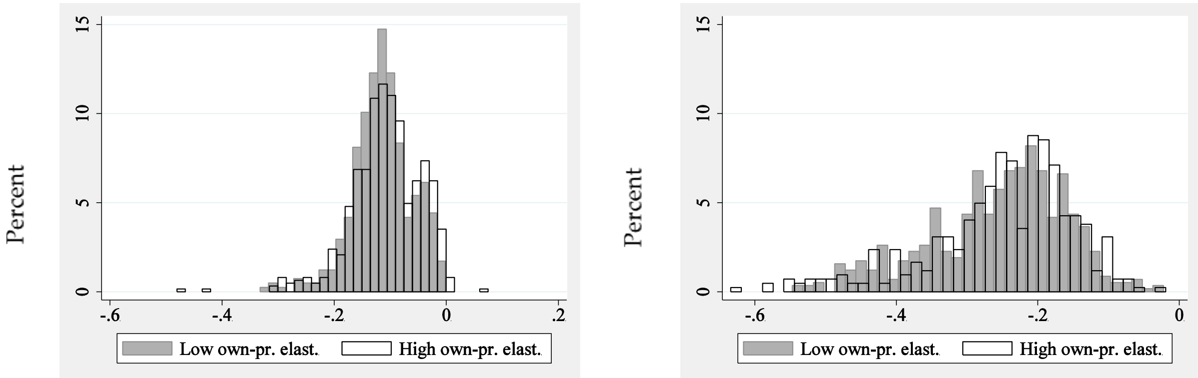
parties with high and low diversion rations between their products. Results suggest that diversion ratios display a significantly better performance when predicting the post-merger change in payoffs. [55]

Result 1: *For mergers between symmetric firms, the construction of a screening tool that aims to predict the impact of the merger on the merged firm CRDF should be based on the pre-merger diversion ratios between the brands produced by the merged firm.*

Figure 4b – The magnitude of $\Delta CRDF$ (Merged firm) – Very symmetric equilibrium payoffs (*)

Panel a) Low pre-merger diversion ratios (**) (***)

Panel b) High pre-merger diversion ratios (**) (***)



Overall Effect

Overall Effect

(*) The ratio of pre-merger equilibrium payoffs is lower than the 25th percentile value (very symmetric firms).
(**) Where "High diversion ratios" ("Low diversion ratios") stand for markets in which the pre-merger diversion ratios between merging parties' products are both higher (lower) than their 50th percentile value.
(***) Where "Low own-price elasticities" ("High own-price elasticities") stand for merging firms' with pre-merger own-price elasticities lower (higher) than the 25th (75th) percentile value (in absolute value).

5.1.2 A merger between two asymmetric firms

In this section, we consider asymmetric merging parties in terms of their pre-merger equilibrium payoffs. For these types of mergers, the payoffs of the smaller firm have a low influence on the post-merger payoffs of the merged firm. Thus, the resulting CRDF is close to the pre-merger one of the larger firm. For this reason, it is necessary to distinguish two cases when the larger firm has, between the two merging parties: (a) the lowest pre-merger CRDF and, (b) the highest pre-merger CRDF. This distinction is important because, as it is shown, only mergers of the first type have the potential to generate a

[55] These results are in line with recent articles that suggest the degree of direct product substitutability among merging firms as a better screening tool for an assessment of the competitive effects of a merger. See for instance, Farrell and Shapiro (2010), who propose the use of margins and the extent of direct substitution between the merged firm's products, in order to assess the unilateral effects of mergers.

significant Overall Effect. In the simulated sample, merging parties are identified as asymmetric when the ratio between the pre-merger equilibrium payoffs of the larger and smaller merging parties is significantly higher than one.

Case (a) The larger firm has the lower pre-merger CRDF

This is the more intuitive scenario. For instance, it corresponds to the case of a larger firm acquiring a small maverick firm (i.e., a firm with a very high CRDF). Basically, the larger firm "absorbs" the smaller one and the Overall Effect is almost equal to the pre-merger difference on CRDFs (i.e., $max\{\delta_i^{*,pre}, \delta_j^{*,pre}\} - min\{\delta_i^{*,pre}, \delta_j^{*,pre}\}$). Panel a) in Figure 5a displays a scatter-graph between the pre-merger CRDF difference and the magnitude of the Overall Effect. Note that there is an almost perfect correlation between both variables. Additionally, Panel b) contains a bar-graph that displays the fraction of the Overall Effect that is explained by both AP (i.e., the dark-gray fraction of each bar in the graph) and CP (i.e., the light-gray fraction of each bar in the graph) effects, for each simulated market (displayed in ascending order with respect to the magnitude of the Overall Effect). As anticipated, most of the change is due to the AP effect.[56]

When the degree of payoff asymmetry is lower and the CP effect starts playing a more important role in explaining the Overall Effect, the fraction that is due to the AP effect still can be deduced by the pre-merger CRDFs' asymmetry. However, the magnitude of this effect becomes weaker as the firms are more symmetric. (See Panel b) of Figure C.2 in Appendix C.)[57]

Certainly, the most natural candidates to predict the degree of pre-merger asymmetry between firms in terms of their incentives to collude are market shares and cross-price elasticities.[58] Specifically, larger firms and firms with lower cross-price elasticities (i.e., with higher degree of product differentiation) should be less tempted to deviate from collusion.[59] The reason is that they would capture only a small fraction of consumers from rival firms (pro-collusive effect). However, a higher

[56] In addition, as shown in the previous section, the fraction of the Overall Effect that is due to the CP effect can be approximated by the magnitudes of the diversion ratios. See Panel a) of Figure C.2 in Appendix C.

[57] Panel b) of Figure C.2 contains scatter-graphs that display the resulting relationship between the pre-merger CRDF difference and the magnitude of the AP effect, for different degrees of asymmetry between the merging parties in terms of their pre-merger equilibrium payoffs. The results show that the magnitude of the AP effect is always correlated with the pre-merger CRDF difference, independently of the degree of payoff asymmetry. However, the magnitudes of the AP effect are significantly stronger for mergers between asymmetric firms.

[58] Ivaldi *et al.* (2003) suggest that, among other factors, firms' market shares and the degree of product differentiation can influence their incentives to engage in collusion.

[59] Note that market shares and price elasticities are endogenous. Indeed, the presence of asymmetries in terms of these variables is probably the result of asymmetries in terms of other market characteristics, such as marginal costs, product attributes, firms' pricing decisions, and consumer preferences, among others. However, since these variables are more easily observed by policy makers, it is convenient to derive qualitative conclusions as a function of them.

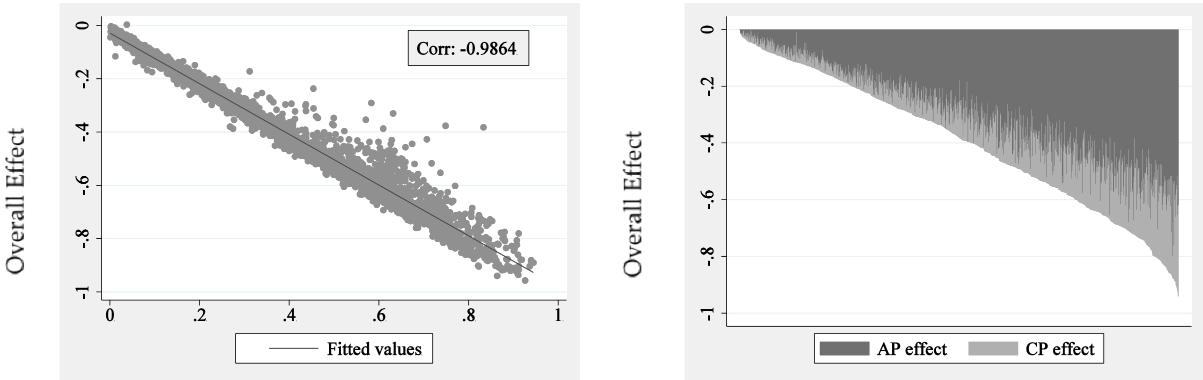
degree of product differentiation should make competition under the Nash equilibrium less intense, weakening the incentives to collude.

Figure 5a– The magnitude of $\Delta CRDF$ (Merged firm) – Very asymmetric equilibrium payoffs (*)

Case (a) The larger firm has the lower pre-merger CRDF

Panel a) Post-merger Overall Effect and pre-merger CRDF difference

Panel b) Post-merger AP and CP effects



Pre-merger CRDF difference

Market i

(*) The ratio of pre-merger equilibrium payoffs is higher than the 75th percentile value (very asymmetric firms).

In order to measure the degree of pre-merger asymmetry between merging parties in terms of cross-price elasticities, we look at the ratio of their weighted cross-price elasticities, i.e., $\frac{wcpe_{sp}}{wcpe_{lp}}$, where sp (lp) stands for the merging party with the smaller (larger) pre-merger equilibrium payoffs. The variable $wpce_i$ is defined as follows:

$$wcpe_i = \sum_{j \neq i} \frac{s_j}{\sum_{j \neq i} s_j} \cdot \frac{\partial s_i}{\partial p_j} \cdot \frac{p_j}{s_i}, \tag{14}$$

where s_i and p_i are the pre-merger market share and price of Firm i, respectively.

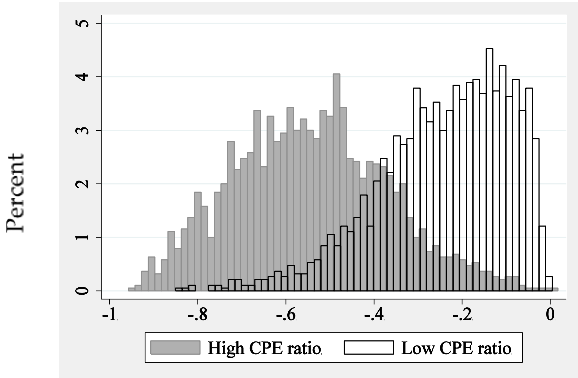
First, Panel a) of Figure 5b displays histograms of the Overall Effect, distinguishing mergers with high and low ratios of pre-merger weighted cross-price elasticities (CPEs in Figure 5b). Results suggest that, merging parties that are more asymmetric in terms of this variable generate on average a stronger impact. Second, Panel b) of Figure 5b displays histograms of the Overall Effect, distinguishing mergers with high and low ratios of pre-merger market shares.[60] Results show that, this variable is not a good predictor of the Overall Impact.

[60] It is defined as the ratio between the market shares of the larger and smaller firms.

Figure 5b – The magnitude of $\Delta CRDF$ (Merged firm) – Very asymmetric equilibrium payoffs (*)

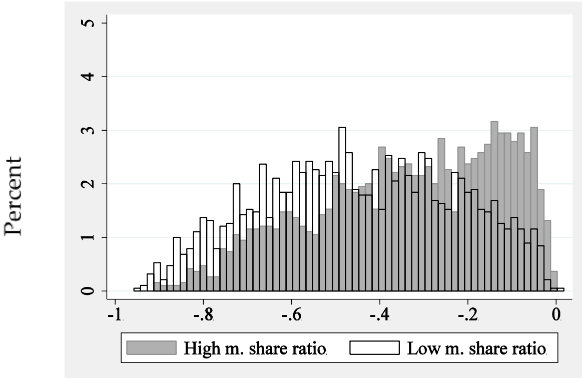
Case (a) The larger firm has the lower pre-merger CRDF

Panel a) Ratio of pre-merger cross-price elasticities (**)



Overall Effect

Panel b) Ratio of pre-merger market shares (***)



Overall Effect

(*) The ratio of pre-merger equilibrium payoffs is higher than the 75th percentile value (very asymmetric firms).
(**) Where "High cross-price elasticity (CPE) ratio" ("Low cross-price elasticity (CPE) ratio") stands for firms with a pre-merger cross-price elasticity ratio higher (lower) than the 50th percentile value.
(***) Where "High market share ratio" ("Low market share ratio") stands for firms with a pre-merger market share ratio higher (lower) than the 50th percentile value (in absolute value).

Result 2: *For mergers between asymmetric firms where the larger firm has the lower pre-merger CRDF, the construction of a screening tool that aims to predict the impact of the merger on the merged firm CRDF should be based on the degree of pre-merger asymmetry between the merging parties in terms of their cross-price elasticities.*

Case (b) The larger firm has the higher pre-merger CRDF

This is the less intuitive case. For instance, it corresponds to a scenario in which a large established firm with low incentives to collude acquires a smaller competitor with high incentives to collude. For these types of mergers, the CRDF of the merged firm is mostly influenced by the payoffs of the merging party with low incentives to collude (i.e., the larger firm), which in turn implies a weak magnitude for the AP effect. In addition, provided that the degree of asymmetry between the merging parties is high, the smaller firm only exerts a weak externality on the pricing behavior of the larger firm, and thus, the CP effect should also be weak.

To verify this prediction, Panel a) of Figure 6 displays the histogram of the Overall Effect for asymmetric firms, distinguishing mergers that qualify as Case (a) or Case (b). The results clearly confirm that the Overall Effect is substantially lower for Case (b).[61]

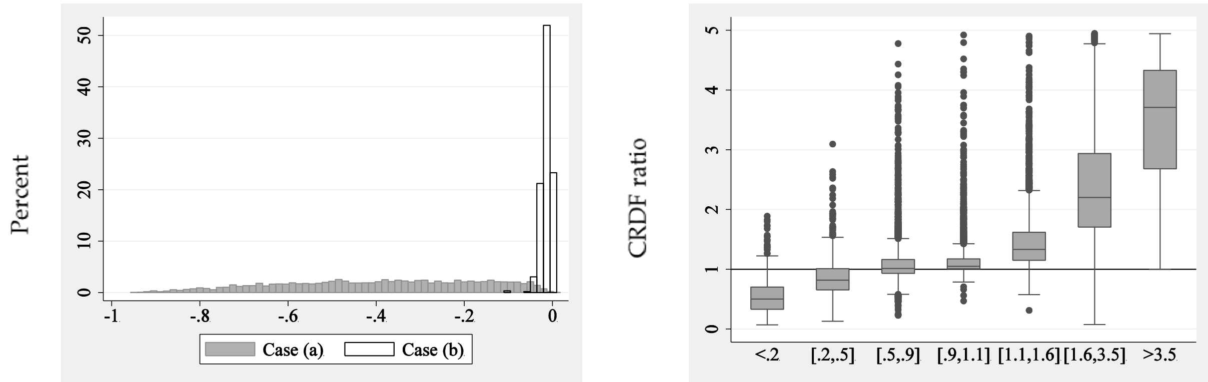
Result 3: *For mergers between asymmetric firms where the larger firm has the higher pre-merger CRDF, the risk of coordinated effects is certainly low*

Figure 6 – The magnitude of $\Delta CRDF$ (Merged firm) – Very asymmetric equilibrium payoffs (*)

Cases (a) and (b)

Panel a) Post-merger Overall Effect, comparison between Cases (a) and (b)

Panel b) Pre-merger CRDF ratio and pre-merger cross-price elasticity ratio (**) (***)



Overall Effect

Cross-price elasticity ratio

(*) The ratio of pre-merger equilibrium payoffs is higher than the 75th percentile value (very asymmetric firms).
(**) For the sake of exposition, the graph only displays CRDF ratios lower than 4.97 (90th per. value).
(***) The thresholds displayed in the x-axis are delimited by the 10th, 25th, 50th, 75th and 90th percentile values.

How to distinguish between Cases (a) and (b)

Panel b) of Figure 6 contains box-graphs that display the relationship between the pre-merger ratio of merging-parties' CRDFs (i.e., $\frac{CRDF_{sp}}{CRDF_{lp}}$) and the ratio of their pre-merger weighted cross-price elasticities.[62] The interpretation of the graph axes is the following: (i) on the y-axis, if the CRDF ratio is higher (lower) than one, it means that the smaller (larger) firm has the higher pre-merger CRDF; (ii) on the x-axis, if the cross-price elasticity ratio is higher (lower) than one, it means that the smaller (larger) firm has the

[61] As the firms become more symmetric, the Overall Effect is driven by the size of the pricing externality, and the distinction between Cases (a) and (b) becomes less relevant. Figure C.4 in Appendix C displays histograms of the Overall Effect, distinguishing mergers in Cases (a) and (b), for different degrees of asymmetry between the merging parties in terms of their pre-merger equilibrium payoffs. The results show that, only for mergers between asymmetric firms, the magnitude of the Overall Effect is significantly different between Cases (a) and (b).
[62] As before, sp (lp) stands for the merging party with the smaller (larger) pre-merger equilibrium payoffs.

higher cross-price elasticity. Results suggest that; (i) when the cross-price elasticity ratio is significantly higher than one, then the CRDF of the smaller firm is in general higher (i.e., previously defined as Case (a)), (ii) when the cross-price elasticity ratio is significantly lower than one, then the CRDF of the larger firm is in general higher (i.e., previously defined as Case (b)), and (iii), when the cross-price elasticity is close to one, then the identity of the firm with the higher CRDF is more ambiguous. Note that these results, as the rest of the results from this paper, are to be interpreted only qualitatively.

5.2 Outsiders

The magnitude of the impact on outsiders' CRDFs should be explained by the impact of the merger on their pricing decisions. Recall that the only change faced by non-merging parties is the increase in their Nash-equilibrium payoffs. Thus, the stronger the CP effect, and the higher the fraction of divested sales that goes from the merged firm to non-merging parties, then the stronger the impact of the merger on outsiders should be.

Figure C.5 in Appendix C displays histograms of the change in a particular outsider CRDF, distinguishing mergers with low and high pre-merger diversion ratios —from products sold by the merged firm to the product sold by this particular outsider firm— and mergers with weak and strong CP effect on the merged firm CRDF. The results show that the impact is on average higher for mergers with a strong CP effect, whereas the pre-merger diversion ratios do not seem to be good predictors of the impact of the merger on the outsider CRDF.

> ***Result 4:*** *For the case of outsiders, the magnitude of the CRDF change is significantly stronger for mergers with a strong CP effect. However, the diversion ratios —from products sold by the merged firm to the product sold by a particular outsider firm— are not good predictors of the magnitude of the change.*

6. Conclusions

The simulation results suggest that a merger can strengthen the coordination incentives of insiders. However, the merger also makes outsiders less willing to collude since deviation becomes more attractive for them. The magnitudes of the results suggest that, while the impact of a merger on the merged firm CRDF can be substantial, its impact on outsiders' CRDFs is moderate. These results are robust to a wide variety of parameters of the demand and supply model, and coincide with what has been found in previous empirical papers.

We provide a novel approach for the assessment of coordinated effects, separating the impact of the merger on the merged firm CRDF into two different effects: namely, the AP and CP effects. In the case of a large firm acquiring a small maverick firm, the impact of the merger is mainly explained by the degree of pre-merger asymmetry between the merging parties in terms of their incentives to collude. In the case of a merger between two symmetric firms, the impact of the merger is mainly driven by the size of the pricing externality. In particular, in the former case, the assessment should be based on the pre-merger cross-price elasticities of the merging parties, while in the latter case the assessment should be built on diversion ratios. Finally, for the case of outsiders, results suggest that only mergers that generate a strong CP effect have the potential to generate a significant impact on their CRDFs.

Chapter 2:

Parallel Accommodating Conduct: Evaluating the Performance of the Coordinated Price Pressure Index

Joint with

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Parallel Accommodating Conduct: Evaluating the Performance of the Coordinated Price Pressure Index

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October, 2016

Abstract

The Coordinated Price Pressure Index (CPPI) measures the incentives of two competitors to engage in a specific kind of Parallel Accommodating Conduct (PAC). Specifically, it measures the incentives of a leader firm to initiate a unilateral percentage price increase, with the expectation that one follower firm will match it. Using a large set of simulated markets, we measure the accuracy of the index in terms of predicting the impact of a merger on firms' incentives to engage in PAC. In addition, we compare the performance of the original index against two alternative indexes that incorporate the pricing externalities existent among the merged firm brands. Results suggest that the CPPI only displays a fair performance when predicting the direction of change of firm's incentives to engage in PAC, and only in mergers in which the diversion ratios between the merged firm brands are low. Moreover, it is shown that both alternative indexes dramatically outperform the original one in terms of predicting mergers with a significant anticompetitive impact, however, the occurrence of cases with a Type II error is still significant.

Keywords Coordinated Price Pressure Index - Parallel Accommodating Conduct - Merger Simulation
JEL classification K21 L41

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Simulation code The original versions of the code and protocol used in this paper were created by Jérôme Foncel, researcher at the University of Lille in France.

1. Introduction

The aim of this paper is to evaluate the performance of the Coordinated Price Pressure Index (CPPI) introduced by Moresi et al. (2011). The CPPI measures the incentives of two competitors to engage in a specific kind of tacit coordination strategy to increase prices. Specifically, a leader firm increases its price by a certain percentage, expecting that a follower firm will observe this change and will match it by exactly the same percentage. This specific conduct is considered as a form of Parallel Accommodating Conduct (PAC).

As explained by Harrington (2013), a PAC could lead firms to reach a supra-competitive outcome. Nevertheless, this conduct requires some kind of retaliation or deterrence mechanism in order to be successfully implemented by firms. The game considered by Moresi et al. (2011) is in line with this argumentation. In particular, the CPPI is derived from a simple model of repeated interaction between two firms, which explicitly considers monitoring and retaliation. The game is built as follows. (i) In a certain period, a leading firm increases its price by a given percentage. (ii) In the subsequent period a follower firm observes the price increase and decides whether to match it or not. (iii) When matching occurs, the price increase becomes permanent. When there is no matching, the leading firm reverses its price to the initial level, with the promise of not initiating any further attempt to engage in PAC.

We construct a set of 50,000 simulated markets.[1] The demand is derived from a discrete choice model with random coefficients. The supply side is composed by a set of heterogeneous single-product firms that offer differentiated products and compete in prices. The initial level of prices is obtained by computing the Nash equilibrium of the one-shot game (hereinafter, equilibrium prices). In each simulated market, we consider the engagement in PAC by two firms (let's say A and B), and for each firm, we compute the percentage price increase that maximizes the present value of the firm's future expected profits. This exercise considers the actual changes in output that result from a given increase in prices. We define Actual Coordinated Price Pressure (ACPP) between Firms A and B, as the minimum of the two percentage price increases potentially initiated by them. Thus, this measure can be seen as the lower bound of the actual supra-competitive prices that two firms can reach through PAC.

The next step is to simulate a merger between one of these firms (let's say A), the acquiring firm, and a third firm (let's say C), the acquired or target firm. Under this new scenario, we re-compute the ACPP, but considering the fact that the acquiring firm in willing to initiate and to follow a PAC by

[1] Using the same model and simulation setting introduced in Chapter 1.

increasing the price of its two products (i.e., its original product plus the product acquired after the merger). The impact of the merger on firms' actual incentives to engage in PAC is measured as the variation of the ACPP induced by the acquisition, and this variation is used as the benchmark to measure the performance of the CPPI.

Note that we use a modified version of the CPPI. The baseline index proposed by Moresi et al. (2011) considers the percentage price increase that leaves to the leader firm indifferent between increasing and not increasing its price (just-profitable variation). While the index used by us considers the percentage price increase that maximizes the present value of the leader firm's expected profits (profit-maximizing variation). However, as already noted by Moresi et al. (2011), in practice this change is just translated into a small difference with respect to the baseline index.[2] Indeed, the index built under the profit-maximization assumption is equal to one half of the baseline one.

The accuracy of the index is measured in two situations: (i) its ability to correctly predict the sign of the change ($\text{ACPP} \geq 0\%$ or $\text{ACPP} < 0\%$), and (ii), its ability to identify mergers that generate a significant anticompetitive impact ($\text{ACPP} \geq 5\%$ or $\text{ACPP} < 5\%$). Then we measure the percentage of cases where the index leads us to incur in Type I and Type II errors. As usual, a Type I error denotes a case in which the index erroneously identifies a merger as anticompetitive, when is not. While a Type II error refers to a case in which the index fails to identify an anticompetitive merger.

First, regarding the direction of change, results suggest that the CPPI only displays a fair performance, and only for mergers involving products with low diversion ratios between them. Second, the results suggest that the CPPI displays a poor performance when predicting mergers that generate a significant increase of firms' incentives to engage in PAC. While the percentage of cases with a Type I error is almost zero, the percentage of cases where the index incurs in a Type II error is considerably high. The reason is that the index consistently underestimates the magnitudes of the actual ACPP variations. We believe that the cause of this problem is that the index omits important information regarding the strategic interactions between the brands produced by the merging parties. Indeed, the index does not consider any of the diversion rations between the acquiring and the target firms' products.

When the acquiring firm decides to increase its prices, a fraction of divested sales from one product are captured by its other product, and vice-versa. Thus, the higher the diversion ratios between the products of the acquiring and target firms, the lower the cost of initiating a PAC. Therefore, not considering this information leads to an underestimation of the actual impact of the merger. In order to account for the presence of this strategic effect, we build two alternative indexes and compare the performance of the CPPI against them. The first alternative index requires the same set of information

[2] See Section II.C.3 of Moresi et al. (2011).

as the original one, plus the diversion ratio from the target firm to the acquiring firm. The second alternative index requires a much richer set of information, including: the diversion ratio from the target to the acquiring firm and vice-versa, the pre-merger price of the target firm, its margin and its own-price elasticity.

Results suggest that the original index still outperforms the two alternative ones in terms of predicting the sign of the change. Nevertheless, the two alternative indexes dramatically outperform the original one in terms of predicting mergers with a significant anticompetitive effect. Indeed, the percentage of cases with a Type II error decreases substantially, while the percentage of cases with a Type I error is just marginally increased. Thus, considering the strategic interactions existent among the merged firm brands significantly improves the accuracy of the index in this regard. However, the percentage of cases in which the alternative indexes incur in a Type II error is still significant.

The rest of the paper is organized as follows. Section 2 briefly reviews the index proposed by Moresi et al. (2011). Section 3 explains the simulations approach. Section 4 shows the main results. Finally, Section 5 presents our main conclusions.

2. The CPPI index

2.1 Pre-merger case

We closely follow the definition proposed by Moresi et al. (2011). The PAC strategy consists in a game in which two (or more) competitors engage in a joint price increase without the need of explicit coordination or communication among them. In particular, a leader firm increases its price by a certain percentage with the expectation that at least one of its competitors will accommodate and follow a similar strategy. The game is defined as follows. (i) In period t, Firm A raises its price by a percentage equal to S_A for at least two periods. (ii) In period $t + 1$, Firm B observes the price increase and decides whether to match it or not, by increasing its price by the exact same percentage. (iii) In period $t + 2$ there are two possible results. First, if Firm B decided to match the price increase in the previous period, then the change becomes permanent for both firms. Second, if Firm B decided not to match the price increase in the previous period, then Firm A returns to its initial price level and commits to not initiate further attempts to engage in PAC.

Moresi et al. (2011) propose an index that captures firm's incentives to participate in the pricing strategy described in the preceding paragraph. However, we choose to study a variation of the original index. Instead of using the maximum percentage price increase that a firm is willing to initiate (just-profitable variation), we use the percentage price increase that maximizes the firm's expected profits from initiating a PAC (profit-maximizing variation). In practice, this latter percentage is just equal to one half of the percentage considered by the original index.[3] Thus, considering this variation, the percentage price increase that Firm A is willing to initiate is given by;

$$S_A^I = \frac{\delta F_{BA} - \theta_A}{1 - \delta F_{BA}} \times \frac{m_A}{2}, \tag{9}$$

with $F_{BA} = \frac{DR_{BA} q_B e_B}{q_A e_A}$ and $\theta_A = 1 - \frac{1}{m_A e_A}$. The pre-merger market shares of Firms A and B are given by q_A and q_B, respectively. The term m_A is the percentage margin charged by Firm A, e_A and e_B are the own-price elasticities of Firms A and B, respectively. The term δ is the inter-temporal discount rate, which is assumed to be equal for every firm in the market. The term DR_{BA} is the diversion ratio from Firm B to Firm A.

The cost/benefit trade-off faced by Firm A when initiating a price increase S_A^I at period t is captured by the term F_{BA}. The numerator represents the size of divested sales from Firm B that Firm A would capture if Firm B decides to match the price increase (from period $t + 1$ onwards). While the denominator contains the size of divested sales from Firm A generated by the initial unilateral price increase (in period t). In addition, the term θ_A measures potential deviations of Firm A with respect to equilibrium prices. Indeed, in equilibrium, it has to be the case that $m_A e_A = 1$ and $\theta_A = 0$. Therefore, when Firm A is already pricing above the equilibrium, its incentives to initiate an additional price increase are reduced (provided that $\theta \in [0,1]$).

The percentage price increase that Firm B is willing to initiate is obtained by an identical procedure and it mirrors Equation (1).

Finally, the pre-merger CPPI is given by;

$$CPPI_{AB} = \min\{S_A^I, S_B^I\}. \tag{2}$$

Note that, as explained by Moresi et al. (2011), the percentage price increase that a firm is willing to follow is always higher than the percentage price increase that a firm is willing to initiate. Thus, $CPPI_{AB}$ captures the lower bound of the range of percentage price increases that two Firms A and B could sustain through PAC.

[3] The mathematical derivations of both indexes are presented in the Technical Appendix of Moresi et al. (2011).

2.2 Post-merger variation

Our purpose is to measure the change in the incentives of Firms A and B to engage in PAC, after the acquisition of a third firm by one of them. Without loss of generality, we assume that Firm A (the acquiring firm) merges with a third firm called Firm C (the acquired or target firm). Under these new circumstances, we re-build the post-merger CPPI index considering the exact same set of assumptions proposed by Moresi et al. (2011). Specifically, to our understanding these are:

1. The variation of the percentage price increase (only motivated by PAC) that Firm i is willing to initiate, i.e., ΔS_i^I with $i = \{AC, B\}$, is measured with respect to the pre-merger level of prices.
2. Thus, we abstract from the presence of unilateral effects.
3. The merged firm (Firm AC hereinafter) raises the prices of all its products by the same percentage (i.e., $S_{AC}^I = S_A^I = S_C^I$).
4. The post-merger sales of Firm AC are equal to the sum of the pre-merger sales of the merging parties (i.e., $q_{AC} = q_A + q_C$).
5. The diversion ratio from Firm B to Firm AC is equal to the sum of the pre-merger diversion ratios D_{BA} and D_{BC}.
6. The diversion ratio from Firm AC to Firm B is equal to the divested sales from Firm AC that are captured by Firm B. We approximate this diversion ratio by the following expression: $D_{AC,B} = \frac{\frac{\partial q_B}{\partial p_A}+\frac{\partial q_B}{\partial p_C}}{\frac{\partial q_A}{\partial p_A}+\frac{\partial q_C}{\partial p_C}}$. All the derivatives are computed using pre-merger prices and market shares.
7. The product produced by Firm C has the same price and margin as the product produced by Firm A. Thus, after the acquisition, Firm AC faces the same elasticity, price and margin for both products.

Then, considering this set of assumptions, the post-merger percentage price increase that Firm AC is willing to initiate takes the simple following form:

$$S_{AC}^I = \frac{\delta F_{B,AC} - \theta_A}{1-\delta F_{B,AC}} \times \frac{m_A}{2} \qquad \text{with} \qquad F_{B,AC} = \frac{(DR_{BA}+DR_{BC})q_B e_B}{(q_A+q_B)e_A}. \tag{3}$$

Similarly, the post-merger percentage price increase that Firm B is willing to initiate is given by;

$$\overline{S}_B^I = \frac{\delta F_{AC,B} - \theta_B}{1-\delta F_{AC,B}} \times \frac{m_B}{2} \qquad \text{with} \qquad F_{AC,B} = \frac{DR_{AC,B}(q_A+q_C)e_A}{q_B e_B}. \tag{4}$$

Note that Equations (3) and (4) are derived from our interpretation of Moresi et al. (2011), since the authors do not present an explicit equation for the post-merger CPPI in the paper.

Finally, the impact of a merger between Firms A and C, on the incentives of Firms A and B to engage in PAC, that is predicted by the CPPI index is given by:

$$\Delta \mathrm{CPPI}_{\mathrm{AC,B}} = \min\{\mathrm{S}_{\mathrm{AC}}^{\mathrm{I}}, \overline{\mathrm{S}}_{\mathrm{B}}^{\mathrm{I}}\} - \mathrm{CPPI}_{\mathrm{AB}}. \qquad (5)$$

3. Simulations

Using the same model and simulation setting introduced in Chapter 1, we simulate 50,000 markets, with 10,000 consumers and 5 single-brand firms in each of them.[4] As in the previous chapter, it is assumed that consumer preferences behave according to a model of discrete choice demand with random coefficients. In addition, we assume that firms offer products with differentiated characteristics or attributes, including a continuous one and a discrete one. Firms have heterogeneous and constant marginal costs of production and compete in prices.[5] In the absence of collusion or PAC, prices are determined by the one-shot Nash equilibrium.

In each market, we simulate a PAC strategy between Firms A and B. The actual percentage price increases (as opposite to the predicted ones presented in the previous section) initiated by firms involved in PAC, are computed by maximizing the sum of firms present and future stream of expected payoffs, assuming that the competitor follows the price increase. Therefore, we observe two percentage price increases: the one potentially initiated by Firm A and the one potentially initiated by Firm B. Then, the Actual Coordinated Price Pressure (ACPP) is defined as the minimum of these two values. In other words, the ACPP represents the actual (instead of the predicted one by the CPPI) lower bound of supra-competitive prices that Firms A and B can reach through PAC. (For further details regarding the computation of the ACPP, see Appendix D.)

As a next step, we simulate the impact of a merger between Firm A (acquiring firm) and Firm C (target firm) on firms' incentives to engage in PAC. Specifically, we re-compute the percentage price increase that Firm A is willing to initiate after acquiring Firm C (which we call merger firm or Firm AC), assuming that it applies the same percentage increase to both products. At the same time, we re-

[4] In this case, we only consider the Calibration 12 of the simulation setting introduced in the previous chapter. For further details, see Table B.3 in Appendix B.

[5] As we explained in the previous chapter, the use of this approach ensures that the set of simulated markets exhibit a much more realistic pattern of own and cross-price elasticities. (See for instance, Nevo 2000.) In addition, having both continuous and discrete quality attributes renders the model more general, and allows us to capture a wider range of preferences. (See for instance, Grigolon and Verboven 2014.) For further details regarding the simulation setting see Chapter 1.

compute the percentage price increase that Firm B is willing to initiate, assuming that it will be followed by the two products of the merged firm. The post-merger ACPP is then defined as the minimum of these two "adjusted" percentage price increases. The impact of the merger is measured as the change in the ACPP. (For further details regarding the computation of the ACPP variation, see Appendix D.) Thus, a positive ACPP variation represents an increase of the lower bound of prices that two firms can reach through PAC, and it can be considered as an anticompetitive effect.

However, an additional adjustment is made to the simulated price increase initiated by the acquiring firm post-merger. Since we are evaluating the impact of the merger with respect to the pre-merger level of prices, we need to adjust for the potential presence of unilateral effects. In order to do so, we compute the percentage price increase that the merged firm is willing to unilaterally initiate, even if there are not competitors willing to follow it. Thus, the post-merger price increase initiated by the acquiring firm and motivated exclusively by PAC, is obtained as follows:

PAC initiated by the merged firm	=	Percentage price increase initiated by the merged firm and followed by a third competitor	-	Percentage price increase that the merger firm would unilaterally initiate

In other words:

PAC effect	=	Overall Effect	-	Unilateral Effects

Note that it is assumed that competitors that are not involved in the PAC strategy do not react and keep their prices at the Nash level. In addition, we are restricting the unilateral effects to be a percentage price increase equally applied to all the products offered by the merged firm. However, the post-merger level of equilibrium prices (Nash equilibrium) does not necessarily satisfy this condition. For further details regarding the maximization problem necessary to obtain the pre-merger and post-merger values of the ACCP, please refer to the Appendix D.

Table 3.1 summarizes the main descriptive statistics of the set of simulated markets. There are already two interesting results that can be deduced from this table. First, on average the CPPI significantly underestimates the actual impact of the merger on firms' incentives to engage in PAC. Second, as predicted by Moresi et al. (2011), the merger can actually reduce firms' incentives to engage in PAC (a negative ACPP variation). Indeed, the ACPP change is negative in 13.57% of the sample.

Table 3.1 - Summary statistics

Variable	Mean	Std. Dev.	Min.	Max.
Own-price elasticity Firm A	-3.482956	1.171715	-24.35604	-0.4310398
Own-price elasticity Firm B	-3.482887	1.169006	-25.7864	-0.2349229
Diversion Ratio (Firm C to Firm A)	0.1683257	0.1246738	0.000008	0.7511157
Diversion Ratio (Firm C to Firm B)	0.1720856	0.1252642	0.000011	0.737363
HHI pre-merger	2769.439	702.6352	2000.255	9441.809
Predicted HHI variation	710.6348	581.8557	0.1590207	4890.431
ACPP pre-merger	0.0456778	0.1350181	-0.000457	21.44375
ACPP variation	0.0402753	0.153141	-2.213478	10.89305
CPPI pre-merger	0.0213234	0.0369831	-0.4044157	0.5667104
CPPI variation (*)	0.0068188	0.0549253	-2.449458	0.3343301
Number of observations			46,093	

(*) It only considers observations with a CPPI variation higher than -2.5

4. Results

4.1 Performance of the index: magnitude of the ACPP change

Figure 4.1 contains a set of scatter-graphs displaying the relationship between the value predicted by the index ($\Delta \text{CPPI}_{\text{AC,B}}$) and the actual variation of firms' incentives to engage in PAC ($\Delta \text{ACPP}_{\text{AC,B}}$). The sample is classified in four groups, according to the actual value of the diversion ratio from the acquired firm (Firm C) to the acquiring firm (Firm A). The upper left panel displays the scatter plot of the observations under the 25th percentile, while the upper right one displays the plot of the observations between the 25th and 50th percentiles, and so on. It is clear to conclude, from a visual examination of the graphs in Figure 4.1, that the index has a better predictive power for those acquisitions with lower diversion ratios between the merging parties.

The obvious explanation behind the existence of this asymmetry, it is that the index omits the information provided by the diversion ratios between the products offered by the merged firm. Indeed, when Firm A is evaluating to initiate a post-merger PAC with Firm B, it has to consider the cost of unilaterally initiating the price increase (i.e., the total divested sales). However, the higher the diversion ratios between the merging parties' products, the lower the cost of initiating a PAC, and thus the higher the impact of the merger on the acquiring firm's incentives to initiate such a conduct. Therefore, for higher values of the merging parties' diversion ratios, the index underestimates the real impact of the merger and becomes considerably less accurate.

Figure 4.1 – Predicted (ΔCPPI) and actual (ΔACPP) variation of firms' incentives to engage in PAC

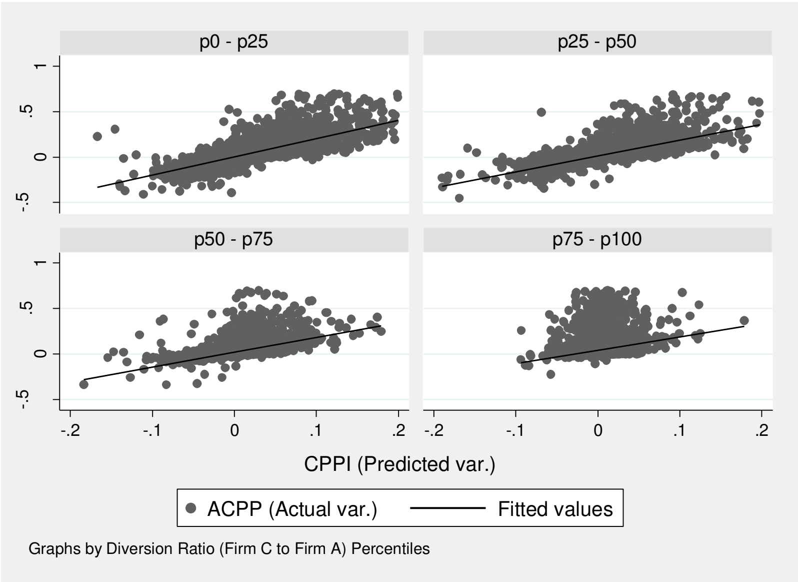
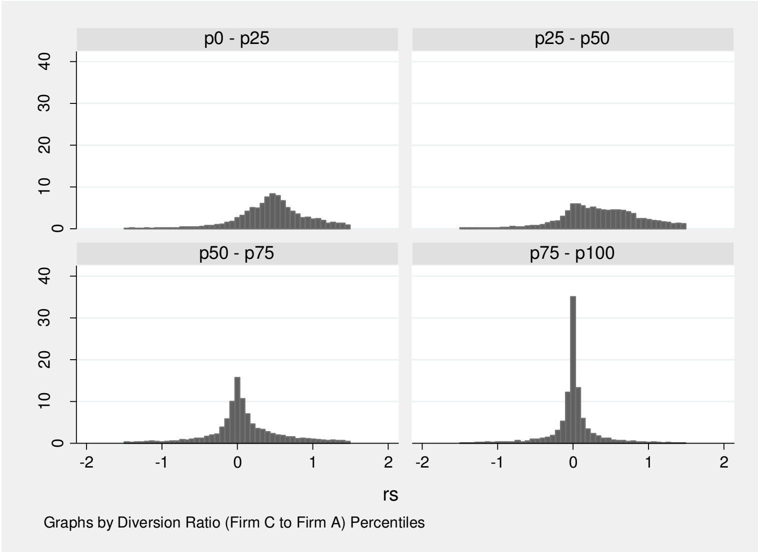


Figure 4.2 displays the empirical distribution of the ratio between the predicted variation of the percentage price increase that the acquiring firm is willing to initiate ($\Delta S_A^I = S_{AC}^I - S_A^I$), and its actual variation. In other words, it shows the percentage of the actual variation that is explained by the CPPI, and it is denoted by r_S. As it seen in the graphs of Figure 4.2, for higher values of the diversion ratio from the acquired firm (Firm C) to the acquiring firm (Firm A), the distribution is centered around 0 (zero). This fact has two implications. First, the index consistently underestimates the actual price variation (otherwise the distribution would be centered around 1). Second, for higher values of the diversion ratio, the index predicts the wrong direction (or sign) of the change on a high percentage of the cases in the sample (almost half of it).

Result 1

For high values of the diversion ratios between the products offered by the merged firm, the CPPI tends to significantly underestimate the actual impact of the merger on firms' incentives to engage in PAC, and to be significantly less accurate when predicting the direction of change.

Figure 4.2 - Histogram of r_S



4.2 Performance of the index: direction of the ACPP change

To study the performance of the CPPI when predicting the direction of change, the sample is classified in two groups: cases with $\Delta\text{ACPP} \geq 0\%$ and cases with $\Delta\text{ACPP} < 0\%$.. Then we measure the percentage of cases where the index leads us to incur in a Type I error and in a Type II error. A Type I error refers to cases in which the index erroneously classifies a merger as potentially anticompetitive, when is not. While a Type II error, corresponds to cases in which the index fails to detect an anticompetitive merger. Table 4.1 summarizes the results. It can be seen that in terms of cases displaying a Type II error, the CPPI displays a fair performance for mergers with a low value of the diversion ratio DR_{CA}, however, the number of cases with a Type I error is still significant.

Table 4.1 – Accuracy of the CPPI: predicting the sign of the change

Diversion Ratio	$\Delta\text{ACPP} < 0\%$		$\Delta\text{ACPP} \geq 0\%$	
Percentile	Freq.	Type-I error	Freq.	Type-II error
25%	2,483	24.77%	9,040	12.88%
50%	2,255	11.84%	9,268	15.47%
75%	1,176	8.67%	10,347	29.22%
100%	343	21.87%	11,181	38.85%
Total	6,257	16.93%	39,836	24.99%

Result 2

In term of predicting the direction of the ACPP change, the CPPI only displays a fair performance, and only for mergers with low values of the diversion ratios between the products offered by the merged firm. Indeed, even in these cases, the probability of incurring in a Type I error is significant.

4.3 Identifying mergers that generate a significant increase in the ACPP

To study the performance of the CPPI in terms of identifying mergers that generate a significant increase in firms incentives to engage in PAC, the sample is classified in two groups: cases with $\Delta ACPP \geq 5\%$ and cases with $\Delta ACPP < 5\%$. As before, we measure the percentage of cases in which the index leads us to incur in a Type I error and in a Type II error. Table 4.2 summarizes the results. The occurrence of cases with a Type I error is substantially low (0.41% of the total number of cases) and stable across the sample. Nevertheless, the accuracy of the index in terms of detecting anticompetitive cases is quite poor. Indeed, the index displays a Type II error in 75.08% of the markets, and in almost 100% of the markets with mergers involving products with high values of the diversion ratio (from Firm C to Firm A).

Table 4.2 – Accuracy of the CPPI: predicting a significant variation of the ACPP

Diversion Ratio (Firm C / Firm A)	$\Delta ACPP < 5\%$		$\Delta ACPP \geq 5\%$	
Percentiles	Freq.	Type-I error	Freq.	Type-II error
25%	8,453	0.70%	3,070	56.09%
50%	9,420	0.73%	2,103	71.56%
75%	9,832	0.17%	1,691	86.16%
100%	8,990	0.07%	2,534	97.32%
Total	36,695	0.41%	9,398	76.08%

Result 3

The port-merger variation of the CPPI displays a poor performance when detecting mergers that generate a significant anticompetitive impact ($\Delta ACPP > 5\%$) on firms' incentives to engage in PAC.

4.4 Incorporating the strategic interactions existent between the merged firm products

In order to test whether the CPPI would enhance its accuracy when taking into account the strategic interactions between the products offered by the acquiring and acquired firms, we compare its performance against two alternative versions of the index that incorporate this information. Indeed, when the merged firm evaluates the possibility of initiating a unilateral price increase, its decision incorporates the fact that some of the resulting divested sales from one brand are partially captured by its other brand and vice versa. This effect generates a positive externality between the merged firm products and it can increase the incentives of the acquiring firm to initiate a PAC. However, the fact that the merged firm is generating divested sales from two products now (instead of only one product, as in the pre-merger case), the acquisition can actually increase the cost of initiating such a conduct in the first place. Therefore, the merger can also decrease the acquiring firm incentives to engage in PAC. The direction of the change depends on which of these effects dominates.

Two alternative indexes are proposed:

1. The first one uses the same set information than the original CPPI, plus the value of the diversion ratio from the acquired firm (Firm C) to the acquiring firm (Firm A) (i.e., the value of D_{CA}). We denote it by $\Delta CPPI^1_{AC,B}$. For its construction we keep the same set of assumptions from Section 2.2.
2. The second one uses much more information. In addition to the information required for the construction of the original CPPI, it also requires the diversion ratios between the two products offered by the merged firm, the pre-merger own price elasticity of the acquired firm, and the pre-merger margin and price of the product produced by the acquired firm. We denote it by $\Delta CPPI^2_{AC,B}$. For its construction we relax the assumption than prices, margins, diversion rations and own-price elasticities are the same for the products offered by the merged firm (i.e., Assumption 7 in Section 2.2).

For further details concerning the derivation of both alternative indexes, please refer to the Appendix E.

Table 4.3 exhibits the performances of the three indexes (the original one plus the two alternative ones) in terms of predicting the direction of the ACPP change. The two alternative indexes display a better performance in terms of occurrence of a Type II error, however, the percentage of cases with occurrence of a Type I error is considerably higher. Therefore, there is no evidence suggesting that the alternative indexes display a better performance in this regard.

Table 4.3 - Accuracy when predicting the sign of the change

Diversion Ratio (Firm C / Firm A)	$\Delta ACPP < 0\%$				$\Delta ACPP \geq 0\%$			
Percentiles	Freq.	Type-I error			Freq.	Type-II error		
		$\Delta CPPI_{AC,B}$	$\Delta CPPI^1_{AC,B}$	$\Delta CPPI^2_{AC,B}$		$\Delta CPPI_{AC,B}$	$\Delta CPPI^1_{AC,B}$	$\Delta CPPI^2_{AC,B}$
25%	2,483	24.77%	39.43%	41.16%	9,040	12.88%	8.87%	7.57%
50%	2,255	11.84%	42.26%	37.16%	9,268	15.47%	9.45%	9.02%
75%	1,176	8.67%	71.51%	58.67%	10,347	29.11%	7.76%	9.75%
100%	343	21.87%	88.34%	80.76%	11,181	38.85%	5.09%	7.26%
Total	6,257	**16.93%**	**49.16%**	**45.18%**	39,836	**24.99%**	**7.66%**	**8.39%**

Result 4

In terms of predicting the direction of the ACPP change, the two alternative indexes do not display a better performance than the original one.

Table 4.4 exhibits a comparison between the performances of the indexes in terms of predicting mergers that generate a significant anticompetitive effect. It can be seen that the two alternative indexes incur in a higher percentage of Type I error, however, this increase seems to be moderate. Regarding the occurrence of a Type II error, both indexes dramatically outperform the original CPPI. Nevertheless, the percentage of cases displaying a Type II error is still significant.

Result 5

The two alternative versions of the CPPI significantly outperform the original index in terms of identifying mergers that generate a significant anticompetitive impact (($\Delta ACPP > 5\%$), while just moderately increasing the occurrence of a Type I error. However, the percentage of cases displaying a Type II error is still significant.

Table 4.4 - Accuracy when predicting a significant variation of the ACPP

Diversion Ratio (Firm C / Firm A)	$\Delta ACPP < 5\%$				$\Delta ACPP \geq 5\%$			
Percentiles	Freq.	Type-I error			Freq.	Type-II error		
		$\Delta\mathrm{CPPI}_{\mathrm{AC,B}}$	$\Delta CPPI^1_{AC,B}$	$\Delta CPPI^2_{AC,B}$		$\Delta\mathrm{CPPI}_{\mathrm{AC,B}}$	$\Delta CPPI^1_{AC,B}$	$\Delta CPPI^2_{AC,B}$
25%	8,453	0.70%	2.77%	2.87%	3,070	56.09%	48.79%	31.82%
50%	9,420	0.73%	1.89%	1.27%	2,103	71.56%	57.20%	36.14%
75%	9,832	0.17%	3.82%	2.28%	1,691	86.16%	52.40%	37.37%
100%	8,990	0.07%	12.63%	6.5%	2,534	97.32%	26.95%	25.14%
Total	36,695	**0.41%**	**5.24%**	**3.19%**	9,398	**76.08%**	**45.44%**	**31.99%**

5 Conclusions

We test the accuracy of the CPPI within a simulated environment, considering a system of non-linear demands and a supply side composed by heterogeneous firms that compete in prices. The results suggest that the index displays a poor performance when predicting significant changes on firm's incentives to engage in PAC. There are two potential explanations for this result. First, the CPPI is derived from a model with linear demands. Thus, it is expected that its accuracy is reduced in a model based on non-linear demands. Second, the CPPI does not consider the strategic interactions between the merged firm's brands. Indeed, the cost of initiating a PAC may be reduced because a fraction of divested sales from one product are captured by the other products offered by the merged firm. Therefore, not considering this positive externality leads us to inaccurate predictions.

We show that incorporating the strategic interactions between the merged firm's brands substantially increase the accuracy of the CPPI in terms of predicting significant variations of the ACPP. The occurrence of Type II errors decreases dramatically, while the number of cases with a Type I error increases just moderately. Therefore, these results highlight the importance of considering these interactions when building a model or an index which attempts to predict the coordinated effects of a merger. Nevertheless, even when accounting for these strategic interactions, the percentage of cases in which the CPPI displays a Type II error is still significant.

Chapter 3:

Effectiveness of Merger Remedies: The Case of Chilean Gasoline Retail Markets

Effectiveness of Merger Remedies: The Case of Chilean Gasoline Retail Markets

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October, 2016

Abstract

The aim of this paper is to quantify the impact on retail prices of the Shell-Terpel merger in the Chilean gasoline market, and to evaluate the effectiveness of gas stations' divestitures in highly concentrated locations as a tool to mitigate an eventual raise in prices. The identification strategy relies on the fact that a merger between two national retail networks should be independent of previous characteristics of different local markets. Results show a modest but significant increase in margins of gas stations geographically affected by the merger. The divestitures were effective in mitigating this anticompetitive effect, but only for retail outlets closely located to divested stations, i.e., within a 2 Km. radius. Notably, these effects are symmetric for both merging and non-merging parties. Moreover, divested gas stations that did not keep the Terpel brand set significantly lower prices on average. Finally, the presence of unbranded gas stations and/or small alternative brands within a 1 Km. radius seems to be enough in order to offset the price increase generated by the merger in these specific locations.

Keywords Divestitures - Gasoline Retail Markets – Merger Evaluation – Merger Remedies

JEL classification K21 L13 L41 L81

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1. Introduction

Recently, Chilean congressmen have shown concerns regarding the possibility of anticompetitive practices among retailers in certain regions of the country, namely: i) homogeneity of prices across competitors, ii) the existence of asymmetric responses of retail prices to changes in import prices (i.e., quick reactions to increases in costs but low reactions to cost reductions), and iii), the fact that prices are considerable higher in some regions than in others. Moreover, they argue that large retailers pressure smaller competitors and its franchises in order to set a minimum floor for prices. [1]

In this context, in April 2012 the Chilean Competition Tribunal blocked a merger between Shell and Terpel, two of the largest retailers in the country, arguing that the merger could generate significant anticompetitive effects on retail prices. In particular, according to the Tribunal, Chilean markets are characterized by high levels of concentration and the presence of significant entry barriers, which creates substantial risks of post-merger unilateral and coordinated effects.[2] In addition, in the Tribunal´s opinion a divestitures package and the entry of small brands would not be an effective remedy. The Tribunal reasoning was based on the fact that small brands would face important disadvantages vis-à-vis larger competitors, due to their impossibility to reach a minimum scale of operation that would allow them to benefit from certain economies of scale and scope in their supply of inputs (i.e., mainly transport networks to supply retail outlets with gasoline).

Nevertheless, this decision was reversed by the Chilean Supreme Court of Justice in January 2013, and the merger was cleared but considering some remedies.[3] Specifically, Shell and Terpel had to divest gas stations in all the communes where the variation of the concentration index (HHI) was higher than the "safe harbor" thresholds established by the guidelines of the Competition Authority.[4] As a result, Shell-Terpel had to divest 61 gas stations in 61 communes across the country, which corresponds

[1] For further details regarding this discussion, see the Congress debate of April 18th 2012 (document written in Spanish), available in the following link: http://www.senado.cl/appsenado/index.php?mo=sesionessala&ac=getDocumento&teseid=34835&nrobol=&tema=Tema&legiid=&parl_ini=906&tagid=6

[2] The decision of the Chilean Competition Tribunal is available in the following link (document written in Spanish): http://www.tdlc.cl/tdlc/wp-content/uploads/resoluciones/Resolucion_39_2012.pdf

[3] For further details, see the following statement of the company controlling Shell in Chile (document written in Spanish): http://www.svs.cl/documentos/hes/hes_2013010009882.pdf

[4] The merger guidelines published by the Chilean Competition Authority are available in the following link: http://www.fne.gob.cl/english/wp-content/uploads/2013/01/Guia-fusiones-traducida-final-2.pdf

to approximately 30% of the stations operated by Terpel prior the merger.[5] The merger was finally executed on June 2013, and the divestitures were implemented within the next six months.[6]

The aim of this paper is to quantify the impact of the Shell-Terpel merger on retail prices, and to evaluate the effectiveness of divestitures as a tool to mitigate any eventual raise in prices. The identification strategy relies on the fact that a merger between two national retail networks should be independent of previous characteristics of different geographic markets. Thus, changes in concentration levels of different local markets due to the merger can be seen as exogenous, generating a kind of natural experiment in which different markets are being asymmetrically affected. The idea behind is that the impact of the merger on prices can be measured by differences between markets affected and not affected by the merger.

I use data from a new website launched by the Chilean government (i.e., www.bencinaenlinea.cl) where each gas station in the country is mandated to report any change in prices. The data covers the period March-2011 / January-2015 and contains information of about 1,500 gas stations across the country. The results displayed by a difference-in-difference reduced form regression suggest a modest but significant increase in prices of markets geographically affected by the merger. Moreover, results suggest that the divestitures of gas stations were effective in offsetting this raise in prices, but only for gas stations located within a 2 Km. radius from the divested stations.

This article is related to two different strands of empirical literature. The first one is the empirical assessment of the impact of mergers on prices, using panel data and geographical variation of local market structures as identification strategy. The second one is the empirical study of the impact of post-merger remedies on prices.

Regarding the former strand of literature, Hastings and Gilbert (2005) empirically examine the relationship between vertical integration and wholesale gasoline prices. They use discrete and differential changes in the extent of vertical integration into a large number of markets, generated by mergers in the West Coast gasoline refining and retailing markets in the United States. They find evidence consistent with the strategic incentive to raise competitors' input costs, suggesting that vertical integration can have a significant impact on wholesale prices. Their identification strategy relies on the fact that market structure in individual markets should have been determined prior to the acquisition decision, and that the acquisition decision was made at the aggregate national level.

Similarly, Houde (2012) studies an empirical model of spatial competition applied to gasoline markets. The model is estimated using panel data of the Quebec City gasoline market and then used to

[5] For further details, see the following statement of company controlling Shell in Chile (document written in Spanish): http://www.svs.cl/documentos/hes/hes_2013030023330.pdf

[6] The auction was finally implemented in September 2013. For further details, see the following online newspaper (article written in Spanish): http://www.economiaynegocios.cl/noticias/noticias.asp?id=112114

evaluate the consequences of a recent vertical merger. Both a reduced form difference-in-difference approach and a structural model with counterfactual simulations are estimated and compared. The identification strategy for the difference-in-difference estimation relies on the idea that a merger between two retail networks creates sharp changes in the structure of local markets. The results suggest that the merger led to statistically significant price increases, and the reduced-form estimates are also shown to align well with the merger simulation predictions.

More recently, Ashenfelter et al. (2015) estimate the effects of increased concentration and efficiencies on pricing, as a result of a large merger in the U.S. brewing industry. According to the authors, two key features of the U.S. beer industry allow them to estimate the effects of the merger. First, due to regulations on the distribution of beer, different metropolitan areas can be viewed as separate markets. Second, there was substantial variation in how the merger was expected to reduce shipping costs and increase concentration across different regional markets. Identification requires that there are no region specific trends in pricing that are correlated with the predicted local increases in concentration or the reduction in costs. The results show small but statistically significant effects on beer prices from both: the increases in concentration and the reductions of shipping costs.[7]

Finally, regarding the literature on post-merger remedies, Friberg and Romahn (2015) evaluate the impact of divestitures on prices, as a consequence of the Carlsberg-Pripps merger in the Swedish beer market. Using both a difference-in-difference approach and a structural model to run counterfactual merger simulations, the authors find that divestitures had a significant impact on offsetting the rise in prices generated by the merger. In addition, they show that the divestitures could be more effective when the recipient firm is smaller and when the set of divested products is larger.

The rest of the paper is organized as follows. Section 2 briefly describes the Shell-Terpel merger and the data. Section 3 explains the identification strategy and displays the main results. Section 4 contains the conclusions.

2. Characteristics of the merger and data

2.1 The merger

The Chilean gasoline retail market is characterized by a high level of concentration. Indeed, prior to the merger only four brands accounted for more than 95% of the overall retail sales. Specifically, according

[7] Other papers that use panel data with difference-in-difference methodologies to estimate the effects of mergers on gasoline markets are Hastings (2004), Hosken and Taylor (2007), and Simpson and Taylor (2008).

to the Chilean Competition Tribunal, the leader retailer Copec had a market share equal to 54.9%, followed by Shell (16.8%), Petrobras (14.9%) and Terpel (9.7%). There are some smaller competitors given by unbranded gas stations and gas stations that belong to considerably smaller alternative brands, but their joint market share is lower than 5%. In this context, the Shell-Terpel merger took place in June-2013, after being initially blocked by the Chilean Competition Tribunal, but cleared by the Supreme Court of Justice afterwards.

The extent to which a merger generates a significant increase in concentration in local markets is determined by the degree of complementarity of the networks operated by the merging parties. Specifically, two retail networks are said to be complementary when the overlapping of outlets locations in different geographical markets is low. Table 1 exhibits the number of communes where both Shell and Terpel were actively operating by the beginning of 2013. Shell had gas stations in 135 communes and Terpel participated in 119 communes. There are 67 communes where they both jointly operate, these communes contain 63.8% of the gas stations branded Shell and 71.6% of the gas stations branded as Terpel. Therefore, the degree of complementarity between the two networks was low.

Table 1 - Number of communes where both firms operate (*) (**)

Firms' presence		Terpel		
		No	Yes	Total
Shell	No	110 (0%)	52 (11.6%)	162
	Yes	68 (21.5%)	67 (66.9%)	135
Total		178	119	297

(*) Reported in January 2013
(**) The information in brackets shows the total percentage of gas stations of Shell and Terpel operating in these communes

Regarding the market concentration generated by the merger, the Chilean Competition Authority considers the following thresholds as safe harbors:

i. The predicted post-merger HHI is lower than 1500. [8]
ii. The predicted post-merger HHI lies between 1500 and 2500, and the index variation is lower than 200.
iii. The predicted post-merger HHI is higher than 2500, and the index variation is lower than 100.

[8] The concentration index is equal to:

$$HHI = \sum_{i=1}^{n} s_i^2,$$

Where n is the number of firms and s_i is the market share of firm i

As a proxy for market shares, I consider the ratio between the number of stations of a certain brand and the total number of stations per commune. In 66 out of 67 communes, the predicted post-merger HHI and its predicted change are above these safe harbor thresholds. Specifically, in all these communes the predicted post-merger HHI is higher than 1500, and the predicted index variation is higher than 200. Table 2 exhibits the predicted post-merger HHI and its variation for communes of different sizes.[9] The overlapping of networks occurs mainly in medium size communes. Additionally, the data shows that the predicted variation of the HHI is lower for larger communes.

As I discussed before, the identification strategy relies on the fact that the merger generates asymmetric effects in different geographic markets. Table 2 contains evidence supporting this feature. Indeed, there is an important number of communes where the merger should not have had any impact on market shares (or at least a relatively weak impact), vis-a-vis communes where its impact on market shares should have been substantial.

Table 2 - Mean predicted post-merger HHI by commune size (*)

Commune size	Variable	Both firms' presence	
		No	Yes
Large	HHI post-merger	3,578	3,165
150,000 < population size	HHI var.	0	592
	Freq.	9	25
Medium	HHI post-merger	4,573	4,155
25,000 < population size < 150,000	HHI var.	0	1,093
	Freq.	70	38
Small	HHI post-merger	7,615	5,729
Population size < 25,000	HHI var.	0	2,292
	Freq.	151	4

(*) Reported in January 2013

As part of a set of post-merger remedies, the merging parties had to divest 61 gas stations in 61 different communes of the country. These divestitures were implemented through an open auction held in September-2013, and the transference of gas stations to the winner bidders was done by January-2013

[9] The predicted post-merger HHI is constructed in the following way:

$$HHI_{post-merger}^{predicted} = (s_{Shell} + s_{Terpel})^2 + \sum_{i \neq Shell,Terpel}^{n-2} s_i^2$$

Where s_i are the pre-merger market shares. Remember that I consider the ratio between the number of stations of a given brand and the total number of stations per commune as a proxy for market share.

(with a few exceptions, see the Appendix F for further details). Table 3 summarizes the timing of the merger procedure.

Table 3 – Timing of the merger procedure

Date	Event
November-2011	Merger notification
Abril-2012	Merger blocked by the Competition Tribunal
January-2013	Merger cleared by the Supreme Court of Justice
June-2013	Merger is executed
September-2013	Divestitures auction
October-2013 / January-2014	Transference of divested stations to the winner bidders

Finally, it is important to mention that there is a group of divested stations that left the market shortly after being transferred to the winner bidders. The most likely explanation is that these outlet locations started to being used in different business not related to the retail distribution of gasoline.

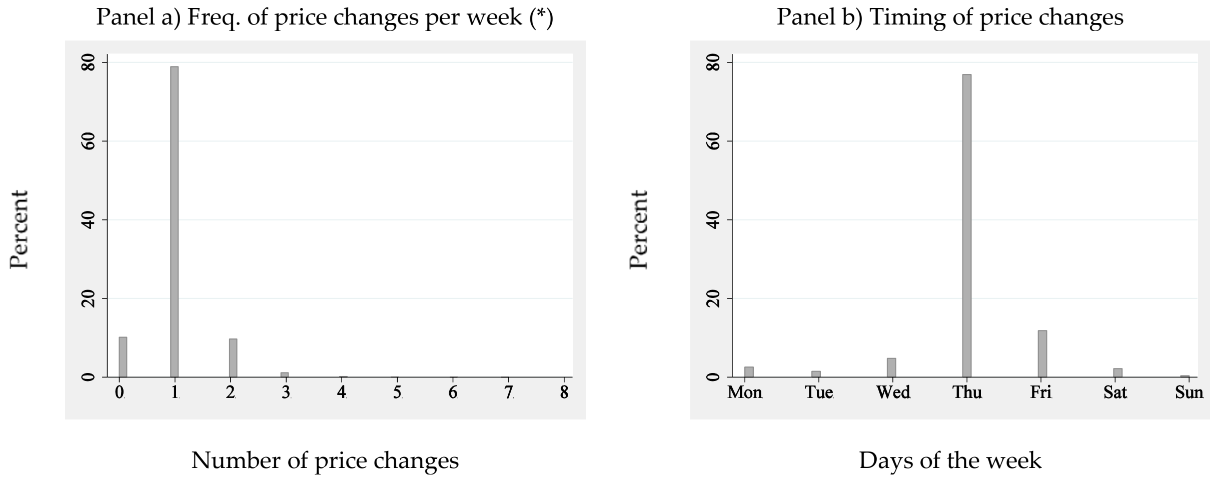
2.2 Data

Starting on March 2012 the Chilean government launched a website where users can follow prices of each gas station across the country (i.e., www.bencinaenlinea.cl/). The main objective of this policy was to increase the information available for consumers, allowing them to find the cheapest prices and thus increasing competition among retailers. Each observation in the database contains the price charged for each station, the exact date and hour of each price modification, the station's location, the brand of the station and the type of gasoline.

The database contains information of about 1,500 gas stations located in 297 communes of Chile. The available data covers the period March 2012 – January 2015, thus considering both pre-merger and post-merger periods. In all, I count with 983,494 observations. Nevertheless, for now I only focus on the most popular type of gasoline sold in Chile, i.e. gasoline with 93 octanes (hereinafter, Gasoline 93). In addition, I drop gas stations from certain communes of the country where I could not identify the addresses of the divested gas stations. For more information regarding the data cleaning process, see the Appendix F.

Since I do not have sales information, it is not possible to compute average prices. Thus, the weekly retail price is defined as the last posted price of a given station in a particular week. This procedure seems appropriate because prices are usually modified only once per week. Figure 1 displays the frequencies of price changes per week, in 78.91% of cases the stations modify their prices once per week, in 9.68% of the sample stations modify their prices twice peer week, in 10.14% of the weeks stations do not modify their prices at all, and in very few cases prices are modified more than two times within a week (the remaining 1.27% of the cases in the sample). The refinery prices are announced every Wednesday and retailers adjust their prices predominantly on Thursdays and Fridays (See Figure 1, Panel b).

Figure 1 – Frequency and timing of price changes (Gasoline 93, national level)



(*) For the sake of exposition, one outlier observation is omitted (in which the price is changed 35 times within a week).

3. Empirical approach and results

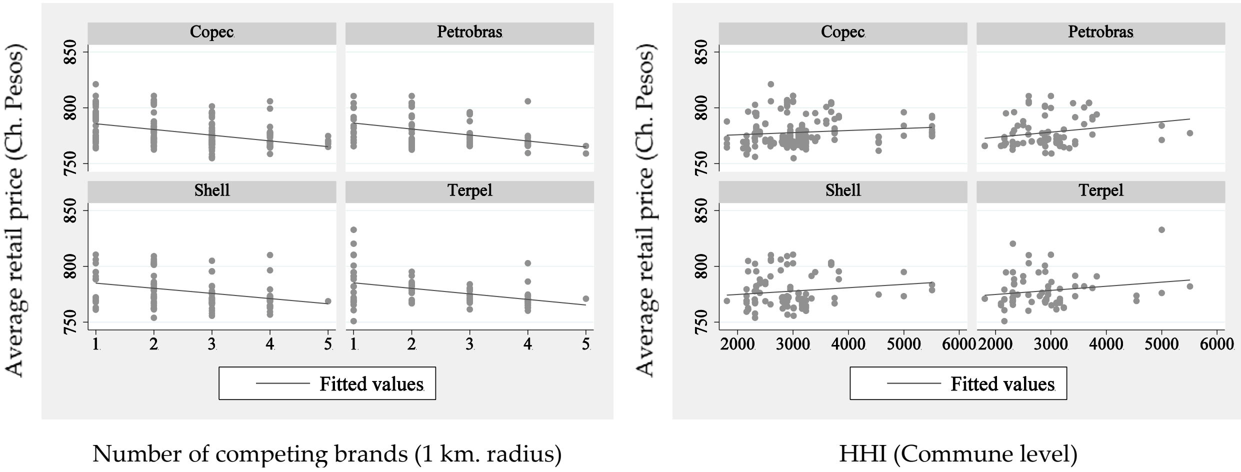
3.1 Identification strategy

I focus on the number of competing brands within the radius around a specific gas station, rather than on geographical markets delimited by communes' boundaries, mainly because the average retail price seems to be highly correlated with this former variable (see Figure 2, Panel a). By contrast, prices do not seem to be well explained by the level of the HHI index at the commune level, which was the tool used by the Chilean Competition Authority in order to identify risky markets (see Figure 2, Panel b).

The identification strategy relies on the assumption that the merger between Shell and Terpel, i.e., two national retail networks, is independent of previous characteristics of local markets (See for instance, Ashenfelter et al. 2015 who relies on a similar assumption). Indeed, as explained by Shell and Terpel during the merger review process, their decision to merge was driven by several reasons, including the strengthen of their brands, the saving of large fix costs, the reduction of variable transport costs, among others. Moreover, even though it is evident that from the merging parties point of view the potential increase in market power generated by the merger is also an important benefit; its evaluation should be done at the national level. Thus, the concentration levels and/or the number and identity of competing brands within specific small local markets should be independent of the firms' decision to merge.[10]

Figure 2 – Pre-merger level of prices (Gasoline 93, Metropolitan Region)

Panel a) Prices and number of competing brands (*) Panel b) Prices and HHI at the commune level (**)



(*) Unbranded gas stations and small brands are grouped in two separate brand categories.
(**) For the sake of exposition the graph does not display observations with an HHI higher than 6000.

A natural way to verify the validity of this exogeneity assumption is to check whether the pre-merger retail prices of gas stations geographically affected by the merger and the pre-merger retail prices of gas stations not geographically affected by the merger follow similar trends. In a difference-in-difference framework, this is the well-known parallel trend assumption. Specifically, it refers to the fact that in the absence of treatment (for instance, a merger), the outcome of interest for both treatment and control groups would have followed a similar trend. (See for instance, Friberg and Romahn 2015 for a similar exposition.)

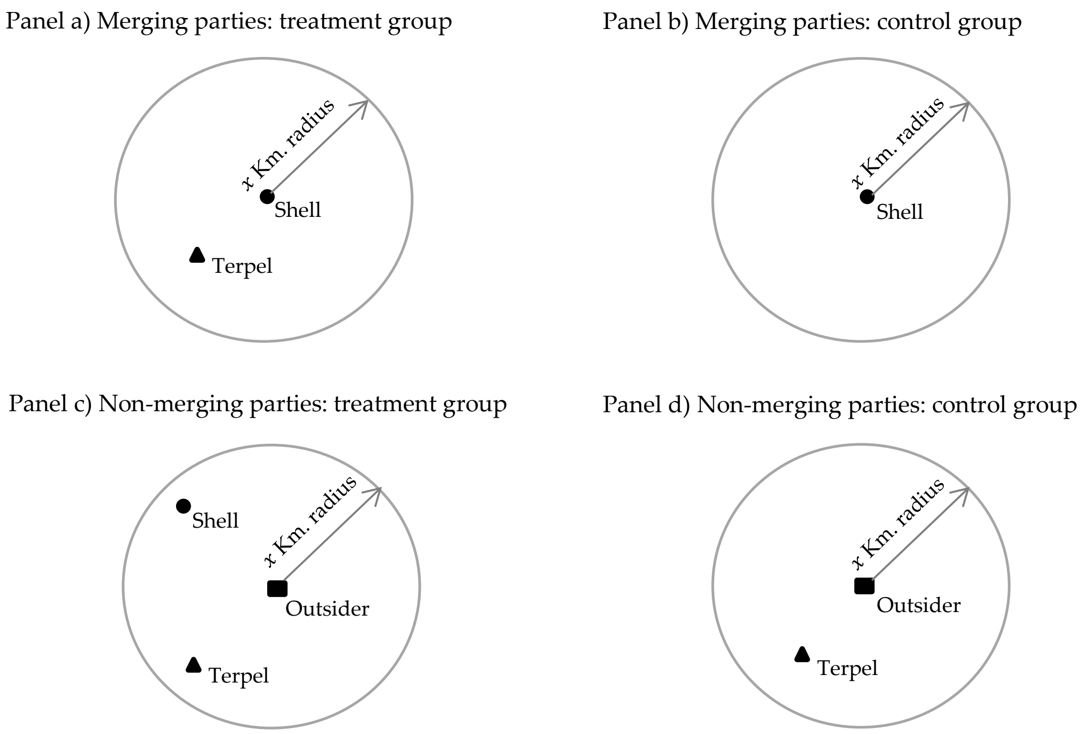
In the setting presented in this paper, in order to define treatment and control groups, it is necessary to distinguish gas stations that belong to the merged firm and gas stations that belong to the group of non-merging parties. For the merged firm, a Shell (resp. Terpel) gas station is said to be geographically affected by the merger when a second gas station belonging to Terpel (resp. Shell) is located within a specific radius. See the examples in Panels a) and b) of Diagram 1 for a simplified illustration of the construction of treatment and control groups in this case (these examples are not exhaustive). For non-merging parties, a gas station is said to be geographically affected by the merger

[10] In addition, the assets of Terpel-Chile had to be mandatorily sold to a firm different than Copec (the firm with the largest market share in Chile) before July 2012, as part of a set of preventive remedies imposed by the Chilean Competition Tribunal after the acquisition of Terpel-Colombia by Copec in December 2010. Thus, the timing of the Shell-Terpel merger in Chile can be also considered as exogenous.

when both Shell and Terpel gas stations are located within a specific radius. See the examples in Panels c) and d) of Diagram 1 for a simplified illustration of the construction of treatment and control groups among gas stations belonging to non-merging parties (these examples are not exhaustive either).

Consequently, gas stations geographically affected by the merger are defined as the treatment group, and gas stations not geographically affected by the merger correspond to the control group.

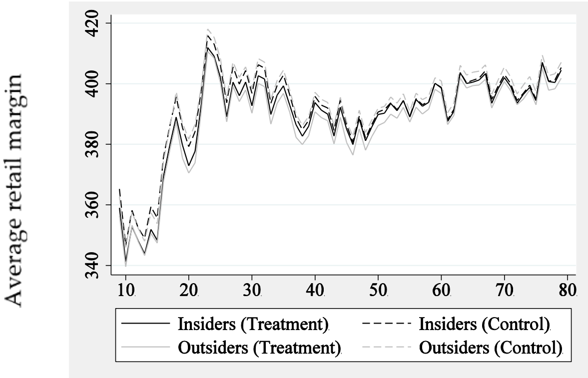
Diagram 1 – Examples of treatment and control groups



Panel a) of Figure 3 displays the pre-merger evolution of the average margin for gas stations affected and not affected by the merger (using 1 Km. radiuses), distinguishing insiders (Shell and Terpel) and outsiders (Copec and Petrobras). It is clear that the pre-merger evolution of prices follow very similar trends, regardless of the status of gas stations. In addition, Panel b) contains a map that shows the locations of gas stations within the Metropolitan Region of Chile. There are no clear specific patterns concerning the geographic distributions of the treatment and control groups (for a 1 Km. radius), which support the idea that the merger has an exogenous asymmetric impact in different geographic markets.

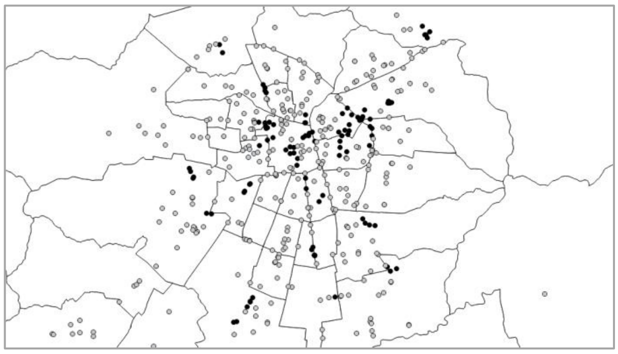
Figure 3 – Pre-merger prices and geographic locations (Gasoline 93)

Panel a) Evolution of retail margins (*)



Week

Panel b) Impact of the merger on local markets (Metropolitan Region) (*) (**)



Black dots: Treatment group
Gray dots: Control group

(*) Treatment and control groups are defined using 1 Km. radiuses
(**) Based on the locations of stations selling Gasoline 93

3.2 Selection of divestitures

As I explained before, the Chilean Supreme Court of Justice identified 61 communes where Shell-Terpel had to implement the divestiture of one gas station in each of them. However, within each commune, it was the merged firm who decided which gas station was finally divested. Therefore, the merging parties could have acted strategically by divesting the set of gas stations that would minimize the impact of the divestitures on prices. If this was the case, then the estimation of the impact of divestitures on prices would be downward biased, and it would only capture the lower bound of its effect.

One way to test the existence of such a strategic behavior would be to verify whether the choice of divestitures is explained by specific features of local markets, including characteristics of the demand and supply sides. Nevertheless, in the current database I only have information regarding certain characteristics of the supply side, namely: the number and identity of competitors within certain distances, the prices and margins charged by these gas stations, and some other characteristics of gas stations (i.e., self-service option, the availability of a grocery store, public toilets, a pharmacy and car maintenance services).

Table G.1 in Appendix G exhibits the results from different Logit regressions estimating the probability of a given Shell-Terpel gas station being divested, as a function of certain pre-merger characteristics. These regressions only consider gas stations operating in communes where the Court identified potential risks of anticompetitive effects. The results suggest that the majority of explanatory variables do not have a significant impact on the probability of a given station being divested. Only two variables have a significant effect, these are: the number of Copec gas stations operating between 2 Km. and 3 Km. radiuses, and the number of Petrobras gas stations operating between 1 Km. and 2 Km. radiuses. However, the signs of the two coefficients associated to these variables display opposite signs, which suggests that there is no clear pattern explaining the selection of divestitures.

3.3 Reduced-form approach

Following Ashenfelter et al. (2015) and Friberg and Romahn (2015), I propose the use of a difference-in-difference approach through the estimation of the following reduced-form equation:

$$\begin{aligned} \log(margin_{i,t}) = \beta_1 \cdot PostM1_t \cdot Merger_i + \beta_2 \cdot PostM2_t \cdot Merger_i \\ +\gamma_1 \cdot PostM1_t \cdot Merger\_Divest_i + \gamma_2 \cdot PostM2_t \cdot Merger\_Divest_i \\ +\delta_1 \cdot PostM1_t \cdot Merger\_Divest\_Rad_i + \delta_2 \cdot PostM2_t \cdot Merger\_Divest\_Rad_i \\ +\alpha_i + \mu_t + \varepsilon_{i,t}, \end{aligned} \tag{10}$$

where $margin_{i,t}$ is the margin (i.e., the difference between retail price and refinery price) of gas station i during week t. $PostM1_t$ is a dummy variable equal to one if week t falls on the post-merger period (i.e. after July-2013), but before the divestitures are implemented (i.e., before January 2014). $PostM2_t$ is a dummy variable equal to one if week t falls on the period after the divestitures are implemented (i.e., after January 2014). The dummy variable $Merger_i$ is equal to one if the following conditions are jointly satisfied: (i) gas station i is geographically affected by the merger, (ii) it is not divested after the merger, and (iii) there are no divested gas stations within a specific radius. The dummy variable $Merger\_Divest_i$ is equal to one if gas station i is geographically affected by the merger, and if it is divested after the merger.[11] The dummy variable $Merger\_Divest\_Rad_i$ is equal to one if gas station i is geographically affected by the merger, and if there is a divested gas station within a specific radius.[12] Finally, α_i and μ_t are fixed effects terms for gas stations and weeks, respectively.

As I mention before, there is a group of divested stations that left the market shortly after being transferred to the winner bidders. Hence, the variables $Merger\_Divest_i$ and $Merger\_Divest\_Rad_i$ only consider the set of divested gas stations that continued operating after the transference.

[11] Depending on the size of the selected radius, it could be the case that a gas station not affected by the merger was divested. However, the variable $Merger\_Divest_i$ does not account for these cases.

[12] Similarly, depending on the size of the selected radius, it could be the case that a gas station not affected by the merger competes with divested gas stations. However, the variable $Merger\_Divest\_Rad_i$ does not account for these cases.

3.4 Results

The first three columns of Table 4 contain the results from the estimation of Equation (1) considering radiuses of 1 Km., 2 Km. and 3 Km. around each gas station, respectively. Results suggest that before the implementation of the divestitures (i.e., between July-2013 and December-2013), the merger generates an average increase in margins between 0.5% and 0.6%, but only for gas stations that are not divested afterwards and do not face competition from divested gas stations within radiuses of 1 Km and 2 Km. After the execution of divestitures (i.e., after December-2013), the impact of the merger on margins becomes stronger. For gas stations not affected by divestments, the average increase in margins is approximately equal to 1.6% for all the selected radiuses (i.e., 1 Km., 2 Km. and 3 Km.).

As expected by the Chilean Competition Authorities, margins of divested gas stations are significantly reduced by more than -2% on average after December-2013, and for all the selected radiuses. Regarding gas stations directly competing with these divested stations, their margins are also significantly reduced by more than -1.5% on average, but only when divested stations are close enough (i.e., within a 1 Km. radius). When the competing divested station is located within a 2 Km. radius, the impact of the merger on margins becomes positive, but with a very weak magnitude. Finally, when the competing divested station is located within a 3 Km. radius, the impact of the merger on margins is similar for stations facing and not facing competition from divested stations. Thus, the implementation of the divestitures offsets the impact of the merger on prices, but only for stations closely located to divested stations (i.e., within a 2 Km. radius).

The last three columns of Table 4 display the results of a model that incorporates interactions between the variables capturing the impact of the merger after the execution of the divestitures, and the identity of gas stations. Specifically, gas stations are classified into three groups: insiders (i.e., Shell and Terpel), outsiders (i.e., Copec and Petrobras), and other brands (i.e., unbranded gas stations and smaller alternative brands). Results suggest that the impact of the merger on margins of gas stations not facing competition from divested stations is practically identical for insiders and outsiders. In addition, the impact of the merger on unbranded stations and small alternative brands is not significantly different from zero, but only for the equation that considers 1 Km. radiuses (i.e., column (4) in Table 4). Finally, regarding the impact of divestitures, their impact is symmetric for insiders and outsiders, but it is considerably stronger for unbranded and small alternative brands.

These results are robust to the introduction of clustered standard errors at the commune level. (See Table G.2 in Appendix G.)

Table 4 – Results Equation (1) (Gasoline 93, national level)

VARIABLES	(1) $\log(margin_{i,t})$ 1 Km. radius	(2) $\log(margin_{i,t})$ 2 Km. radius	(3) $\log(margin_{i,t})$ 3 Km. radius	(4) $\log(margin_{i,t})$ 1 Km. radius	(5) $\log(margin_{i,t})$ 2 Km. radius	(6) $\log(margin_{i,t})$ 3 Km. Radius
Anticompetitive effect						
$PostM1_t \cdot Merger_i$	0.00536***	0.00546***	0.00590***	0.00517***	0.00540***	0.00589***
	(0.000484)	(0.000357)	(0.000375)	(0.000484)	(0.000357)	(0.000375)
$PostM2_t \cdot Merger_i$	0.0162***	0.0162***	0.0159***			
	(0.000378)	(0.000277)	(0.000293)			
$\times\ insider_i$				0.0172***	0.0166***	0.0147***
				(0.000497)	(0.000385)	(0.000401)
$\times\ outsider_i$				0.0175***	0.0171***	0.0169***
				(0.000545)	(0.000343)	(0.000368)
$\times\ other_i$				0.000498	0.00644***	0.0161***
				(0.00126)	(0.000880)	(0.000771)
Divestitures						
$PostM1_t \cdot Merger\_Divest_i$	-0.00156	-0.00144	-0.00169*	-0.00156	-0.00144	-0.00169*
	(0.00128)	(0.000973)	(0.000914)	(0.00128)	(0.000972)	(0.000913)
$PostM2_t \cdot Merger\_Divest_i$	-0.0248***	-0.0220***	-0.0226***	-0.0248***	-0.0220***	-0.0226***
	(0.00101)	(0.000759)	(0.000721)	(0.00101)	(0.000759)	(0.000720)
Neighbors of divested gas stations						
$PostM1_t \cdot Merger\_Divest\_Rad_i$	-0.00253***	0.00222***	0.00671***	-0.00269***	0.00213***	0.00663***
	(0.000739)	(0.000443)	(0.000355)	(0.000739)	(0.000442)	(0.000354)
$PostM2_t \cdot Merger\_Divest\_Rad_i$	-0.0154***	0.00157***	0.0142***			
	(0.000575)	(0.000346)	(0.000280)			
$\times\ insider_i$				-0.0127***	-0.00200***	0.0115***
				(0.000860)	(0.000530)	(0.000416)
$\times\ outsider_i$				-0.0160***	0.00517***	0.0170***
				(0.000734)	(0.000424)	(0.000325)
$\times\ other_i$				-0.0333***	-0.0101***	-0.00196**
				(0.00250)	(0.00107)	(0.000924)
Constant	5.917***	5.918***	5.919***	5.917***	5.918***	5.919***
	(0.00132)	(0.00132)	(0.00131)	(0.00132)	(0.00132)	(0.00131)
Station and week fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	203,345	203,345	203,345	203,345	203,345	203,345
R-squared	0.794	0.796	0.797	0.794	0.796	0.797
Number of gas stations	1,419	1,419	1,419	1,419	1,419	1,419

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

3.5 Extensions

3.5.1 Presence of smaller competitors

It is interesting to investigate whether the presence of unbranded stations and/or small alternative brand's stations in a given geographic location is enough in order to offset the rise in prices generated by the merger. To answer this question, I re-estimate Equation (1) but adding interactions between the variables capturing the impact of the merger on margins of stations not affected by divestitures (i.e., the variable $PostM2_t \cdot Merger_i$ in Equation 1), and the presence of small brands. Specifically, I introduce the dummy variable $comp\_other_i$ which is equal to one when an unbranded station and/or a station that belongs to a small alternative brand are located within a specific radius. Results are reported in Table 5 below.

The results suggest that the presence of small brands mitigates the impact of the merger on prices, but only when they are located within a 1 Km. radius. Indeed, on the one hand, with presence of small brands within a 1 Km. radius, the post-merger margins are only increased by 0.3% and 0.5% on average for insiders and outsiders, respectively. On the other hand, without presence of small brands within a 1 Km. radius, post-merger margins are increased by 2.23% and 2.20% on average for insiders and outsiders, respectively.

For larger radiuses, the presence of smaller brands does not seem to mitigate the impact of the merger on prices.

Table 5 – Controlling by the presence of smaller brands (Gasoline 93, national level) (*) (**)

VARIABLES	(1) $\log(margin_{i,t})$ 1 Km. radius	(2) $\log(margin_{i,t})$ 2 Km. radius	(3) $\log(margin_{i,t})$ 3 Km. radius
$PostM2_t \cdot Merger_i$			
$\times\ insider_i \times comp\_other_i$	0.00289***	0.0142***	0.0167***
	(0.000925)	(0.000583)	(0.000544)
$\times\ insider_i \times (1 - comp\_other_i)$	0.0223***	0.0188***	0.0136***
	(0.000570)	(0.000476)	(0.000537)
$\times\ outsider_i \times comp\_other_i$	0.00485***	0.0156***	0.0188***
	(0.00102)	(0.000509)	(0.000472)
$\times\ outsider_i \times (1 - comp\_other_i)$	0.0220***	0.0187***	0.0155***
	(0.000627)	(0.000423)	(0.000516)
Station and week fixed effects	Yes	Yes	Yes
Observations	182,054	182,054	182,054
Number of gas stations	1,261	1,261	1,261
R-squared	0.796	0.797	0.798

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
(*) It only considers gas stations of large brands, namely: Shell, Terpel, Copec and Petrobras
(**) The table only displays the coefficient estimates of the interactions with the variable $comp\_other_i$

3.5.2 Divested stations keeping the Terpel brand

In order to increase the attractiveness of the auction implemented to execute the divestitures, Shell-Terpel gave to the winner bidders the option to keep the Terpel brand for a period of 3 years after the acquisition. This policy could have a strategic component. Indeed, divested stations branded Terpel should be able to exploit the benefits of brand loyalty from consumers, and therefore, should be less aggressive when competing in prices. In order to capture the effect of this policy on margins, I reestimated Equation (1) but adding interactions between the variables capturing the impact of divestitures, and the post-merger brand identity of divested stations. In particular, the dummy variable $terpel_i$ is equal to one when the divested station i opted for keeping the Terpel brand, and it is equal to zero otherwise. Results are displayed in Table 6 below.

Divested gas stations that opted for not keeping the Terpel brand are significantly more aggressive when pricing. Indeed, while their margins are reduced by more than -4.3% on average after the divestitures, the margins of gas stations that kept the Terpel brand are only reduced by less than -1.3% on average. However, interestingly, margins of gas stations that belong to the merging parties and compete with divested stations are reduced by a higher percentage when the divested station kept the Terpel brand (but only within radiuses of 1 Km. and 2 Km.). For non-merging parties (i.e., Copec and Petrobras) the effect of competition is similar regardless of the brand of the divested station.

Table 6 – Controlling by the identity of divested stations (Gasoline 93, national level) (*) (**)

VARIABLES	(1) $\log(margin_{i,t})$ 1 Km. radius	(2) $\log(margin_{i,t})$ 2 Km. radius	(3) $\log(margin_{i,t})$ 3 Km. radius
$PostM2_t \cdot Merger\_Divest_i$			
$\times\ terpel_i$	-0.0127***	-0.00537***	-0.00606***
	(0.00119)	(0.000970)	(0.000902)
$\times\ (1 - terpel_i)$	-0.0504***	-0.0430***	-0.0452***
	(0.00169)	(0.00110)	(0.00106)
$PostM2_t \cdot Merger\_Divest\_Rad_i$			
$\times\ insider_i \times terpel_i$	-0.0150***	-0.00207***	0.0139***
	(0.00104)	(0.000647)	(0.000453)
$\times\ insider_i \times (1 - terpel_i)$	-0.00829***	-0.000964	0.00809***
	(0.00144)	(0.000784)	(0.000554)
$\times\ outsider_i \times terpel_i$	-0.0168***	0.00402***	0.0193***
	(0.000871)	(0.000499)	(0.000340)
$\times\ outsider_i \times (1 - terpel_i)$	-0.0144***	0.00816***	0.0111***
	(0.00127)	(0.000620)	(0.000436)
Station and week fixed effects	Yes	Yes	Yes
Observations	182,054	182,054	182,054
Number of gas stations	1,261	1,261	1,261
R-squared	0.796	0.798	0.800

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
(*) It only considers gas stations of large brands, namely: Shell, Terpel, Copec and Petrobras
(**) The table only displays the coefficient estimates of the interactions with the variable $terpel_i$

4. Conclusions

The results suggest that the Terpel-Shell merger generated a modest but significant increase in margins of gas stations geographically affected by the merger. In addition, the implementation of divestitures seems to be an appropriate tool in order to mitigate the anticompetitive effects of this merger, but only for gas stations closely located to the divested ones (within a 2 Km. radius).

I also answer two interesting empirical questions. First, I show how the presence of unbranded stations and/or stations that belong to small alternative brands seem to be enough in order to offset the impact of the merger on prices (but only when the unbranded and/or alternative brand is located within a 1 Km. radius). Second, results suggest that divested stations that opted for not keeping the Terpel brand are pricing more aggressively. However, interestingly it seems that the gas stations of the merging parties react stronger to the competition of divested stations that kept the Terpel brand. Thus, there is no evidence of strategic behavior intended to soften competition from divested gas stations.

Appendix A – Theoretical framework and proofs

A.1 Properties of the profit function

We consider a market with M single-product firms that compete in prices. The profit function of Firm i has the simple following form:

$$\Pi_i = (p_i - c_i)s_i(p)N, \tag{A.1}$$

where $s_i(p)$ is the market share of Firm i, such that $\frac{\partial s_i(p)}{\partial p_i} \leq 0$ and $\frac{\partial s_k(p)}{\partial p_i} \geq 0$ for all $k \neq i$. We assume that the profit function $\Pi_i(p_i, p_{-i})$ is strictly concave in p_i, which implies that $\frac{\partial^2 \Pi_i(p_i, p_{-i})}{\partial p_i^2} < 0$ for all p_i and p_{-i}. In addition, we assume that prices p_i and p_k are strategic complements, i.e., $\frac{\partial^2 \Pi_i(p_i, p_{-i})}{\partial p_i \partial p_k} \geq 0$ for all i and k, with $k \neq i$.

A.2 Nash payoffs

The pure strategy Nash equilibrium in prices satisfies the following system of first-order conditions:

$$\Lambda_i(p^{N,pre}) = s_i(p^{N,pre}) + \left(p_i^{N,pre} - c_i\right)\frac{\partial s_i(p^{N,pre})}{\partial p_i} = 0, \forall i, \tag{A.2}$$

where $p^{N,pre}$ is the vector of pre-merger equilibrium prices. The strict concavity of the profit function guarantees that the first-order conditions are sufficient for a Nash equilibrium. (See Tirole 1988.)

Let us define $R_i(p_{-i})$ as the pre-merger best response function of Firm i given prices p_{-i}. This function satisfies $\Lambda_i(R_i(p_{-i}), p_{-i}) = 0$, where $\Lambda_i = \frac{\partial \Pi_i}{\partial p_i}$. From the strict concavity assumption, it follows that there is a unique p_i such that $p_i = R_i(p_{-i})$. In addition, considering the assumption of strategic complementarity of prices, then $\frac{\partial R_i}{\partial p_k} \geq 0$ for all $k \neq i$.

After a merger between Firms i and j, the pure strategy Nash equilibrium in prices satisfies the following system of first-order conditions:

$$\overline{\Lambda}_i(p^{N,post}) = \Lambda_i(p^{N,post}) + \left(p_j^{N,post} - c_j\right)\frac{\partial s_j(p^{N,post})}{\partial p_i} = 0 \tag{A.3}$$

$$\overline{\Lambda}_j(p^{N,post}) = \Lambda_j(p^{N,post}) + \left(p_i^{N,post} - c_i\right)\frac{\partial s_i(p^{N,post})}{\partial p_j} = 0 \tag{A.4}$$

$$\overline{\Lambda}_k(p^{post}) = 0, \forall k \neq \{i, j\}, \tag{A.5}$$

where $p^{N,post}$ denotes the vector of post-merger equilibrium prices. The post-merger best response functions of the merging parties $\bar{R}_i(p_{-i})$ and $\bar{R}_j(p_{-j})$ satisfy $\overline{\Lambda}_i(\bar{R}_i(p_{-i}), p_{-i}) = 0$ and $\overline{\Lambda}_j\left(\bar{R}_j(p_{-j}), p_{-j}\right) = 0$, and the post-merger best response function of Firm k for all $k \neq \{i, j\}$ satisfies $\overline{\Lambda}_k(\bar{R}_k(p_{-k}), p_{-k}) = 0$.

Proposition 1: *Consider a merger between Firms i and j. The post-merger equilibrium prices $p_i^{N,post}$ and $p_j^{N,post}$ are higher than or equal to the pre-merger equilibrium prices $p_i^{N,pre}$ and $p_j^{N,pre}$, respectively.*

Proof: First, considering that $(p_j - c_j)\frac{\partial s_j(p)}{\partial p_i} \geq 0$ and $(p_i - c_i)\frac{\partial s_i(p)}{\partial p_j} \geq 0$ for relevant values of p_i and p_j, then the post-merger best response functions of Firms i and j satisfy $\bar{p}_h = \bar{R}_h(p_{-h}) \geq p_h = R_h(p_{-h})$ for $h = \{i.j\}$ and all p_{-h}. In addition, the post-merger best response function of Firm k for all $k \neq \{i,j\}$, satisfies $\bar{R}_k(p_{-k}) = R_k(p_{-k})$ for all p_{-k}. Thus, $\bar{R}_l(p_{-l}) \geq R_l(p_{-l})$ for all l.

Second, the fact that prices are strategic complements, i.e., $\frac{\partial^2 \Pi_l}{\partial p_l \partial p_r} \geq 0$, implies that $\frac{\partial R_l}{\partial p_r} \geq 0$ for all l and $r \neq l$, and ensures that $\frac{\partial \bar{R}_k}{\partial p_r} \geq 0$ for $k \neq \{i,j\}$ and all $r \neq k$. Moreover, assuming that $\frac{\partial^2 s_j}{\partial p_i \partial p_k} \geq 0$ and $\frac{\partial^2 s_i}{\partial p_j \partial p_k} \geq 0$ for $k \neq \{i,j\}$, ensures that $\frac{\partial \bar{R}_h}{\partial p_k} \geq 0$ for $h = \{i.j\}$ and all $k \neq \{i,j\}$.

Finally, assuming that $\frac{\partial^2 s_j}{\partial p_i^2} \leq 0$ and $\frac{\partial^2 s_i}{\partial p_j^2} \leq 0$ guarantees strict concavity of the merged firm profit function. Thus, by Theorem 4 of Milgrom and Roberts (1994), the post-merger Nash equilibrium in prices satisfies $p_l^{N,post} \geq p_l^{N,pre}$ for all l.

A.3 Collusion payoffs

The joint-profit maximization (or perfect-collusion) vector of prices p^c is obtained by solving: $\Pi^{JPM} = max_{p_1,\dots,p_M} \sum_{i=1}^{M} \Pi_i(p_1, \dots, p_M)$.

We only consider cases in which the perfect-collusion payoffs of every firm in the market are higher than the one-period Nash equilibrium payoffs, i.e., $\Pi_i(p_1^C, \dots, p_M^C) \geq \Pi_i(p_1^{N,pre}, \dots, p_M^{N,pre})$ for all i. Finally, note that the vector of collusion prices is independent of the ownership of the different products in the market. In other words, a merger does not have any impact on p^C.

A.4 Pre-merger deviation payoffs

The pre-merger deviation payoffs of Firm i are given by:

$$\Pi_i^{D,pre} = \Pi_i(p_i^{D,pre}, p_{-i}^C) = \left(p_i^{D,pre} - c_i\right) s_i\left(p_i^{D,pre}, p_{-i}^C\right) N, \tag{A.6}$$

where $p_i^{D,pre}$ is the pre-merger deviation price of Firm i and p_{-i}^C is the vector of collusion prices for the rest of the firms in the market. The price $p_i^{D,pre}$ satisfies:

$$\Lambda_i(p_i^{D,pre}, p_{-i}^C) = s_i\left(p_i^{D,pre}, p_{-i}^C\right) + (p_i^{D,pre} - c_i)\frac{\partial s_i\left(p_i^{D,pre}, p_{-i}^C\right)}{\partial p_i} = 0. \tag{A.7}$$

A.5 Post-merger deviation payoffs

The post-merger deviation payoffs of the merged firm are given by:

$$\Pi_{i,j}^{D,post} = \Pi_i\left(p_i^{D,post}, p_j^{D,post}, p_{-i,j}^C\right) + \Pi_j(p_i^{D,post}, p_j^{D,post}, p_{-i,j}^C) = \tag{A.8}$$

$$\left(p_i^{D,post} - c_i\right) s_i\left(p_i^{D,post}, p_j^{D,post}, p_{-i,j}^C\right) N + \left(p_j^{D,post} - c_j\right) s_j\left(p_i^{D,post}, p_j^{D,post}, p_{-i,j}^C\right) N,$$

where $p_i^{D,post}$ and $p_j^{D,post}$ are the post-merger deviation prices of Firms i and j, and $p_{-i,j}^C$ is the vector of collusion prices of the rest of the firms in the market. The pair of prices $p_i^{D,post}$ and $p_j^{D,post}$ satisfy:

$$s_i\left(p_i^{D,post}, p_j^{D,post}, p_{-i,j}^C\right) + \left(p_i^{D,post} - c_i\right) \frac{\partial s_i\left(p_i^{D,post}, p_j^{D,post}, p_{-i,j}^C\right)}{\partial p_i} + \left(p_j^{D,post} - c_j\right) \frac{\partial s_j\left(p_i^{D,post}, p_j^{D,post}, p_{-i,j}^C\right)}{\partial p_i} = 0, \tag{A.9}$$

and,

$$s_j\left(p_i^{D,post}, p_j^{D,post}, p_{-i,j}^C\right) + \left(p_j^{D,post} - c_j\right) \frac{\partial s_j\left(p_i^{D,post}, p_j^{D,post}, p_{-i,j}^C\right)}{\partial p_j} + \left(p_i^{D,post} - c_i\right) \frac{\partial s_i\left(p_i^{D,post}, p_j^{D,post}, p_{-i,j}^C\right)}{\partial p_j} = 0. \tag{A.10}$$

Proposition 2: *For every Firm k, its pre-merger and post-merger deviation prices $p_k^{D,pre}$ and $p_k^{D,post}$ are lower than or equal to its perfect-collusion price p_k^C.*

Proof: Considering that $\frac{\partial s_h}{\partial p_k} \geq 0$ for all h and k, with $h \neq k$, then a deviation price higher than p_k^C would jointly increase the profits of Firm k and every Firm h, for $h \neq k$, which is not consistent with the fact that the vector of collusion prices p^C is the one that maximizes the joint-profits of all the firms in the market. Hence, the price that maximizes Firm k's deviation payoffs is lower than p_k^C.

Proposition 3: *Consider a merger between Firms i and j. If the post-merger deviation price of Firm j belongs to the interval $\left[p_j^{D,pre}, p_j^C\right]$, and the pricing externality that Firm j exerts on Firm i is stronger than the marginal effect of p_i on $\Pi_i(p_i^{D,pre}, p_j^{D,post}, p_{-i,j}^C)$, then the post-merger deviation price of Firm i is higher than its pre-merger deviation price.*

Proof: Considering that prices p_i and p_j are strategic complements, then the price p_i that maximizes $\Pi_i(p_i, p_j^{D,post}, p_{-i,j}^C)$ for $p_j^{D,post} \in \left[p_j^{D,pre}, p_j^C\right]$, is lower than $p_i^{D,pre}$, which in turn implies that $\Lambda_i(p_i^{D,pre}, p_j^{D,post}, p_{-i,j}^C) < 0$. Thus, considering post-merger deviation prices $p_i^{D,pre}$ and $p_j^{D,post} \in \left[p_j^{D,pre}, p_j^C\right]$, and considering that the pricing externality that Firm j exerts on Firm i, i.e., $\left(p_j^{D,post} - c_j\right) \frac{\partial s_j\left(p_i^{D,pre}, p_j^{D,post}, p_{-i,j}^C\right)}{\partial p_i}$, is higher than the marginal effect of p_i on $\Pi_i(p_i^{D,pre}, p_j^{D,post}, p_{-i,j}^C)$ in absolute value, *i.e.*, $\left|\Lambda_i(p_i^{D,pre}, p_j^{D,post}, p_{-i,j}^C)\right|$, and assuming that $\frac{\partial^2 s_j}{\partial p_i^2} \leq 0$ for relevant values of p_i and p_j, then the price $p_i^{D,post}$ that satisfies Equation (A.9) is higher than $p_i^{D,pre}$.

Appendix B – Simulation setting

Table B.1 – List of papers extracted from Knittel and Metaxoglou (2014)

Journal	Authors	Industry	Observations	
Rand Journal of Economics	Armantier and Richard (2008)	Airlines		
	Mean	Std. Dev	Min.	Max.
Own-price elast.	-2.22	0.50	-2.79	-1.54
Cross-price elast.	0.21	0.09	0.09	0.35
Rand Journal of Economics	Bonnet and Dubois (2010)	Bottled Water (Retail)	Averages computed among brands and retailers	
	Mean	Std. Dev	Min.	Max.
Own-price elast.	-9.97	1.87	-12.96	-4.97
Cross-price elast.	0.06	0.03	0.02	0.11
Rand Journal of Economics	Copeland (2011)	Automobile	The cross-price elasticities are computed between vintages of the same model	
	Mean	Std. Dev	Min.	Max.
Own-price elast.	-2.61	0.49	-3.60	-1.50
Cross-price elast.	0.02	0.02	0.00	0.17
Rand Journal of Economics	Iizuka (2007)	Prescription Drugs	Only the average own-price elasticity is provided	
	Mean	Std. Dev	Min.	Max.
Own-price elast.	-2.3	-	-	-
Cross-price elast.	-	-	-	-
Rand Journal of Economics	Nevo (2000)	Ready-to-Eat Cereals	We only report the cross-price elast. between Kellogg and General Mills. Brands	
	Mean	Std. Dev	Min.	Max.
Own-price elast.	-2.18	0.76	-3.70	-1.32
Cross-price elast.	0.05	0.04	0.00	0.13
Rand Journal of Economics	Villas-Boas (2009)	Coffee (Retail)	We report the mean elasticities across manufacturers	
	Mean	Std. Dev	Min.	Max.
Own-price elast.	-7.63	0.66	-8.47	-6.80
Cross-price elast.	0.04	0.02	0.01	0.07
Econometrica	Goeree (2008)	Personal Computer		
	Mean	Std. Dev	Min.	Max.
Own-price elast.	-6.65	3.25	-12.86	-3.26
Cross-price elast.	0.03	0.01	0.01	0.09
Econometrica	Nevo (2001)	Ready-to-Eat Cereal	We only report the cross-price elast. between Kellogg and General Mills. Brands	
	Mean	Std. Dev	Min.	Max.
Own-price elast.	-3.02	0.64	-4.25	-2.28
Cross-price elast.	0.09	0.06	0.01	0.24
Review of Economic Studies	Nakamura and Zerom (2010)	Coffee	The median price elasticity from the Logit with random coefficients estimation	
	Mean	Std. Dev	Min.	Max.
Own-price elast.	-3.46	-	-	-
Cross-price elast.	-	-	-	-
Review of Economic Studies	Villas-Boas (2007)	Supermarkets		
	Mean	Std. Dev	Min.	Max.
Own-price elast.	-5.71	0.64	-6.74	-4.67
Cross-price elast.	0.03	0.01	0.01	0.04

Table B.2 Baseline simulations setting

Parameter	Baseline Setting
M	Number of firms is fixed to 5 for all the markets. Each firm produces only one product.
N	Number of consumers is set to 10,000 for all the markets.
NS	Number of simulations for computing the expected market shares is fixed to 1,000 for all the markets.
α (*)	It is constant within each market, but it varies across markets with uniform distribution $U_{[0,\bar{\alpha}]}$.
$\tilde{\alpha}_n$	For a given market varies among consumers with exponential distribution E_{1/σ_α}. The parameter σ_α is distributed uniformly $U_{[0,7]}$ across markets.
β_1 (*)	It is constant within each market, but it varies across markets with uniform distribution $U_{[0,\bar{\beta}_1]}$.
β_2	It is constant within each market, but it varies across markets with uniform distribution $U_{[0,3]}$.
$\tilde{\beta}_{1,n}$, $\tilde{\beta}_{2,n}$	For a given market both vary among consumers with normal distributions $N_{[0,\sigma_{\beta_1}]}$ and $N_{[0,\sigma_{\beta_2}]}$. The parameters σ_{β_1} and σ_{β_2} are distributed uniformly $U_{[0,5]}$ across markets.
$\tilde{\varepsilon}_{n,j}$, $\tilde{\varepsilon}_{n,0}$	They are both drawn from an extreme value distribution $F_{[\lambda]}$, where the scale parameter λ is equal to 0.5.
$x_{1,j}$ (*)	For each market $x_{1,j} = \exp(\tau \cdot \xi_j)$ where $\tau = 0.3$ and ξ_j are distributed normally with $N_{[2,\sigma_{x_1}]}$.
$x_{2,j}$	For each market $x_{2,j} = \mathrm{I}(\eta_j > 0)$ where η_j are distributed normally with $N_{[0,1]}$.
x_0	For each market x_0 is drawn from a normal distribution $N_{[0,4]}$.
$\tilde{x}_{n,0}$	For a given market varies among consumers with normal distribution $N_{[0,\sigma_x]}$. The parameter σ_x is distributed uniformly $U_{[0,3]}$ across markets.
ω_j	For each market ω_j is drawn from a normal distribution $N_{[0,0.05]}$.
γ_1, γ_2	Both are fixed for each market, but they vary across markets with the same uniform distribution $U_{[0,1]}$.

(*) Parameters that are modified in each calibration. See Table B.3 below

Table B.3 Calibrations

Calibration	Parameters		
	$\bar{\alpha}$	$\bar{\beta}_1$	σ_{x_1}
(1)	15	1.1	5
(2)	8	1.1	5
(3)	3	1.1	5
(4)	15	4	5
(5)	8	4	5
(6)	3	4	5
(7)	15	1.1	2
(8)	8	1.1	2
(9)	3	1.1	2
(10)	15	4	2
(11)	8	4	2
(12)	3	4	2

Table B.4 Data cleaning

Calibration	**(1)**	**(2)**	(3)	**(4)**	(5)	(6)	(7)	(8)	(9)	**(10)**	Total
1	**367**	**1,020**	4	**443**		1	6	1	11	**223**	2,076
2	**411**	**365**	7	**243**			13	1	9	**393**	1,442
3	**440**	**96**	17	**22**		1	19	8	3	**399**	1,005
4	**547**	**911**	3	**584**			12		5	**254**	2,316
5	**682**	**285**	4	**383**			24	2	7	**413**	1,800
6	**687**	**77**	6	**54**	1		29	7	2	**504**	1,367
7	**121**	**883**	6	**531**			10	1	4	**82**	1,638
8	**140**	**264**	5	**202**		1	9		3	**130**	754
9	**159**	**63**	9	**6**	1		16	1	3	**99**	357
10	**207**	**691**	4	**717**			15	1	1	**93**	1,729
11	**265**	**166**	1	**281**			15	1	7	**133**	869
12	**278**	**33**	3	**12**		1	14	6	3	**108**	458
Total	**4,304**	**4,854**	69	**3,478**	2	4	182	29	58	**2,831**	15,811
Percentage	**11.96%**	**13.48%**	0.19%	**9.66%**	0.01%	0.01%	0.51%	0.08%	0.16%	**7.86%**	43.92%

(1) **The solution of the fixed-point algorithm that computes equilibrium prices does not converge** (after a maximum of 200 iterations).

(2) **At least one of the brands' pre-merger market shares is equal to zero.**

(3) At least one of the brands' pre-merger own-price elasticities is lower than 1.

(4) **Observations with extreme elasticity values.** (Own-price elast. lower than -19.16266 and/or cross-price elast. higher than 4.061562.)

(5) It was possible to find a profitable deviation from the pre-merger Nash equilibrium (for Firm 1). With a margin of error of +/- 1%.

(6) It was possible to find a profitable deviation from the post-merger Nash equilibrium (Firms 1 and 2). With a margin of error of +/- 1%.

(7) The pre-merger (perfect) collusion prices founded by two different algorithms do not coincide. With a margin of error of +/- 1%.

(8) The deviation prices found by using two different sets of starting values do not coincide. With a margin of error of +/- 1%.

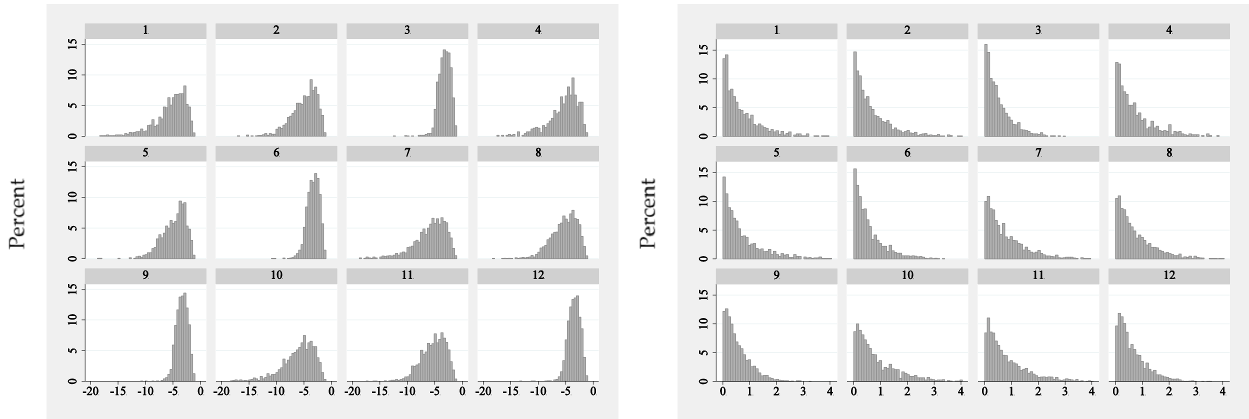
(9) The merger is not feasible (the total profits of the merged firm are lower than sum of the pre-merger profits of the merging parties).

(10) **Perfect-collusion is not feasible** (At least one of the collusion profits is lower than the Nash equilibrium profits).

Figure B.1 Empirical distributions

Panel a) Own-price elasticity by calibration setting

Panel b) Cross-price elasticity by calibration setting



Own-price elasticity (Firm 1)

Cross-price elasticity (Firm 1 / Firm 2)

Appendix C – Figures and tables (Chapter 1)

Table C.1 – CRDF estimates extracted from Davis and Huse (2010) and Brito *et al.* (2013)

Paper	Market	Firm (*)	Estimated CRDF Pre-merger	Estimated CRDF Post-merger	% Var.
Davis and Huse (2010)	Network server industry EU, 4-10 price segment (Merger: Compaq-HP)	Compaq	0.303	0.246	-61.1%
		HP	0.632		
		Unisys	0.724	0.782	8.0%
	Network server industry Japan, 4-10 price segment (Merger: Compaq-HP)	Compaq	0.528	0.482	-19.3%
		HP	0.597		
		Hitachi	0.632	0.642	1.5%
	Network server industry US, 4-10 price segment (Merger: Compaq-HP)	Compaq	0.549	0.530	-23.9%
		HP	0.697		
		Data Gen	0.817	0.832	1.8%
Brito *et al.* (2013)	Wet Shaving Industry (Merger WS-Gillette)	Wilkinson Sword	0.815	0.260	-68.1%
		Gillette	0.262		
		A Safety Razor	0.888	0.894	0.68%
	Wet Shaving Industry (Merger WS-WL)	Wilkinson Sword	0.815	0.788	-3.31%
		Warner-Lambert	0.790		
		A Safety Razor	0.888	0.890	0.23%

(*) Only selected firms: merging parties and the outsider with the highest CRDF

Table C.2 – The impact of efficiency gains on post-merger payoffs

Scenario		Variable	Change in payoffs: Insiders	Change in payoffs: Outsiders
Nash	(1)	% of cases $\Delta\Pi^N > 0$	99.99%	0.01%
		Interpretation	**Anti-collusive**	It cancels out the previous effect (*)
Deviation	(2)	% of cases $\Delta\Pi^D > 0$	99.94%	0.35%
		Interpretation	It weakens the previous effect (*)	**Pro-collusive**
Collusion	(3)	% of cases $\Delta\Pi^C > 0$	99.97%	0.14%
		Interpretation	**Pro-collusive**	**Anti-collusive**
Comparison	(4)	% of cases $\lvert\Delta\Pi^C\rvert > \lvert\Delta\Pi^N\rvert$	98.33%	-
	(5)	% of cases $\lvert\Delta\Pi^C\rvert > \lvert\Delta\Pi^D\rvert$	-	83.82%
		Prediction	**Pro-collusive**	**Ambiguous**
		Observations	38,024	57,036

(*) Where "previous effect" refers to the impact of the merger before efficiency gains

Table C.3 – The impact of higher product differentiation on post-merger payoffs

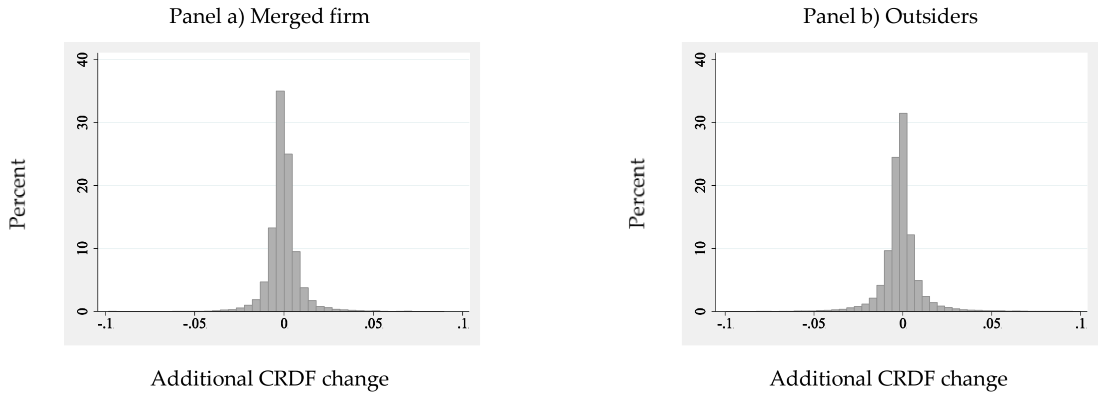
Only cases where $x_{1,1}$ $difference > 0$ (**)

Scenario		Variable	Change in payoffs	
			Insiders	Outsiders
Nash	(1)	% of cases $\Delta\Pi^N > 0$	98.69%	5.33%
		Interpretation	**Anti-collusive**	It weakens the previous effect (*)
Deviation	(2)	% of cases $\Delta\Pi^D > 0$	98.65%	2.65%
		Interpretation	It weakens the previous effect (*)	**Pro-collusive**
Collusion	(3)	% of cases $\Delta\Pi^C > 0$	98.69%	3.56%
		Interpretation	**Pro-collusive**	**Anti-collusive**
Comparison	(4)	% of cases $\lvert\Delta\Pi^C\rvert > \lvert\Delta\Pi^N\rvert$	98.38%	-
	(5)	% of cases $\lvert\Delta\Pi^C\rvert > \lvert\Delta\Pi^D\rvert$	-	66.73%
		Prediction	**Pro-collusive**	**Ambiguous**
		Observations	17,924	26,886

(*) Where "previous effect" refers to the impact of the merger before efficiency gains

(**) The term "$x_{1,1}$ $difference$" stands for the pre-merger difference between the continuous characteristic of the product sold by Firm 1 and the average continuous characteristic from the rest of products in the market

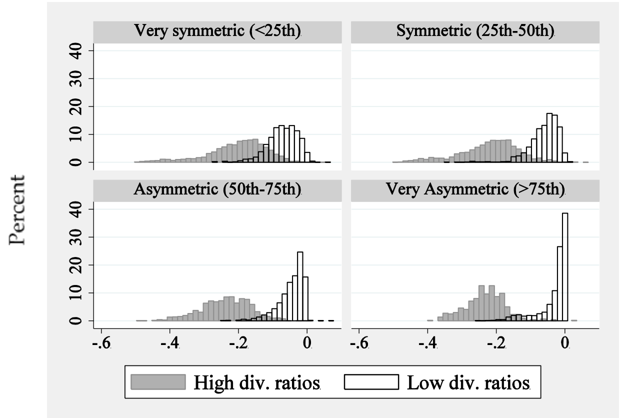
Figure C.1 – Impact of higher consumers' mean price sensitivity (α) (*)



(*) For the sake of exposition, the graphs only display changes within the interval [-0.1, 0.1].

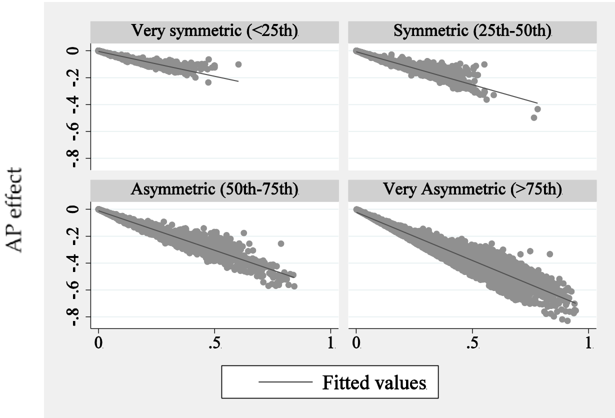
Figure C.2 – The magnitude of the CP and AP effects (Merged firm)

Panel a) CP effect (by equilibrium payoffs' ratio) (*)



CP effect

Panel b) AP effect (by equilibrium payoffs´ ratio) (**)

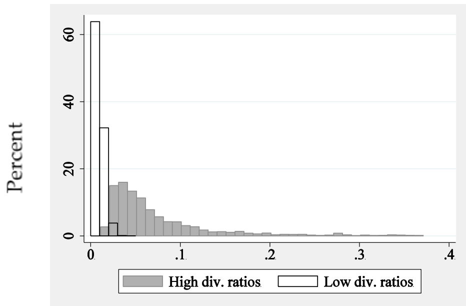


Pre-merger CRDF difference

(*) For the sake of exposition, it only considers cases where the CP effect is lower than 0.1
(**) It only considers mergers from Case (a) (as defined in Section 5.1.2)

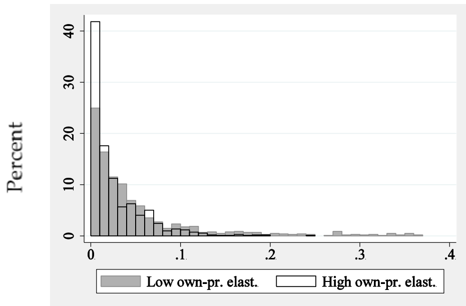
Figure C.3 – Post-merger changes in equilibrium and deviation payoffs

Panel a) Post-merger equilibrium payoffs' change and pre-merger diversion ratios (*)



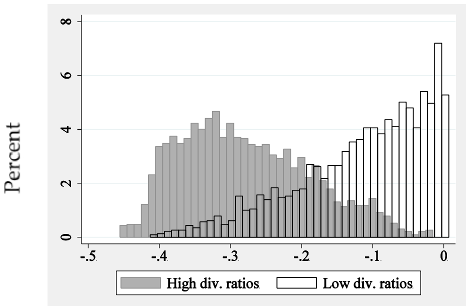
Change in equilibrium payoffs

Panel b) Post-merger equilibrium payoffs' change and pre-merger own-price elasticities (*)



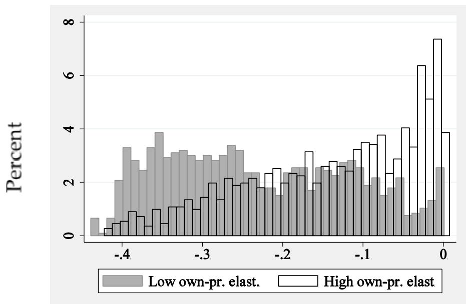
Change in equilibrium payoffs

Panel c) Post-merger deviation payoffs' change and pre-merger diversion ratios



Change in deviation payoffs

Panel d) Post-merger deviation payoffs' change and pre-merger own-price elasticities

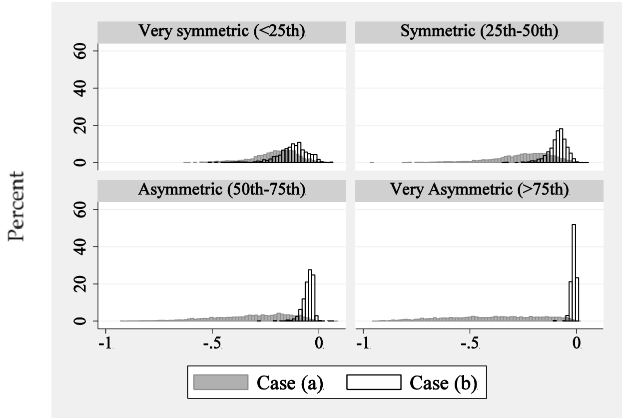


Change in deviation payoffs

(*) For the sake of exposition, it only considers equilibrium payoff's changes lower than the 99th percentile value

Figure C.4 – The magnitude of $\Delta CRDF$ (Merged firm) (*)

Comparison between Cases a) and b) (by equilibrium payoffs' ratio)

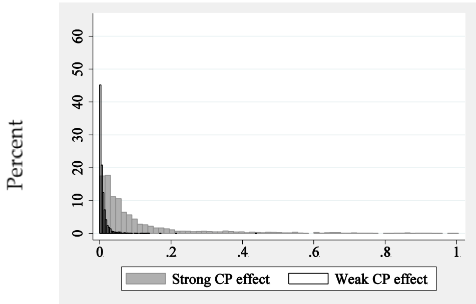


Overall Effect

(*) For the sake of exposition, it only considers cases where the Overall Effect is lower than 0.1

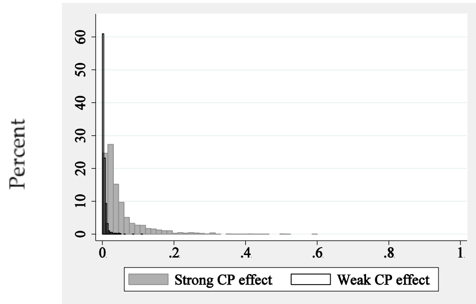
Figure C.5 – The magnitude of the CRDF change (Outsiders) (*)

Panel a) Low pre-merger diversion ratio (**)



CRDF change

Panel b) High pre-merger diversion ratio (**)



CRDF change

(*) It only considers the change on the CRDF of Firm 3. In addition, for the sake of exposition, the graphs only display changes lower than 1

(**) Where "High diversion ratio" ("Low diversion ratio") stands for firms with a diversion ratio higher (lower) than the 50^{th} percentile value. While "Strong CP effect" ("Weak CP effect") stands for cases where the CP effect on the merged firm CRDF is higher (lower) than the 75^{th} (25^{th}) percentile value.

Appendix D – Computation of the ACPP

The actual pre-merger price increase motivated by PAC and initiated by Firm i, denoted by $S_i^{I,A}$, for $i = A, B$, is computed as follows:

$$S_i^{I,A} = max_s \left\{\pi_i(p_i^N(1+s), p_{-i}^N) + \pi_i\big(p_A^N(1+s), p_B^N(1+s), p_{-A,-B}^N\big)\frac{\delta}{1-\delta}\right\},$$

where the superscript N stands for a Nash equilibrium price.

While the actual post-merger percentage price increases initiated by the merged firm and Firm B, denoted by $S_{AC}^{I,A}$ and $\bar{S}_B^{I,A}$, respectively, are obtained with the following equations:

$$S_{AC}^{I,A} = max_{s_1} \left\{\pi_A\big(p_A^N(1+s_1), p_C^N(1+s_1), p_{-A,-C}^N\big) + \pi_C\big(p_A^N(1+s_1), p_C^N(1+s_1), p_{-A,-C}^N\big) + \pi_A\big(p_A^N(1+s_1), p_C^N(1+s_1), p_B^N(1+s_1), p_{-A,-C,-B}^N\big)\frac{\delta}{1-\delta} + \pi_C(p_A^N(1+s_1), p_C^N(1+s_1), p_B^N(1+s_1), p_{-A,-C,-B}^N)\frac{\delta}{1-\delta}\right\} - max_{s_2} \left\{\pi_A\big(p_A^N(1+s_2), p_C^N(1+s_2), p_{-A,-C}^N\big)\frac{1}{1-\delta} + \pi_C\big(p_A^N(1+s_2), p_C^N(1+s_2), p_{-A,-C}^N\big)\frac{1}{1-\delta}\right\},$$

and;

$$\bar{S}_B^{I,A} = max_s \left\{\pi_B(p_B^N(1+s), p_{-B}^N) + \pi_B\big(p_A^N(1+s), p_C^N(1+s), p_B^N(1+s), p_{-A,-C,-B}^N\big)\frac{\delta}{1-\delta}\right\}.$$

The pre-merger ACPP is given by:

$$\mathrm{ACPP_{AB}} = \min\{\mathrm{S_A^{I,A}}, \mathrm{S_B^{I,B}}\}.$$

The post-merger ACPP is given by:

$$\mathrm{ACPP_{AC,B}} = \min\{\mathrm{S_{AC}^{I,A}}, \bar{S}_B^{I,A}\}.$$

Finally, the impact of the merger on firms' actual incentives to engage in PAC is given by:

$$\Delta\mathrm{ACPP_{AC,B}} = \mathrm{ACPP_{AC,B}} - \mathrm{ACPP_{AB}}.$$

Appendix E – Derivation of the alternative CPPI indexes

E.1 Derivation of the alternative versions of the post-merger CPPI

We propose a modified version of the CPPI that takes into consideration the strategic interactions between the brands produced by the merged firm. For the construction of this index we closely follow the methodology proposed by Moresi et al. (2011).

E.1.1 Acquiring firm (Firm A)

1. At period t the acquiring firm increases the prices of its two brands by S_{AC} percent. It incurs in a loss of profits equal to the difference between: (i) the value of the divested sales generated by the price increase, and (ii) the higher price charged on its remaining sales. This is given by the following expression:

$$
\begin{aligned}
L_{AC} = {} & [S_{AC} \cdot e_A \cdot q_A - S_{AC} \cdot e_C \cdot q_C \cdot DR_{CA}] \cdot m_A \cdot p_A \\
& + [S_{AC} \cdot e_C \cdot q_C - S_{AC} \cdot e_A \cdot q_A \cdot DR_{AC}] \cdot m_C \cdot p_C \\
& - [q_A - S_{AC} \cdot e_A \cdot q_A + S_{AC} \cdot e_C \cdot q_C \cdot DR_{CA}] \cdot S_{AC} \cdot p_A \\
& - [q_C - S_{AC} \cdot e_C \cdot q_C + S_{AC} \cdot e_A \cdot q_A \cdot DR_{AC}] \cdot S_{AC} \cdot p_C.
\end{aligned}
$$

We define $\Delta q_A = e_A \cdot q_A - e_C \cdot q_C \cdot DR_{CA}$ and $\Delta q_C = e_C \cdot q_C - e_A \cdot q_A \cdot DR_{AC}$, and the previous formula becomes:

$$
\begin{aligned}
L_{AC} = {} & S_{AC} \cdot \Delta q_A \cdot m_A \cdot p_A + S_{AC} \cdot \Delta q_C \cdot m_C \cdot p_C \\
& - [q_A - S_{AC} \cdot \Delta q_A] \cdot S_{AC} \cdot p_A - [q_C - S_{AC} \cdot \Delta q_C] \cdot S_{AC} \cdot p_C.
\end{aligned}
$$

2. Assuming that from period $t + 1$ onward, the price increase is followed by Firm B, then the acquiring firm gets profits equal to the difference between: (i) the higher price charged on its overall sales, including the fraction of divested sales from Firm B that are captured by the acquiring firm, and (ii) the value of the divested sales generated by the price increase. Thus, the per-period gain from PAC is given by:

$$
\begin{aligned}
G_{AC,B} = {} & [q_A - S_{AC} \cdot (\Delta q_A - e_B \cdot q_B \cdot DR_{BA})] \cdot S_{AC} \cdot p_A \\
& + [q_C - S_{AC} \cdot (\Delta q_C - e_B \cdot q_B \cdot DR_{BC})] \cdot S_{AC} \cdot p_C \\
& - S_{AC} \cdot (\Delta q_A - e_B \cdot q_B \cdot DR_{BA}) \cdot m_A \cdot p_A \\
& - S_{AC} \cdot (\Delta q_C - e_B \cdot q_B \cdot \mathrm{DR}_{BC}) \cdot m_C \cdot p_C.
\end{aligned}
$$

3. Assuming that Firm B permanently matches the price increase, then the acquiring firm chooses S_{AC} in order to maximize the present value of its expected payoffs. Therefore, the optimal price increase, i.e., S_{AC}^{*}, is found by maximizing the following expression:

$$S_{AC}^{*} = max_{S_{AC}} \left\{-L_{AC}(S_{AC}) + \frac{\delta}{1-\delta} \cdot G_{AC,B}(S_{AC})\right\},$$

and is given by;

$$S_{AC}^{*} = \frac{\delta \widetilde{F_{B,AC}} + \gamma_A + \gamma_C}{\omega_A + \omega_C - \delta \widetilde{F_{B,AC}}} \times \frac{1}{2},$$

with;

$$\widetilde{F_{B,AC}} = e_B \cdot q_B \cdot (DR_{BA} \cdot m_A \cdot p_A \ + \ DR_{BC} \cdot m_C \cdot p_C) \quad , \quad \widehat{F_{B,AC}} = e_B \cdot q_B \cdot (DR_{BA} \cdot p_A \ + \ \mathrm{D}R_{BC} \cdot p_C),$$

$$\gamma_i = (q_i - \Delta q_i \cdot m_i) \cdot p_i \qquad for \ \ i = A, C,$$

$$\omega_i = \Delta q_i \cdot p_i \qquad for \ \ i = A, C.$$

4. However, we need to make an additional adjustment to this formula. Provided that the PAC incentives are evaluated at the pre-merger prices, the acquiring firm has an incentive to initiate a unilateral percentage price increase S_{AC}^{U}. Therefore, since the S_{AC}^{*} considers the strategic interactions between the merged firm brands, it also nests this unilateral price increase S_{AC}^{U}. In order to clean our index from this effect, we propose the following corrected formula: $S_{AC}^{I,**} = S_{AC}^{I,*} - S_{AC}^{U}$.

The unilateral price increase S_{AC}^{U} can be found by maximizing the following expression:

$$S_{AC}^{U} = max_{S_{AC}} \left\{\frac{1}{(1-\delta)} \cdot L_{AC}(S_{AC})\right\} \geq 0,$$

and it is given by;

$$S_{AC}^{U} = \frac{\gamma_A + \gamma_C}{\omega_A + \omega_C} \times \frac{1}{2}.$$

Thus, the post-merger percentage price increase that the acquiring firm is willing to initiate, and only motivated by PAC (on top of the unilateral effects of the merger), is given by:

$$S_{AC}^{I,**} = \frac{\delta \widetilde{F_{B,AC}} + \gamma_A + \gamma_C}{\omega_A + \omega_C - \delta \widetilde{F_{B,AC}}} \times \frac{1}{2} \quad - \quad S_{AC}^{U}.$$

Finally, considering the same set of assumptions than in Section 2.2[1], the previous formula is simplified to:

$$S_{AC}^{I,1} = \frac{\delta F_{B,AC}+DR_{CA}-\theta_A}{1-DR_{CA}-\delta F_{B,AC}} \times \frac{m_A}{2} \quad - \quad S_{AC}^{U,1},$$

$$with \qquad F_{B,AC} = \frac{(DR_{BA}+DR_{BC})q_B e_B}{(q_A+q_C)e_A} \qquad and \qquad S_{AC}^{U,1} = \frac{(1-e_A(1-DR_{CA})m_A)}{e_A(1-DR_{CA})} \times \frac{1}{2}.$$

E.1.2 Outsider firm (Firm B)

1. At period t the outsider firm increases it price by S_B percent. It incurs in a loss of profits equal to the difference between: (i) the value of the divested sales generated by the price increase, and (ii) the higher price charged on its remaining sales. This is given by the following expression:

$$L_B = [S_B \cdot e_B \cdot q_B] \cdot m_B \cdot p_B - \quad [q_B - S_B \cdot e_B \cdot q_B] \cdot S_B \cdot p_B.$$

2. Assuming that from period $t+1$ onward, the price increase is followed by Firm AC, then the outsider firm gets profits equal to the difference between: (i) the higher price charged on its overall sales, incorporating the divested sales from the brands of the merged firm, and (ii) the value of the divested sales generated by the price increase. Thus the per-period gain from PAC is given by:

$$G_B = [q_B - S_B \cdot e_B \cdot q_B + S_B \cdot e_A \cdot q_A \cdot DR_{AB} + S_B \cdot e_C \cdot q_C \cdot DR_{CB}] \cdot S_B \cdot p_B$$
$$- \quad (S_B \cdot e_B \cdot q_B - S_B \cdot e_A \cdot q_A \cdot DR_{AB} - S_B \cdot e_C \cdot q_C \cdot DR_{CB}) \cdot m_B \cdot p_B.$$

3. Assuming that Firm AC matches the price increase permanently, then Firm B chooses $\mathrm{S_B}$ in order to maximize the present value of its expected payoffs. Therefore, the optimal $\mathrm{S_B^*}$ is found by maximizing the following expression:

$$\mathrm{S_B^{I,*}} = \max_{\mathrm{S_B}} \left\{ -\mathrm{L_B(S_B)} + \frac{\delta}{1-\delta} \cdot \mathrm{G_B(S_B)} \right\},$$

and is given by;

[1] The assumptions are:

1. The prices, margins and own-price elasticities of the brands produced by the merged firm are the same ($p_A = p_C$, $m_A = m_C$ and $e_A = e_C$).
2. The diversion ratios between the brands produced by the merged firm are identical ($DR_{AC} = DR_{CA}$).

$$S_B^{I,*} = \frac{\delta\widetilde{F_{AC,B}} - \theta_B}{1 - \delta\widetilde{F_{AC,B}}} \times \frac{m_B}{2},$$

with:

$$\widetilde{F_{AC,B}} = \frac{q_A e_A DR_{AB} + q_C e_C DR_{CB}}{q_B e_B} \qquad \text{and} \qquad \theta_B = 1 - \frac{1}{m_B e_B}.$$

Finally, considering the same set of assumptions than in section 2.2, the previous formula is simplified to:

$$S_B^{I,1} = \frac{\delta\widetilde{F_{AC,B}} - \theta_B}{1 - \delta\widetilde{F_{AC,B}}} \times \frac{m_B}{2} \qquad \text{with} \qquad \widetilde{F_{AC,B}} = \frac{e_A(q_A DR_{AB} + q_C DR_{CB})}{q_B e_B}$$

E.2 Alternative versions of the CPPI

Finally, and considering the previous formulas, the corrected versions of the post-merger CPPI variations are given by:

$$\Delta CPPI_{AC,B}^{1} = \min\{S_{AC}^{I,1}, S_B^{I,1}\} - \min\{S_A^{I}, S_B^{I}\},$$

and;

$$\Delta CPPI_{AC,B}^{2} = \min\{S_A^{I,**}, S_B^{I,*}\} - \min\{S_A^{I}, S_B^{I}\}.$$

Appendix F – Database cleaning

- Geographic coordinates

A database received in September-2013 (from the Chilean Sectorial Regulator, i.e., the "Comisión Nacional de Energía" - www.cne.cl) is used to approximate the structure of the market by the time of the merger, i.e., June-2013. Note that since the auction implemented to proceed with the divestitures took place in September 4th 2013 and the transfer of the divested stations only started in October-2013, this is a good approximation.

The 2013 database does not contain geographic coordinates. Thus I matched the 2013 addresses with the coordinates' information provided by the database received in February-2015 (using the station id variable). There are 36 stations (2.27%) that did not match. The most likely reason is that these stations left the market. These are stations from three small alternative brands (Autogasco (6), Lipigas (16) and Coopeserau (5)), some unbranded stations (8) and one from Terpel (1).

- Dropped stations from the sample

I have pre and post-merger price data for 1550 gas stations. There are 9 communes where I could not identify the addresses of divested stations. These communes were dropped from the sample, which reduces the sample to 1439 stations. In addition, I also dropped the commune "Lota" because the station that was supposed to be divested stopped reporting prices during week 68 (before week 80 when the merger took place). After this adjustment, the sample contains 1435 stations.

Finally, stations with very low pricing activity (changing prices on less than 45% of the weeks) were also deleted from the sample. This reduces the sample to 1419 gas stations.

- The divestment dummies

The deadline to subscribe the divestment contracts was October 16th 2013. Most of the contracts were signed before December 27th 2013. However, since I do not know the exact date in each case, I set the divestment dummy to be equal to 1 for every month starting on January-2014. There are a few exceptions. First, for the divested gas stations located in "Paillaco", "Peñalolen", "Castro", "San Felipe", "Parral", "Talca", "Temuco", "Illapel", "Buin" and "Paine", the contracts were signed between December 28th 2013 and January 15th 2014. Therefore, for these cases the divestment dummy is equal to 1 for every month starting on February-2014. Second, regarding the divested gas station in "San Bernardo", the contract was signed on April-2014, thus the divestment dummy takes the value of 1 starting on May-2014 in this case. Finally, in the case of “Maipu”, the divestment contract was signed on March-2014. Therefore, in this case the divestment dummy takes the value of 1 starting on April-2014.

Appendix G – Tables (Chapter 3)

Table G.1 – Logit model – Probability of being divested (Communes with divestitures, Shell-Terpel stations)

	(1)	(2)	(3)	(4)	(5)
VARIABLES	$merger\_divest_i$	$merger\_divest_i$	$merger\_divest_i$	$merger\_divest_i$	$merger\_divest_i$
$\log(margin_{i,t})$	-2.012			-2.510	-3.777
	(4.039)			(4.199)	(4.957)
$grocery\_store$		-0.447		-0.488	-0.168
		(0.470)		(0.478)	(0.510)
$public\_toilet$		0.00924		0.0671	-0.130
		(0.459)		(0.473)	(0.488)
$car\_maintenance\_services$		-0.194		-0.188	0.0418
		(0.346)		(0.347)	(0.376)
$gas\_elf\_service$		-0.272		-0.341	-0.117
		(0.572)		(0.583)	(0.623)
$pharmacy$		-		-	-
		-		-	-
n_copec_1km			-0.00893		-0.00979
			(0.180)		(0.187)
$n\_copec\_1km\_2km$			-0.214		-0.225*
			(0.133)		(0.133)
$n\_copec\_2km\_3km$			**0.160****		**0.141***
			(0.0794)		**(0.0825)**
$n\_petrobras\_1km$			0.132		0.139
			(0.288)		(0.298)
$n\_petrobras\_1km\_2km$			**-0.621*****		**-0.587****
			(0.232)		**(0.237)**
$n\_petrobras\_2km\_3km$			-0.0987		-0.0878
			(0.194)		(0.196)
$n\_unbranded\_1km$			-1.392		-1.521
			(1.006)		(1.043)
$n\_unbranded\_1km\_2km$			0.611		0.567
			(0.381)		(0.391)
$n\_unbranded\_2km\_3km$			-0.498		-0.519
			(0.447)		(0.475)
n_other_1km			-0.0632		-0.105
			(0.481)		(0.497)
$n\_other\_1km\_2km$			0.503		0.501
			(0.549)		(0.556)
$n\_other\_2km\_3km$			-		-
Table G.1 (Extended)			-		-
$Constant$	10.63	-1.223***	-1.061***	13.88	21.84
	(24.31)	(0.241)	(0.277)	(25.26)	(29.90)
Observations	253	253	253	253	253

Table G.2 – Results Equation (1) (Gasoline 93, national level)

Clustered Standard Errors – Commune Level

VARIABLES	(1) $\log(margin_{i,t})$ 1 Km. radius	(2) $\log(margin_{i,t})$ 2 Km. radius	(3) $\log(margin_{i,t})$ 3 Km. radius	(4) $\log(margin_{i,t})$ 1 Km. radius	(5) $\log(margin_{i,t})$ 2 Km. radius	(6) $\log(margin_{i,t})$ 3 Km. radius
$PostM1_t \cdot Merger_i$	0.00536*	0.00546**	0.00590**	0.00517*	0.00540**	0.00589**
	(0.00279)	(0.00218)	(0.00257)	(0.00277)	(0.00218)	(0.00257)
$PostM2_t \cdot Merger_i$	0.0162***	0.0162***	0.0159***			
	(0.00607)	(0.00527)	(0.00542)			
$\times\ insider_i$				0.0172***	0.0166***	0.0147***
				(0.00564)	(0.00523)	(0.00545)
$\times\ outsider_i$				0.0175**	0.0171***	0.0169***
				(0.00710)	(0.00576)	(0.00593)
$\times\ other_i$				0.000498	0.00644	0.0161**
				(0.00609)	(0.00596)	(0.00687)
$PostM1_t \cdot Merger\_Divest_i$	-0.00156	-0.00144	-0.00169	-0.00156	-0.00144	-0.00169
	(0.00469)	(0.00365)	(0.00377)	(0.00469)	(0.00365)	(0.00377)
$PostM2_t \cdot Merger\_Divest_i$	-0.0248**	-0.0220**	-0.0226**	-0.0248**	-0.0220**	-0.0226**
	(0.00999)	(0.0100)	(0.00981)	(0.00999)	(0.0100)	(0.00981)
$PostM1_t \cdot Merger\_Divest\_Rad_i$	-0.00253	0.00222	0.00671***	-0.00269	0.00213	0.00663***
	(0.00221)	(0.00197)	(0.00233)	(0.00220)	(0.00197)	(0.00232)
$PostM2_t \cdot Merger\_Divest\_Rad_i$	-0.0154*	0.00157	0.0142**			
	(0.00797)	(0.00695)	(0.00640)			
$\times\ insider_i$				-0.0127	-0.00200	0.0115*
				(0.00781)	(0.00662)	(0.00623)
$\times\ outsider_i$				-0.0160*	0.00517	0.0170**
				(0.00878)	(0.00795)	(0.00676)
$\times\ other_i$				-0.0333***	-0.0101	-0.00196
				(0.00469)	(0.0117)	(0.00962)
$Constant$	5.917***	5.918***	5.919***	5.917***	5.918***	5.919***
	(0.00283)	(0.00288)	(0.00288)	(0.00283)	(0.00286)	(0.00286)
Station and week fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	203,345	203,345	203,345	203,345	203,345	203,345
R-squared	0.794	0.796	0.797	0.794	0.796	0.797
Number of gas stations	1,419	1,419	1,419	1,419	1,419	1,419

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

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