Profit-sharing and Ineffiencies in vertically related markets

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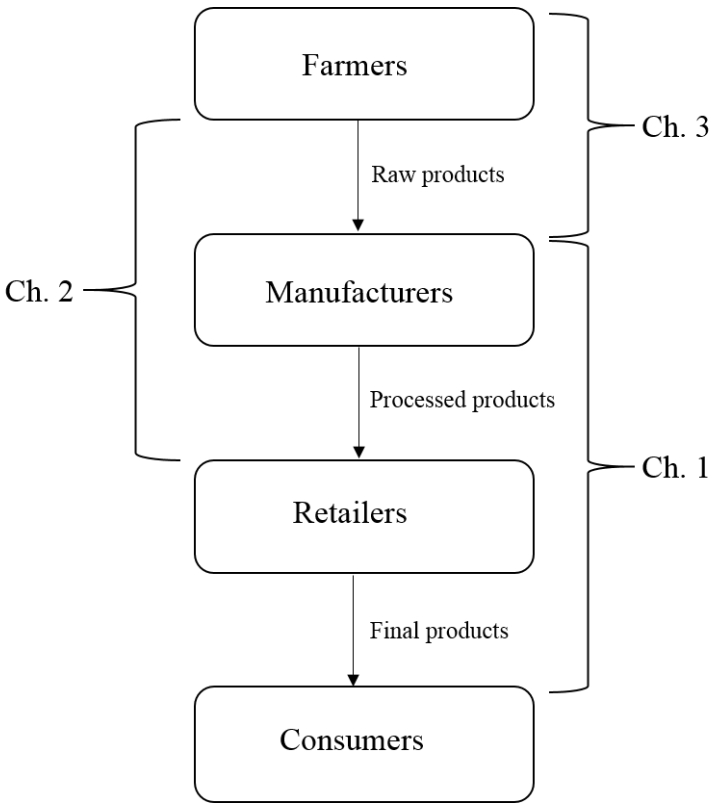
Contents

General Introduction

A *vertical relation* (or a supply chain) defines the buyer-seller relationships between firms in the production process of a good. It is a common feature to almost all markets in modern economies. This dissertation focuses on two potential economic issues at stake in such markets: the *inefficiencies* and the *profit-sharing*. A market is inefficient if the total value produced is not maximized. This work, documents inefficiencies from multiple origins: product variety, price distortions, and production allocation between firms. Particular attention is paid to analyzing how profit sharing and market efficiency are intertwined. It provides examples of inefficiencies due to rent extraction from powerful firms and challenges public authorities face to regulate these markets.

This dissertation focuses on the French agri-food industry, particularly the dairy market. There is an important demand from the society to better understand the aforementioned issues in this sector, as shown by the burgeoning contributions in medias (*e.g. Planète lait (2017), L'ogre du lait (2020), Où va l'argent du beurre ? (2018)*), movies (*e.g. Petit Paysan (2017), Au Nom de la Terre (2019), La Terre des Hommes (2020)*) and books (*e.g. Serotonine (2019)*). The Egalim laws (2018, 2020) aim to tackle these concerns. The full name of these laws – *i.e., Law for the balance of commercial relations in the agricultural and food sector and a healthy, sustainable and accessible food for all* – illustrates that the questions addressed in this thesis are at the heart of the public debate.



Dissertation Organization

Asymmetric concentration is characteristic of the French agri-food industry. Upstream, farmers are atomistic. For example, there are 54 000 dairy farms of relatively homogeneous size in the dairy industry in 2018. Farmers sell their raw milk production to 300 manufacturers of heterogeneous sizes. The ten biggest firms represent 75% of the total market share. Finally, manufacturers sell their processed products to retailers, which are very concentrated. The five biggest French retailers represent 80% of the market.

This thesis documents each stage of this supply chain in three chapters. Chapter 1 focuses on negotiations between retailers and manufacturers. Chapter 2 analyzes manufacturers' ability to exert market power upstream and downstream. Chapter 3 deals with farms production and efficiency.

Chapter 1 is entitled *Purchasing Alliances and Product Variety*. It is a theoretical work co-authored with Marie-Laure Allain and Claire Chambolle. It analyses the impact of purchasing alliances on the efficiency of product variety available for consumers and the profit-sharing between retailers and manufacturers. This paper has been motivated by the two recent waves of alliances in France. Retailers create a purchasing alliance to negotiate with their suppliers over listing products and/or tariffs. Traditionally, competition authorities perceived these alliances well because they can benefit consumers if the tariff discount obtained by retailers transmits to consumers. However, the French competition authority has expressed concerns regarding the scope of these buying groups. In particular, the authority has recommended excluding private labels to the scope of the joint negotiation and allowing joint negotiation only on national brands, arguing that private labels are generally sold by SMEs with low bargaining power; purchasing alliances are seen as a potential threat for these firms. This paper questions the impact of such restriction. The main results of the model are the following. Buying groups generate inefficient equilibrium assortments with a loss of variety. They are detrimental to industry profit and consumer surplus, and they distort the profit-sharing to the benefit of retailers. Limiting buying groups' scope to national brands' products is insufficient to protect SMEs from profit losses or exclusion. The intuition of this result is that buying group improves the bargaining position of retailers when negotiating with large suppliers; thus, the outside option of retailers when negotiating with small suppliers is better.

Chapter 2 is a structural approach focusing on manufacturers' market power. It is entitled *Markups and Markdowns in the French Dairy Market*, and it is joint work with Etienne Guigue. Market power is the ability of firms to set prices; it comes from two possible origins: the capacity to sell output at a high price, imposing a *markup*, and the capacity to purchase input at a low price, imposing a *markdown*. It is an essential issue as

it decreases consumer welfare, generates misallocation, and distorts value-added sharing. It is crucial to quantify and disentangle buyer and seller market power to tackle this issue and design public policies. This paper addresses this issue, focusing on the French dairy market.

The modeling of this paper aims to fit key features of the milk processing firms' activity. Firms are multi-source and multi-product. In practice a manufacturers purchase raw milk for different department (*i.e.* source) and sell different products (*i.e.* a product is defined at the NC8 level). This work relies on a few assumptions on competition structures, only assuming that manufacturers face elastic demand and supply curves. The necessary structure to estimate the model relies on the production process on which we have rich data. The data cover the period 2003-2018. The first data set provides information on inputs and outputs at the firm level. On inputs, it contains quantities and prices of raw milk purchased by each firm in each department and the labor and capital used by each firm. On outputs, it contains quantities and factory-gate prices of dairy products sold. The second data set gives information on milk input content by product allowing to know how much milk is required to produce one kilogram of each product. Confronting the model to the data allows the estimation of total margins and their decomposition into markups and markdowns. The estimation is made in three steps. The production function estimation allows recovering marginal costs. Using cost and prices gives total margins estimate. Margin is thus decomposed into markups and markdowns, assuming that manufacturers are price takers on milk powder and milk powder is a substitute for raw milk in the production process.

The estimation gives the following results. The average total margin is estimated at 62% and decomposed into an average markup of 45 % and an average markdown of 15%. Results document multiple dimensions of heterogeneity between markups and markdowns (firms, inputs and outputs markets). On average, markups are higher on differentiated products, markups and markdowns are higher on concentrated markets, and larger firms exert higher market power. Another important finding of this paper is that markups and markdowns fluctuate across time; markdowns are pro-cyclical and markups counter-cyclical. These results suggest that manufacturers face a relatively more (respectively less) elastic supply when the price of raw milk is low (high), which may be due to the relatively low (high) profitability of dairy farms. Downstream, demand is more (respectively less) elastic when prices are high (low).

Chapter 3 is an empirical work focusing on farmer's production; it relies on microeconomic theory and descriptive statistics to analyze the effect of raw milk production quotas on French dairy farms. This paper is entitled *Production Quotas Reforms and the Cream-skimming of the French Dairy Market*, it is also joint work with Etienne Guigue. From 1984 to 2015, production quotas constrain European raw milk production. Their removal

has been progressive from 2008 to 2015. The quotas objective was twofold: to support farmers' incomes and control produced quantities. Production waste was a massive issue at the beginning of the 1980s due to the price support policy implemented. In France, the quota allocation policy had two additional objectives. The first objective was to reduce farm size dispersion, leading to mechanisms increasing quota acquisition cost with farm size. The second objective was to attenuate territorial inequalities; it leads to production quotas fixed at the department level.

This work relies on departmental and farm-level data. The departmental data give the quantity produced by the department over the entire period. Farm-level data provide farms' raw milk quotas between 1995-2015 and raw milk quantities from 2007 to 2018. Data are analyzed in light of precise textbook arguments which drive and explain descriptive statistics findings. This work focuses on two types of distortions: *spatial distortions* and *farm size distortions*. On spatial distortions quota prevents competition between territories, the production cannot concentrate in most efficient territories. The concentration started in 2008 with the start of quotas increase. On individual production distortions, we observe that under the quota regime, small farms' growth rate is decreasing with their size; the relation is reversed with the loosening of the quotas constraints. Interestingly, quotas become non-binding at different times, and the change in farms' growth rate relation happens at this moment. Finally, the removal of the quotas has led to important efficiency gains due to the industry reorganization, competition between and within departments has increased. The individual effect of the liberalization on farmers depends on two elements: the individual efficiency gains that the farm can achieve with the liberalization but also its localization, *i.e.* whether it is localized in a department protected by the quota or in a competitive department constrained in its production.

Version française de l'introduction

Une relation verticale (ou une chaîne d'approvisionnement) définit l'ensemble des rapports commerciaux qui lient les entreprises intervenant dans le processus de production d'un même bien. Ce type de relation se retrouve dans presque tous les marchés des économies modernes. Cette thèse se concentre sur l'analyse des *inefficacités* et du *partage de la valeur* au sein des relations verticales. Un marché est dit inefficace si la valeur totale produite n'est pas maximisée. Les travaux présentés ici documentent des inefficacités aux sources diverses : la variété des produits, les distorsions de prix et la répartition de la production entre les entreprises. Dans l'analyse du partage de la valeur, une attention particulière est accordée à ses conséquences sur l'efficacité du marché.

Cette thèse s'intéresse à l'industrie agroalimentaire française, et plus particulièrement au marché des produits laitiers. Il y a actuellement une forte demande pour comprendre les enjeux économiques sur ces marchés, comme le montre la multiplication des contributions sur le sujet : dans les médias (*Planète lait (2017), L'ogre du lait (2020), Où va l'argent du beurre ? (2018)*), les films (*Petit Paysan (2017), Au Nom de la Terre (2019), La Terre des Hommes (2020)*) et les romans (*Sérotonine (2019)*). Les lois Egalim (2018, 2020) visent à répondre à ces préoccupations. Le nom complet de ces lois – à savoir, *Loi pour l'équilibre des relations commerciales dans le secteur agricole et alimentaire et une alimentation saine, durable et accessible à tous* – illustre l'importance des questions abordées par cette thèse dans le débat public.

L'industrie agroalimentaire française est caractérisée par une forte asymétrie de la concentration au sein de la chaîne. En amont, les agriculteurs sont atomistiques : en 2018, l'industrie laitière compte 54 000 exploitations de taille relativement homogène. Ces agriculteurs vendent leur production de lait cru à 300 industriels de tailles hétérogènes. Parmi eux, les dix plus grandes entreprises représentent 75 % de la part de marché totale. Enfin, les industriels vendent leurs produits transformés aux distributeurs qui sont, eux, très concentrés. En effet, les cinq plus gros distributeurs français représentent 80 % du marché.

Cette thèse documente chacune des étapes de cette chaîne d'approvisionnement à travers trois chapitres. Le chapitre 1 se concentre sur les négociations entre les distributeurs et les industriels. Le chapitre 2 analyse la capacité des industriels à exercer un pouvoir de marché en amont et en aval. Le chapitre 3 traite de la production et de l'efficacité des exploitations agricoles.

Le chapitre 1 est intitulé *Purchasing Alliances and Product Variety.* Il s'agit d'un

article théorique co-écrit avec Marie-Laure Allain et Claire Chambolle. Il analyse l'impact des centrales d'achat sur la variété des produits disponibles, ainsi que le partage de la valeur entre les distributeurs et les industriels. La France a connu en 2014 et 2018 deux vagues de créations de centrales d'achat, au sein desquelles les distributeurs négocient avec leurs fournisseurs le référencement des produits et les tarifs. Traditionnellement, les régulateurs étaient favorables à ces alliances, qui peuvent bénéficier aux consommateurs si la réduction tarifaire obtenue par les distributeurs conduit à une baisse des prix finaux. Cependant, en 2018, l'autorité de la concurrence française a exprimé des inquiétudes quant au champ d'application de ces alliances. En particulier, elle a recommandé d'exclure les marques de distributeurs du champ d'application de ces centrales. Ainsi, la coopération à l'achat est autorisée uniquement sur les marques nationales, et ce afin de protéger les PME productrices de marques de distributeurs. Ces dernières ont en effet généralement un faible pouvoir de négociation, les centrales d'achat sont donc considérées comme une menace potentielle pour elles. Cet article interroge l'impact d'une telle restriction.
Les principaux résultats du modèle sont les suivants. Les centrales d'achat génèrent des assortiments de produits inefficaces, avec une perte de variété. Elles ont pour conséquence de réduire le profit de l'industrie et le surplus des consommateurs, et de modifier le partage du profit en faveur des distributeurs. Par ailleurs, Limiter le champ d'action des centrales d'achat aux produits des marques nationales s'avère être insuffisant pour protéger les PME des pertes de profit ou de l'exclusion. L'intuition de ce résultat est que la centrale d'achat améliore le pouvoir de négociation des distributeurs lorsqu'ils négocient avec les grands fournisseurs ; ainsi, l'option alternative des distributeurs lorsqu'ils négocient avec les petits fournisseurs est meilleure.

Le chapitre 2 analyse le pouvoir de marché des industriels à travers une approche structurelle. Il s'intitule *Markups and Markdowns in the French Dairy Market*, et il s'agit d'un travail co-écrit avec Etienne Guigue. Le pouvoir de marché est la capacité des entreprises à fixer les prix, il a deux origines possibles : la capacité à vendre la production à un prix élevé, en imposant un *markup*, et la capacité à acheter les intrants à un prix bas, en imposant un *markdown*. Le pouvoir de marché est à l'origine d'une diminution du bien-être des consommateurs, d'une mauvaise allocation des ressources et d'une distorsion du partage de la valeur ajoutée. Afin d'aborder ces distorsions et de proposer des politiques publiques pertinentes, il est indispensable de pouvoir distinguer et quantifier les markups et markdowns. Cet article aborde ces enjeux en se concentrant sur le marché français des produits laitiers.
L'industrie laitière est modélisée afin d'en capturer aux mieux les caractéristiques. On considère des entreprises *multi-sources* et *multi-produits*. Un industriel achète du lait cru au sein de différents départements (les sources) et vend différents produits (définis

au niveau NC8). La modélisation utilisée fait appel à peu d'hypothèses concernant la structure de la concurrence, on suppose uniquement que les industriels font face à des fonctions d'offre et de demande élastiques. Les hypothèses permettant l'estimation du modèle reposent donc sur la structure des coûts et le processus de transformation laitière, pour lesquels nous disposons de données riches couvrant la période 2003-2018.
Le premier volet des données mobilisées documente les quantités produites et les facteurs de production mobilisés au niveau de l'entreprise. Pour les facteurs de productions, on observe les quantités et les prix du lait cru acheté par chaque entreprise dans chaque département, ainsi que le travail et le capital utilisés par chaque entreprise. Pour la production, on observe les quantités et les prix des produits laitiers vendus. Le deuxième volet des données mesure la qualité du lait et l'intensité en lait de chaque produit, il permet ainsi de mesurer la quantité de lait nécessaire à la production d'un kilogramme de chaque produit. La confrontation du modèle aux données permet d'estimer les marges totales et de les décomposer en markups et markdowns.
L'estimation du modèle se déroule en trois étapes. D'abord, l'estimation de la fonction de production donne les coûts marginaux. Ensuite, l'utilisation des coûts et des prix permet de retrouver les marges totales. Enfin, les marges sont décomposées en markups et markdowns. Cette décomposition repose sur deux hypothèses : les industriels n'ont pas de pouvoir de marché sur le lait en poudre, et celui-ci est un substitut du lait cru dans le processus de production.
L'estimation donne les résultats suivants. La marge totale moyenne de l'industrie est de 62 %, et se décompose en un markup moyen de 45 % et un markdown moyen de 15 %. Les résultats mettent en évidence de multiples dimensions d'hétérogénéité entre les markups et markdowns entre entreprises, facteurs de productions et produits finis. En moyenne, les markups sont plus élevées sur les produits différenciés, les markups et markdowns sont plus élevées sur les marchés concentrés, et les grandes entreprises exercent un pouvoir de marché plus important. Une autre conclusion importante de ce travail est que les markups et markdowns fluctuent dans le temps ; les markdowns sont pro-cycliques et les markups contra-cycliques. Ce résultat suggère que les industriels font face à une offre relativement plus (respectivement moins) élastique lorsque le prix du lait cru est faible (élevé), ce qui peut être dû à la rentabilité faible (élevée) des exploitations laitières. En aval, la demande est plus (respectivement moins) élastique lorsque les prix sont élevés (bas).

Le chapitre 3 est un travail empirique axé sur la production des agriculteurs ; il s'appuie sur la théorie microéconomique et des statistiques descriptives pour analyser l'effet des quotas laitiers sur les exploitations laitières françaises. Cet article s'intitule : "*Production Quotas Reforms and the Cream-skimming of the French Dairy Market*", il s'agit également d'un travail co-écrit avec Etienne Guigue.

De 1984 à 2015, les quotas laitiers ont contraint la production européenne de lait cru. Les droits à produire ont augmenté graduellement à partir de 2008. L'objectif des quotas était double : soutenir les revenus des agriculteurs et maîtriser les quantités produites. La surproduction était très importante au début des années 1980 en raison de la politique de soutien des prix mise en oeuvre.

En France, la politique d'allocation des quotas avait deux objectifs supplémentaires. Le premier était de réduire la dispersion de la taille des exploitations. Pour cela, des mécanismes ont été instaurés afin de rendre le coût d'acquisition des droits de productions croissant avec la taille des exploitations. Le second objectif était d'atténuer les inégalités territoriales ; il conduit à des quotas de production fixés au niveau départemental.

L'article mobilise des données à deux niveaux d'observation : au niveau départementale et au niveau individuel. Les données départementales donnent la quantité produite par département sur l'ensemble de la période. Les données individuelles fournissent les quotas de lait cru de chaque exploitation entre 1995-2015 ainsi que les quantités de lait cru produite de 2007 à 2018. Ces données sont analysées à la lumière d'arguments théoriques et de statistiques descriptives. Deux types de distorsions sont analysées : les *distorsions spatiales* et les *distorsions liées à la taille des exploitations*. Concernant les distorsions spatiales, les quotas annihilent la concurrence entre les territoires en empêchant la production de se concentrer dans les territoires les plus efficaces. La phénomène de concentration commence en 2008 avec l'accroissement des droits à produire. En ce qui concerne les distorsions de la production individuelle, sous le régime des quotas, le taux de croissance des petites exploitations diminue avec leur taille ; la relation s'inverse lorsque la contrainte imposée par les quotas se relâche. Il est intéressant de noter que les quotas deviennent non contraignants à différents moments selon les département, et que le changement dans la relation du taux de croissance se produit toujours à ce moment là.

Enfin, la suppression des quotas a entraîné d'importants gains d'efficacité en raison de la réorganisation de l'industrie. L'effet de la libéralisation sur une exploitation dépend donc de deux éléments : des gains d'efficacité individuels qu'elle peut opérer suite à la libéralisation, mais aussi de son département d'origine, à savoir s'il était protégé de la concurrence ou au contraire contraint dans sa production.

Chapter 1

Purchasing Alliances and Product Variety

Note: This chapter is co-authored with Marie-Laure Allain and Claire Chambolle. It has been published in *International Journal of Industrial Organization* in 2020.[1]

Abstract

We analyze the impact of purchasing alliances on product variety and profit sharing in a setting, in which capacity constrained retailers operate in separated markets and select their assortment in a set of differentiated products offered by heterogeneous suppliers (multinationals vs. local SMEs). Retailers may either have independent listing strategies or build a buying group, thereby committing to a joint listing strategy. This alliance may cover the whole product line (full buying group) or only the products of large suppliers (partial buying group). We show that a buying group may enhance the retailers' buyer power and reduce the overall product variety to the detriment of consumers. Our most striking result is that partial buying groups do not protect the small suppliers from being excluded or from bearing profit losses; they may even be more profitable for retailers than full buying groups.

Keywords: Vertical relations, buying group, purchasing alliance, buyer power, vertical foreclosure.

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1. Introduction

Buying groups are purchasing alliances between retailers designed to enable them to negotiate together with their suppliers over the listing of products and/or tariffs. Those agreements are widespread, and they often gather retailers that operate in different countries.[1] Such alliances are not supposed to affect downstream competition, as retailers keep operating their stores independently, but they are a mean to enhance buyer power, which is usually well perceived by competition authorities.

The pro-competitive effects of buyer power have been first coined by Galbraith (1952), who explains how this "countervailing power" enables retailers to obtain discounts that translate into lower consumer prices. Since then, the economic literature has reconsidered these conclusions. First, discounts obtained by retailers may not translate into lower consumer prices: the countervailing power effect relies on strong assumptions regarding the shape of tariffs, namely linear contracts (see von Ungern-Sternberg (1996) and Iozzi and Valletti (2014)) and intense retail competition (see Gaudin (2018)). Yet it has been widely documented that tariffs in the retail sector are scarcely linear (see Berto Villas-Boas (2007) and Bonnet and Dubois (2010)), and that the retail sector has achieved a high level of concentration both in Europe and in the United States (see Allain et al. (2017), Barros et al. (2006), and Hosken et al. (2018)). Furthermore, recent empirical and theoretical developments point out potential adverse effects of buyer power on product variety and innovation (see European Economic Community (2014) and Inderst and Mazzarotto (2008) for a survey, Inderst and Shaffer (2007), Caprice and Rey (2015) and Chambolle and Villas-Boas (2015).)

Despite the potential adverse effects highlighted in the above literature, purchasing alliances are usually not subject to *ex ante* approval by competition authorities, contrary to mergers. In the European Union, buying groups are subject to scrutiny under Article 101 of the Treaty on the Functioning of the European Union, as any horizontal co-operation agreements: they are lawful if and only if their restrictive effects are more than outweighed by pro-competitive effects, provided that consumers receive a "fair share" of the resulting benefits. There is no *ex ante* control by the European Competition Authority, but firms entering into a purchasing agreement must carry out a self-assessment of the legality of such agreement, based on the *Guidelines on the applicability of Article 101 of the Treaty on the Functioning of the European Union to Horizontal Co-operation Agreements* (henceforth the Guidelines) and on the rules on the vertical agreements displayed

[1] For instance, the buying group AMS, set up in 1988, is an alliance between Delhaize (Belgium), Essalunga (Italy) and Migros (Switzerland); European Marketing Distribution, created in 1989, grouped together retailers from 20 countries including Germany, the Netherlands, Italy, Spain, Portugal, and Russia; Agecore, created in 2015, is an alliance between Colruyt (Belgium), Conad (Italy), Coop (Switzerland), Edeka (Germany), and Eroski (Spain); Eurelec has been created in 2016 by Leclerc (France) and Rewe (Germany); Horizon, set up in 2019, is an alliance between Casino and Auchan (France), Dia (Spain), Metro (Germany), Schiever Group (France and Poland).

in the *Guidelines on Vertical Restraints*. Section 5 of the Guidelines acknowledges that "joint purchasing arrangements [...] may force suppliers to reduce the range or quality of products they produce, which may bring about restrictive effects on competition such as quality reductions, lessening of innovation efforts, or ultimately sub-optimal supply" (§ 194 and 202). However, the Guidelines consider that if "competing purchasers co-operate who are not active on the same relevant selling market (for example, retailers which are active in different geographic markets and cannot be regarded as potential competitors), the joint purchasing arrangement is unlikely to have restrictive effects on competition [...] " (§ 212 and 223). In this paper, we therefore focus on the case where retailers cannot be regarded as potential competitors.

Recent waves of buying alliances in the grocery industry have attracted the attention of several Competition Authorities, including the European Commission[2] and the French[3] and Belgian[4] national authorities. Between September and December 2014, three large purchasing agreements have been signed in France: between System U and Auchan, between Intermarché and Casino, and between Carrefour and Cora. In its 2015 Opinion (15-A-06), the French Competition Authority claims that these buying groups are likely to have limited anticompetitive effects because their scope is restricted to national brand products: they cannot affect products manufactured by small suppliers or fresh agricultural products, that are more likely to be in a situation of dependence. A second wave of international purchasing agreements involving French retailers started in 2018: besides Horizon (see footnote 1), two new agreements involve Carrefour and System U on the one hand, and Carrefour and Tesco on the other. An important difference with the previous wave is that the new buying groups gather retailers operating on separate markets. Furthermore, they cover a wider scope of brands.[5] The French competition authority states that new agreements "differ from the alliances made in 2015 due to their larger scope involving an international dimension, and because they include not only national brand products but also store-brand products".[6] The retailers argue that this may give opportunities of international development to the suppliers of private labels.[7]

[2]The DG AGRI organized a Workshop on "The role of national and international retail alliances in the agricultural and food supply chain" in 2019 which led to the following report. In 2019 the European Commission launched an investigation on supermarket commercial strategies and the conditions they impose when they build alliances: see Reuters.

[3]The Loi Macron 2015-990 made mandatory for retailers to notify to the Competition Authority their decision to create a buying group at least two months in advance. Yet, no tools for controlling such alliances were granted to the Competition Authorities.

[4]The Belgian Competition Authority launched an inquiry in 2019 regarding the practices of Carrefour and Provera.

[5]Carrefour claimed for instance that "the alliance will cover the strategic relationship with global suppliers [and] the joint purchasing of own brand products" Source: Carrefour.com.

[6]The French competition authority launched a new evaluation in July 2018 to investigate *"the competitive impact of these purchasing partnerships on the concerned markets, both upstream for the suppliers, and downstream for the consumers"*. Source: autoritedelaconcurrence.fr.

[7]Horizon communication thus claimed that "Auchan Retail, Casino Group and METRO will assist

In this paper, we study the effect of alliance strategies on product variety, and we compare two types of alliances: partial buying groups, in which the retailers negotiate jointly with the suppliers of leading brands, and full buying groups, in which they also negotiate jointly with local SMEs. We deliberately abstract from the effects of such alliances on downstream competition, and thus consider two retailers acting as monopolists on two independent markets, (*e.g.* two countries).[8] We model two types of suppliers: a large supplier who offers two products in both markets (typically a multinational company selling leading brands across markets), and, in each market, a small local supplier who offers only one product (typically, a SME producing a private label). Each small supplier must incur export costs to enter in the other market. We assume that there is heterogeneity of the products profitability across markets.[9] We consider that retailers may either adopt an independent listing strategy or build a buying group, thereby committing to listing the same product assortment. Buying groups may cover the whole product line (full buying group) or only part of it (partial buying group, targeting only the products of the large producer).

In each of these situations, retailers and suppliers contract over three part tariffs following the timing of Chambolle and Molina (2019). First, on each market, suppliers compete for being listed by the retailer by simultaneously offering lump-sum slotting fees. After the listing decision, which is publicly observed, retailers engage in a "Nash-in-Nash" bargaining over efficient two-part tariff contracts, with the supplier(s) of the selected products. Finally, retailers sell their products on the downstream markets.

Absent buying group, we first highlight that each retailer chooses the efficient assortment of products in its market, excluding the least efficient product - this efficient assortment differs however across market. Hence, with a buying group, committing to a similar assortment in the two markets always generates inefficiencies in one of the markets and in some cases in both. Despite this inefficiency, retailers may find this strategy profitable because the alliance enhances their buyer power, as it increases competition among the suppliers for being listed. Indeed, in one market the excluded product is no longer the least efficient: its supplier is therefore ready to pay a higher slotting fee to be listed, and this, in turn, leads to an increase in the slotting fees paid by the selected supplier. In that case, the buying group enables the retailers to receive "a larger share of a smaller pie". As a result, it may be jointly profitable for the retailers to create a buying group when their bargaining power is low, as retailers have relatively more to win

SMEs in their international development, [...] and will be able to launch invitations to tender for their general expenses and their non-differentiating basic private-label brands" groupe-casino.fr.

[8]Many buying groups involve retailers active in different countries: for instance, Carrefour and Tesco, are both active in many countries, but simultaneously in only two countries in Europe (Poland and Slovakia) and one in Asia (China). Similarly, the Horizon alliance gathers retailers active on separate markets.

[9]Inderst and Shaffer (2007) make similar assumptions.

from the intense competition for slots than they loose from bargaining over a reduced industry profit. Our most striking result is that partial buying groups do not protect the small suppliers from being excluded or from bearing profit losses; they may even be more profitable for retailers than full buying groups.

This article contributes to the growing theoretical literature on buying groups. A large part of the existing literature on buying groups focuses on the rationality of purchasing cooperation between retailers who compete on the downstream market. In such a framework, Caprice and Rey (2015) show that a joint listing decision enhances each retailer's buyer power by increasing its outside option in the negotiation with a supplier: in case of a breakdown in the negotiation, the profit of the retailer decreases less, as its competitors also delist the products of this supplier. We consider instead the incentives of non-competing retailers to form a buying group. Chipty and Snyder (1999) have shown that retailers active on separate markets benefit from buying together when bargaining with a supplier with convex production costs, because it decreases their relative gains from trade with such a supplier (see also Inderst and Wey (2003) and Jeon and Menicucci (2019)). The most closely related paper is Inderst and Shaffer (2007), which analyzes the impact of a cross-border merger between two single product retailers active in two separated markets with different consumer preferences. They show that the merger can enhance the retailers buyer power when they commit to a single sourcing strategy. This creates inefficiency in one market because of the reduction of the overall product variety.[10] Building on the vertical contracting process developed by Chambolle and Molina (2019), we extend the framework of Inderst and Shaffer (2007) to multi-product suppliers and retailers. This multi-product setting allows us to consider different types of buying alliances that differ in their scope, and to analyze their effects on different types of suppliers (single- or multi-products). We also depart from their analysis by highlighting possible inefficiencies of the alliance in the two markets.

Our model clearly leaves aside product reasons for buying groups to be welfare enhancing, such as the reduction of double marginalization, investment incentives, or synergies leading to cost reduction that may be passed through to consumers (see, for instance, Inderst and Wey (2007)). A recent empirical analysis by Molina (2019) confirms that buying groups may lead to a decrease in retail prices through a countervailing power mechanism. We also do not consider possible pro-collusive effects of buying groups. Piccolo and Miklós-Thal (2012) and Doyle and Han (2014) show that buying groups agreements can improve retailers' ability to sustain collusive retail prices, by coordinating on high wholesale prices and using back margin payments.[11] Here we consider retailers active on separate markets

[10] See also Dana Jr (2012) in a setting with downstream competition.

[11] These pro-collusive aspects of buying groups have been identified by competition authorities. For instance, section 5 of the above-mentioned Guidelines states that joint purchasing arrangements may lead to a collusive outcome if they facilitate the coordination of the parties' behavior on the selling market (see, *e.g.*, par. 201 and 213).

to abstract from the effects of buying alliances on retail competition.

This paper is also related to the literature on endogenous network formation in vertically related markets. Marx and Shaffer (2010) show that retailers can strategically use capacity constraints in order to increase their buyer power towards suppliers.[12] In the same vein, Ho and Lee (2019) develop a bargaining procedure called "Nash-in-Nash with threat of replacement" to explain the hospital network reduction of American health insurers by profit extraction motives. Rey and Vergé (2017) and Nocke and Rey (2018)) also endogenize the retail network in more complex vertical structure with both upstream and downstream competition and show that, absent any capacity constraint, in equilibrium not all products are sold at all retailers, which harms consumer surplus and welfare.

The article is organized as follows. Section 2. presents the main insights of our results in a streamlined example. Section 3. presents the setup and notations. Section 4. derives the equilibrium outcomes in the three cases : No buying group, partial buying group, and full buying group. Section 5. endogenizes the retailers decision to form a buying group and analyzes the effects of these buying groups on the sharing of profits in the industry, on product variety, and on welfare. Section 6. concludes.

2. A simple example

Let us first build a toy model to present the intuitions underlying our main results. We leave the discussions of our assumptions to the next section.

Consider two separated markets (*i.e.* markets 1 and 2) in which respective retailers (*i.e.* retailers r_1 and r_2) are monopolists. On each market i, retailer r_i can sell at most two products among three available (*i.e.* A, B and C). While products A and C are supplied by a large supplier l in the two markets, product B is supplied on each market i by a small, local supplier s_i. We assume that products are independent, hence the industry profit generated with an assortment of two products is the sum of industry profits generated by each product separately. In market 1 the industry profit generated by each product are: $\Pi_1^A = 8$, $\Pi_1^B = 6$, $\Pi_1^C = 4$. In market 2, the industry profit generated by products A and C are reversed and that of product B is unchanged: $\Pi_2^A = 4$, $\Pi_2^B = 6$ and $\Pi_2^C = 8$.

Contracting between suppliers and retailers follows a two-stage process. First, suppliers compete in slotting fees paid to the retailers to ensure the listing of their products, and each retailer then selects its assortment. The retailer then engages with each selected supplier in an efficient negotiation, in which the bilateral profit is shared equally (since the products are independent, the marginal contribution of a product to the industry profit is not affected by the assortment). Consequently, the profit of r_i is the sum of its bargaining profit and possible slotting fees paid by the selected suppliers.

[12] Montez (2007) shows the same mechanism within a vertical structure in which a producer may strategically restrict its production capacity to increase its bargaining power towards retailers.

We compare the equilibrium assortments and profits when the two retailers are independent and when they form a partial buying group. With a partial buying group, the two retailers make a joint listing decision with respect to the large supplier's product(s).

No buying group Retailers make their listing decision independently and thus we can focus in market 1, say, the other being symmetric. Retailer r_1 chooses between assortments AB, AC and BC. Without slotting-fees, r_1 would prefer to list the assortment AB, which leaves it the larger bargaining profit $\frac{\Pi_1^A+\Pi_1^B}{2} = 7$. However, the large supplier is willing to pay a slotting fee to enforce the assortment AC: it is ready to pay up to its bargaining profit on product C, that is, 2. To avoid the threat of being replaced by product C, the small supplier also wishes to pay a slotting fee up to its bargaining profit 3. In equilibrium, the small supplier's maximum bid is more attractive, as $\frac{\Pi^A+\Pi^B}{2}+3 > \frac{\Pi_1^A+\Pi_1^C}{2}+2$; hence it wins this competition stage by matching the large supplier's best offer with a fee of 1. In market 1 the equilibrium assortment is thus AB, the small supplier receives 2, the large supplier 2, and the retailer 8. By symmetry, in market 2, the assortment is BC instead of AB and firms make the same profit.

Partial buying group Retailers make their listing decision jointly, *i.e.* to maximize the sum of their profits. Such a joint listing decision only concerns the products offered by the large supplier (*i.e.* products A and C). An immediate consequence is that the efficient assortment with AB and BC respectively listed in markets 1 and 2 is no longer available. For simplicity we focus on competition between assortments AB and AC (AB and BC being symmetric); they both leave the retailers the same joint bargaining profit 12. Assume first that if suppliers do not offer slotting fee, AB is selected. The large supplier is then ready to pay a slotting fee up to 6 to enforce the listing of AC. This amount exceeds its willingness to pay in the case without buying group (that was equal to 4), as product C generates more profit in market 2. Hence in equilibrium each small supplier dissipates all its profit and offers 3 to match the offer of the large supplier and secure the listing of its product. If instead firms anticipate the listing AC, the small suppliers offer 6 to promote the listing of B and the large supplier must pay a slotting fee 6 to avoid one of its products being replaced. With a partial buying group, retailers are indifferent between all assortments. They manage to extract a joint profit of 18, which is larger than 16 the sum of their profits without buying groups. All suppliers are hurt. The small suppliers receive zero, that is a total profit loss of 4, whether they are selected or excluded. The large supplier incurs a profit loss of 2, which is captured by the retailers. The total surplus destroyed is 4.

Full buying group Retailers make their listing decision jointly over all products: when they list either AB or BC in both markets, they must purchase from the same small supplier which incurs an export cost 2. Again, the two assortments AB and AC on the two markets generate the joint bargaining profits for the retailer, that is, 12. Again, the large supplier is ready to pay up to 6 to foster the assortment AC, while the small

suppliers compete for the procurement of product B: each of them is thus willing to pay up to $6-2$. The equilibrium assortment is then AC, the large supplier pays a fee 4, the retailers' joint profit is 16: the full buying group leaves the retailers the same profit they obtain without buying group but all suppliers are hurt. Compared to the situation without buying groups, the large suppliers incur a profit loss of 2, and the small are excluded and loose 4. The total surplus destroyed is 6.

In this example, a partial buying group is profitable whereas a full is not. Therefore restricting the scope of buying group to the decision regarding the large supplier does neither constrain the retailer's decision nor protect any supplier.

3. The model

We consider two separate markets $i \in \{1,2\}$, and in each of these markets three active firms r_i, s_i and l. In market i, r_i is a monopolist retailer with a constrained stocking capacity: its shelf space consists of two indivisible slots, hence it can sell at most two products.[13] The suppliers produce three varieties of differentiated products at a constant per unit production cost.[14] Supplier l is a "large supplier" who carries two differentiated products A and C, which it can sell in the two markets through retailers r_1 and r_2. Each supplier s_i is a "small supplier" who carries one product, B. For the sake of simplicity, we assume that s_1 and s_2 supply perfectly substitute products. This assumption can reflect for instance the fact that a small supplier's product is sold under the retailer's own brand. In contrast with the large supplier who features a multinational company able to offer its products indifferently in the two markets, we assume that small suppliers incur an export cost if they wish to offer their product on the foreign market: supplier s_i incurs a fixed cost $E \geq 0$ to sell in market $j \neq i$.[15]

Industry profits To keep things simple, we adopt a reduced-form model of industry profits. We define the maximum industry profit for a given product assortment in market i, that is the profit made by an integrated monopolist on that market. In each market a product is positioned according to the maximum industry profit it generates: H for "High", M for "Medium" and L for "Low". Formally, Π^{a_i} denotes this industry profit

[13] There is empirical evidence that retailers' capacity constraints lead them to sell a limited number of references. Marx and Shaffer (2010) state that "the typical supermarket carries less than 30,000 products, and yet, at any given time, there may be over 100,000 products from which to choose. To help supermarket retailers decide which products to carry, it has become common in recent years for them to put at least some of their shelf space up for bid and let manufacturers compete for their patronage." Both theoretical (e.g. Marx and Shaffer (2010), Chambolle and Molina (2019)) and empirical articles (Ho and Lee (2019)) highlight that it may be profitable for retailers to strategically restrict their capacity in order to gain buyer power.

[14] We rule out any externality of production among products and markets, *e.g.* economies of scale or scope.

[15] We follow Melitz (2003) and model the export cost as a fixed cost.

where $a_i \in \mathcal{A} \equiv \{H, M, L, HM, HL, ML\}$ denotes the assortment sold in market i and (a_1, a_2) denotes the assortment chosen in markets 1 and 2. The ranking of products A, B and C according to their profitability differs across markets. Such heterogeneity may come from differences in consumer preferences or in production costs.[16] For instance, product A may generate Π^H in market 1 and Π^M in market 2.

We make the following assumption on industry profits:

Assumption 1.

$$\Pi^H > \Pi^M > \Pi^L \geq 0$$
$$\Pi^{HM} > \Pi^{HL} > \Pi^{ML}$$

From the industry perspective, HM is thus the "efficient" assortment in a country.[17]

Products can be either imperfect substitutes or independent, hence any assortment of two products does not yield more profit than the sum of profits generated by each product:

Assumption 2. *For all X and Y in the subset $\{H, M, L\}$ and $\Pi^X > \Pi^Y$:*

$$\Pi^X + \Pi^Y \geq \Pi^{XY} > \Pi^X$$

We also assume that product M contributes more to industry profit when associated to product L than when associated to product H.

Assumption 3.

$$\Pi^{ML} - \Pi^L \geq \Pi^{HM} - \Pi^H$$

Assumption 3 ensures that we obtain a unique equilibrium outcome. We make this assumption for the sake of simplicity, and it is satisfied for a wide range of standard horizontal differentiation setups, for instance in a Shaked and Sutton (1983) model of vertical differentiation (see Chambolle and Molina (2019)), or in the quadratic utility setup we will develop in section 5. (see online Appendix H for a detailed presentation of that setup).

Timing and buying strategies In an *ex ante* stage the retailers must choose among three buying strategies: *no buying group*, *partial buying group*, and *full buying group*. This decision is common knowledge.

Then, for a given buying strategy, we consider the following two stage game.

[16] For instance, Pepsi-Cola (resp. Coca-Cola) is the favorite cola brand in the US (resp. EU). We follow Inderst and Shaffer (2007) who assume that consumers located in different regions/ countries differ in their preferences.

[17] Assumption 1 also ensures efficiency for consumers for usual demand functions (see section 5.).

- **Stage 1**: The suppliers compete in slotting fees to ensure the listing of their products. The small supplier offers a unique slotting fee to have its product B listed. The large supplier offers a menu of slotting fees to have either A only, C only or A and C listed. Accepting a slotting fee creates a commitment to listing the corresponding products for the retailer. Each retailer can list at most two products and the listing decision is publicly observed.[18]

- **Stage 2:** Each retailer r_i engages in a bilateral negotiation with the supplier(s) of the products listed. Negotiations are simultaneous, contracts are secret and consist of fixed fee(s) $F_{k,i}^{a_i}$, where $k \in \{l, s_1, s_2\}$ denotes the supplier involved in the bargaining and $a_i \in \mathcal{A}$ the product assortment. Stage 2 is independent of the retailers' buying strategy.

We explicitely assume that the slotting fees offered in stage 1 cannot be conditional on the assortment offered by the retailer. This assumption is in line with antitrust law: such a contract would be likely to be considered as exclusionary. Note that, as in a Bertrand competition model with asymmetric costs, the competition for slots in stage 1 has a multiplicity of Nash equilibria. To select among these equilibria, we rely on Selten's (1975) concept of trembling hand perfection.

The buying strategies have the following distinctive features:

- *No buying group*: The supplier l offers each retailer r_i a menu of slotting fees $(S_{l,i}^A, S_{l,i}^C, S_{l,i}^{AC})$ to have respectively A only, C only, or both A and C listed by r_i; small suppliers s_1 and s_2 offer respectively slotting fee $S_{s_1,i}^B$ and $S_{s_2,i}^B$ to have product B listed by r_i. Each retailer chooses independently which product to list, and receives the corresponding slotting fee(s).

- *Partial buying group*: The supplier l offers a single menu $S_l = (S_l^A, S_l^C, S_l^{AC})$ to have its product(s) listed in the two markets by the partial buying group; small supplier s_1 and s_2 offer respectively a slotting fee $S_{s_1,i}^B$ and $S_{s_2,i}^B$. Retailers make a joint listing decision on the large supplier's product(s) and the buying group receives the corresponding slotting fees, but they continue to list independently small suppliers' products and they receive individually the corresponding slotting fee(s).

- *Full buying group*: The supplier l offers a single menu $S_l = (S_l^A, S_l^C, S_l^{AC})$ to have its product(s) listed in the two markets by the full buying group; each small supplier s_i offers a single slotting fee $S_{s_i}^B$ to be listed in the two markets by the full buying group. Retailers make a joint listing decision over the whole product line (large and

[18] Once it accepts a slotting fee from a supplier, the retailer is committed to entering into the Stage-2 negotiation process with this supplier but is not tied to sell the product. Note also that a retailer can list a product without accepting the slotting fee.

small suppliers' products), and the buying group receives the corresponding slotting fee(s).

As by assumption small suppliers are perfect substitutes (they offer the same product B), at most one small supplier is listed on each market, hence a retailer cannot select the two of them.

When a buying alliance is formed, we assume that the buying group is a common entity that collects slotting fees and redistributes them among its participants. We do not explicitly model the redistribution process, but we assume that the decision is efficient: the alliance strategy maximizing the joint profit is implemented in equilibrium. As the buying strategy only affects the listing decision stage, we are close to Caprice and Rey (2015) who also assume that within a buying group, downstream firms make common listing decisions,[19] but keep negotiating secretly and bilaterally with their suppliers. This assumption contrasts with the setup of Inderst and Shaffer (2007), who focus on cross border mergers and thus assume that once merged, the retailers enter in a joint bargaining with their suppliers. Our setup is thus closer to the case of buying groups, who commonly adopt a two-stage timing of negotiations with their suppliers: the suppliers must first pay a slotting fee to launch commercial negotiation with the buying group, before negotiating individually with all members at national level. Trade press releases suggest that when this fee is not paid, retaliations in the form of collective de-listings at national level are to be expected.[20]

Equilibrium concept In Stage 2 of the game, we use a bargaining protocol à la Horn and Wolinsky (1988) commonly referred to as the "Nash-in-Nash" bargaining protocol (see Collard-Wexler et al. (2019)). This equilibrium concept is an extension of the contract equilibrium concept developed in Crémer and Riordan (1987) (see also Allain and Chambolle (2011)). This bargaining protocol assumes that negotiations are simultaneous, that firms are schyzophrenic and that they form passive beliefs about others' negotiations.[21] We denote by α (resp. $(1-\alpha)$) the exogenous bargaining weight of the retailer (resp. supplier).

This Nash-in-Nash bargaining takes place in Stage 2 within the selected network of suppliers previously determined in Stage 1. As in Stage 1 all suppliers compete for a

[19] More precisely, Caprice and Rey (2015) assume that any retailer can veto the offer of a supplier for all the members of the buying group.

[20] See for instance the example of the negotiations between Nestlé and the buying group Agecore: reuters.com link. See also contributions by professionals at the European Commission DG Agri Workshop on Retail Alliances, *e.g.* europa.eu link.

[21] Schizophrenia here means that, when negotiating simultaneously with two partners, a firm delegates a different negotiator for each partner, each negotiator ignoring the outcome of other ongoing negotiations. Passive beliefs means that, when bargaining, a given pair of firms does not change its beliefs about the outcome of other pairs' negotiations when receiving an out-of-equilibrium offer (McAfee and Schwartz (1994)).

restricted number of slots, our setting enables products that are not sold in equilibrium to affect the equilibrium profits. Yet, the total profit obtained by a retailer comes from both the contracts negotiated in the bargaining and the slotting fees offered by suppliers. We follow the timing proposed by Chambolle and Molina (2019) who show that the outcome of this two-stage game coincides with that of a one-stage Nash-in-Nash bargaining with outside option, or to the Nash-in-Nash bargaining with threat of replacement equilibrium concept developed by Ho and Lee (2019).[22] In our approach the outside option assortment of the retailer is to replace one of the products listed in equilibrium by the non-listed product that competes for slots in Stage 1; we may also refer for simplicity to this outside option assortment as the second best assortment of the retailer. The non-listed supplier is ready to offer all the surplus generated by the relationship if it were listed, *i.e.* if the outside option assortment were selected by the retailer. If equilibrium slotting fees are zero, the equilibrium profit sharing among the retailer and its selected suppliers is the outcome of the Nash-in-Nash bargaining. In contrast, when equilibrium slotting fees are positive, that is when the outside option is binding, it affects the profit sharing.

Bilateral efficiency Stage 2 involves bargaining over a fixed fee. First, we rule out linear tariffs, as these inefficient tariffs create a source of efficiencies for the buying groups through the increase in buyer power, which we want to exclude from our model (see for instance Dobson and Waterson (1997), Chipty and Snyder (1999) and von Ungern-Sternberg (1996)). Furthermore, Stage 2 is itself a short version of a two-stage-game in which (i) firms would instead bargain over a two-part-tariff contract (w, F) and (ii) the retailer would choose quantities or prices maximizing its profit given this contract. Indeed, bilateral efficiency, i.e., cost-based wholesale contracts, always prevails in our vertical structure with a downstream monopoly on each separated market. Indeed, as shown by, *e.g.*, Bernheim and Whinston (1985) or O'Brien and Shaffer (2005), competing upstream suppliers internalize the competition between their products through their common monopolist retailer and therefore maximize the industry profit irrespective of the distribution of bargaining power in the vertical chain.[23] Such a result implies that, when selling an assortment a_i, r_i always chooses prices or quantities that maximize the integrated industry profit previously defined by Π^{a_i} and the fixed fee F simply shares the integrated profit among them. Based on this result, we consider a single stage (Stage 2) in which each supplier-retailer pair bargains over a fixed fee to share the integrated industry profit.

In our model the heterogeneity of product positioning among the two markets plays a key role. In section 4., we solve the model under the following assumption:

[22] See also Manea (2018) and Ho and Lee (2019) who provide non cooperative microfoundations for the Nash-in Nash bargaining with outside option equilibrium concept when these outside options are to deal with rival partners.

[23] This efficiency result would also hold under public contracts.

Assumption 4.

- *$B \equiv M$ in both markets.*
- *$A \equiv H$ and $C \equiv L$ in market 1.*
- *$C \equiv H$ and $A \equiv L$ in market 2.*

An extensive discussion of the robustness of our results to a change in this ranking, for all possible combinations of product positioning, is available online.[24]

4. Equilibrium outcomes for each buying strategy

In this section, we determine the equilibrium outcomes, *i.e.* the equilibrium assortment and firm's profits, under each buying strategy. We thus solve the two-stage game under each possible buying strategy (no buying group, partial or full buying group) under the assumptions 1-4.

4.1. Bargaining outcomes

The stage-2 continuation equilibria on each market i depend only on the listing decisions of the retailer –that are public at this stage–, irrespective of the buying strategies. Regardless of the assortment, suppliers have a zero status-quo profit.[25] We denote by $\pi_{k,i}^{a_i}$, where $k \in \{l, s_1, s_2, r_i\}$, the gross profit (*i.e.* gross of slotting fees and of export costs) obtained in market i by firm k active in a negotiation for assortment a_i.

If the assortment HL is listed, then the retailer bargains with a unique supplier. Each of the negotiator has a zero status-quo profit, hence the joint profit is split according to the Nash bargaining weight: The retailer receives $\pi_{r_i,i}^{HL} = \alpha \Pi^{HL}$, while the large supplier receives $\pi_{l,i}^{HL} = (1-\alpha)\Pi^{HL}$.

If by contrast the assortment is XM (with $X \in \{H, L\}$), then the retailer benefits from a positive status-quo profit in its negotiation with each supplier; equilibrium profits are then as follows:

$$\begin{aligned}
\pi_{r_i,i}^{XM} &= \alpha \Pi^{XM} + (1-\alpha)(\Pi^X + \Pi^M - \Pi^{XM}) \\
\pi_{l,i}^{XM} &= (1-\alpha)(\Pi^{XM} - \Pi^M) \\
\pi_{s_i,i}^{XM} &= (1-\alpha)(\Pi^{XM} - \Pi^X)
\end{aligned}$$

In online Appendix A we consider in turn all potential assortment decisions. Comparing the equilibrium profits yields the following lemma.

[24] See Section 5 of Allain et al. (2020).

[25] This derives from the absence of economies of scale and economy of scope that ensures the profit the large supplier obtains in the two markets are independent.

Lemma 1. *Under Assumptions 1-4, firms' gross profits can be ranked as follows:*

$$\pi_{r_i,i}^{HM} \geq \max\{\pi_{r_i,i}^{HL}, \pi_{r_i,i}^{ML}\}, \text{ and } \min\{\pi_{r_i,i}^{HL}, \pi_{r_i,i}^{ML}\} \geq \pi_{r_i,i}^{H} \geq \pi_{r_i,i}^{M} \geq \pi_{r_i,i}^{L} \geq 0$$
$$\pi_{l,i}^{HL} \geq \pi_{l,i}^{H} \geq \max\{\pi_{l,i}^{HM}, \pi_{l,i}^{L}\}, \text{ and } \min\{\pi_{l,i}^{HM}, \pi_{l,i}^{L}\} \geq \pi_{l,i}^{ML} \geq 0$$
$$\pi_{s_i,i}^{M} \geq \pi_{s_i,i}^{ML} > \pi_{s_i,i}^{HM} \geq 0;$$

Proof. We provide a complete proof of lemma 1 in online Appendix A.4. □

Lemma 1 highlights that the gross profit of a retailer is the largest with the efficient assortment HM. The large supplier is better off when it sells its two products, and it benefits more from the sale of product H than from that of product L. Finally, a small supplier earns a larger gross profit when listed with product L rather than when listed with product H.

4.2. Listing decisions

We now solve the stage 1 of the game which depends on the buying strategy chosen by the retailers in the *ex ante* stage. In this stage, the capacity constrained retailer (resp. buying group) makes the listing decision that maximizes its profit (resp. their joint profits), which is the sum of the slotting fees collected and the gross profit(s) obtained in the bargaining stage. First we provide some general properties of the equilibrium listing decision that hold irrespective of the buying strategy (lemma 2). Then for each buying strategy we characterize the listing decisions of the retailers in stage 1.

Lemma 2. *Under Assumptions 1-4, for any buying strategy, (i) on each market, two products are listed – the listing assortment is either HM, HL or ML. (ii) Supplier l has no incentive to pay a positive slotting fee to ensure the listing of one of its products only.*

Proof. We provide a complete proof of lemma 2 in online Appendix B. □

Lemma 2 (i) derives from two properties: first, each retailer's gross profit is larger when it sells two products than when it sells only one (see lemma 1); second, as the menu of slotting fees offered by suppliers is fixed when the retailer makes its listing decisions, listing several suppliers (weakly) increases the amount of slotting fees it receives. Lemma 2 (ii) highlights that whenever the large supplier wishes to place only one of its two products on a retailer's shelves, its incentives are aligned with those of the retailer irrespective of the buying strategy. Therefore the large supplier does not need to pay a positive slotting fee to ensure that product H or L is listed. Henceforth, we simplify the notation and denote by $S_{l,i} \equiv S_{l,i}^{HL}$ the slotting fee offered by supplier l to secure the listing of its two products in market i.

We now consider in turn the equilibrium listing decisions for each of the three buying strategies.

No buying group

Absent buying group, retailers' listing decisions are independent across markets. The large supplier and the small suppliers are in symmetric positions in the two markets: in market 1 (resp. 2) the large supplier offers product A (resp. C) positioned as H and product C (resp. A) positioned as L; on each market the small suppliers offer product B positioned as M. Therefore without loss of generality we solve the game considering the assortments HM, HL, and ML for a given market i, with $i \in \{1, 2\}$.

Product assortment Note first that small suppliers cannot enforce the inefficient assortment ML which maximizes their gross profit, as by assumption, the slotting fees offered by the small suppliers cannot be conditional on the other product listed, and the retailer is always better off with the assortment HM: she receives a larger bargaining profit with the assortment HM (see lemma 1), no slotting fee is offered by l in both cases (see lemma 2).

Hence the suppliers compete in slotting fees to influence the retailer's choice between the three possible assortments: HL or HM, M being possibly supplied by the local or by the foreign small supplier. The large supplier is willing to push for the assortment HL in which it obtains the larger gross profit (see lemma 1). By contrast, the small suppliers are willing to push for being listed. Consider now the suppliers' willingness to pay (that is, the maximum amount they are ready to bid as a slotting fee) to influence the retailer r_i's listing decision.

- The maximum fee the large supplier is willing to pay to impose HL instead of HM is the amount that leaves him indifferent between these two assortments: $\overline{V}_{l,i} \equiv \pi^{HL}_{l,i} - \pi^{HM}_{l,i}$.
- The local small supplier s_i makes no profit in market i if its product is not listed, hence the maximum amount it is ready to pay to be listed is: $\overline{V}_{s_i,i} \equiv \pi^{HM}_{s_i,i}$.
- Similarly, the maximum amount the foreign small supplier s_j is ready to pay to be listed in market i is: $\overline{V}_{s_j,i} \equiv \max\{\pi^{HM}_{s_j,i} - E, 0\}$.

The outcome of the first stage competition process is detailed in the following proposition.

Proposition 1. *Under Assumptions 1-4, absent buying group, the efficient equilibrium assortment HM is offered on each market, and product M is provided by the local small supplier.*

Proof. Competition for the two slots drives the retailer to list the assortment that leaves it the highest profit. Comparing the suppliers' willingness to pay reveals which supplier

can outbid its competitors. Under Assumptions 1-4, in market i we have:

$$\underbrace{\pi^{HM}_{r_i,i} + \overline{V}_{s_i,i}}_{HM\text{, local small supplier}} \geq \max\Big\{ \underbrace{\pi^{HL}_{r_i,i} + \overline{V}_{l,i}}_{HL}, \underbrace{\pi^{HM}_{r_i,i} + \overline{V}_{s_j,i}}_{HM\text{, foreign small supplier}} \Big\} \tag{1.1}$$

Hence, in equilibrium, the efficient assortment HM is chosen and the local small supplier is selected. We provide a complete proof and characterization of the equilibrium profits in online Appendix C. □

Equilibrium slotting fees and profits In equilibrium, the local small supplier may have to pay a positive slotting fee to ensure the listing of its product.

The slotting fee paid by the local small supplier is the minimum non-negative value that outbids the two competing offers, that is, that precludes the threats of replacements from the large supplier, and from the foreign small supplier.

$$\overline{S}_{s_i,i} = \max\{\pi^{HL}_{r_i,i} - \pi^{HM}_{r_i,i} + \overline{V}_{l,i}, \overline{V}_{s_j,i}\} \tag{1.2}$$

These threats of replacement are strengthened when α decreases because suppliers anticipate a higher gross profit in stage 2, and they are willing to compete fiercely to enforce their favorite listing decision. Hence, the equilibrium slotting fee is positive if and only if the retailers' bargaining power is sufficiently low.[26] Whenever the small supplier offers a zero slotting fee, each retailer obtains itsgross profit with the assortment HM. By contrast when the slotting fee is positive, the retailer obtains the profit that leaves itindifferent with the second most profitable offer, the "threat of replacement". The relative profitability of product M (that is, the comparison between $\Pi^{HM} - \Pi^{HL}$ and E) is key to determine the binding threat of replacement: when product M is very profitable, the second best option is to sell the same assortment but buying product M from the foreign supplier (that is, the binding terms in the right-hand side of equation 1.1 is the second term); by contrast, when it is less profitable, the second best option is to sell the two products of the large supplier (assortment HL).

Equilibrium profits are as follows:

$$\overline{\Pi}_{r_i,i} \equiv \pi^{HM}_{r_i,i} + \overline{S}_{s_i,i}, \qquad \overline{\Pi}_{s_i,i} \equiv \pi^{HM}_{s_i,i} - \overline{S}_{s_i,i}, \qquad \overline{\Pi}_{s_j,i} \equiv 0, \qquad \overline{\Pi}_{l,i} \equiv \pi^{HM}_{l,i}$$

Partial buying group

Assume now that retailers r_1 and r_2 have opted for a partial buying-group: they commit to adopting a common listing decision regarding the large supplier's product(s), but keep deciding separately from which of the small suppliers they buy product B if they

[26] Namely, when $\alpha \leq \frac{\max\{\Pi^{HL} - \Pi^{H}, \Pi^{HM} - \Pi^{H} - E\}}{\Pi^{HM} - \Pi^{H}}$).

wish to list it. This implies that the product assortment is the same in both markets: it is either AB, BC, or AC.

The listing decision AB leads to product assortment HM in market 1 and ML in market 2, we denote this assortment by (HM, ML). Similarly, the listing decisions BC and AC respectively result in product assortments (ML, HM) and (HL, HL). As the markets are symmetric, we can focus without loss of generality on the choice between the product assortments (HL, HL) and (HM, ML). In the latter case, each retailer can choose its supplier of product M.

Product assortment Consider first the suppliers' willingness to pay for being listed.

- In market 1, the suppliers' willingness to pay are the same than in the absence of buying group, because the listing decisions are either HM or HL. Again, the large supplier is willing to impose the listing of product L; the maximum amount it is ready to pay for this leaves him indifferent between the assortments HL and HM: $\widehat{V}_{l,1} \equiv \pi_{l,1}^{HL} - \pi_{l,1}^{HM} = \overline{V}_{l,1}$. The small suppliers are ready to offer their whole profit, namely, $\widehat{V}_{s_1,1} \equiv \pi_{s1,1}^{HM} = \overline{V}_{s_1,1}$ and $\widehat{V}_{s_2,1} \equiv \max\{\pi_{s2,1}^{HM} - E, 0\} = \overline{V}_{s_2,1}$.

- In market 2, the two possible assortments are ML or HL. From lemma 1 we know that $\pi_{s_i,2}^{ML} \geq \pi_{s_i,2}^{HM}$ and $\pi_{l,2}^{ML} \leq \pi_{l,2}^{HM}$. The large supplier is now ready to pay up to $\widehat{V}_{l,2} \equiv \pi_{l,2}^{HL} - \pi_{l,2}^{ML} \geq \overline{V}_{l,2}$ to secure the assortment HL, while the local supplier s_2 is ready to pay up to $\widehat{V}_{s_2,2} \equiv \pi_{s2,2}^{ML} \geq \overline{V}_{s_2,2}$ and the foreign supplier s_1 $\widehat{V}_{s_1,2} \equiv \max\{\pi_{s1,2}^{ML} - E, 0\} \geq \overline{V}_{s_1,2}$. As a result, the suppliers are competing more fiercely to impose their favorite assortment with a partial buying group than without buying group.

The competition for slots results in the assortment decision detailed in the following proposition:

Proposition 2. *Under Assumptions 1-4, with a partial buying group, two types of assortments may arise in equilibrium:*

- *When* $\Pi^{HM} + \Pi^{ML} \geq 2\Pi^{HL}$ *the efficient equilibrium assortment* HM *is offered in one market, but the inefficient assortment* ML *is offered in the other market. Product* M *is provided by the local small supplier.*

- *When* $\Pi^{HM} + \Pi^{ML} \leq 2\Pi^{HL}$ *the inefficient equilibrium assortment* HL *is offered in both markets.*

Proof. First, whenever product M is listed, in each market, the local small supplier wins the competition for the slot against the foreign small supplier, because $\widehat{V}_{s_i,i} > \widehat{V}_{s_j,i}$. With a partial buying group, the assortment chosen in equilibrium for the two markets maximizes

the retailers' joint profit under the constraint that they must list the same product(s) from l. Therefore, the buying group chooses to list (HM, ML) if the following condition is satisfied:

$$\underbrace{\pi^{HM}_{r_1,1} + \pi^{ML}_{r_2,2} + \widehat{V}_{s_1,1} + \widehat{V}_{s_2,2}}_{(HM,ML) \text{ with local small suppliers}} \geq \underbrace{\pi^{HL}_{r_1,1} + \pi^{HL}_{r_2,2} + \widehat{V}_{l,1} + \widehat{V}_{l,2}}_{(HL,HL)}$$
$$\Leftrightarrow \quad \Pi^{HM} + \Pi^{ML} \geq 2\Pi^{HL} \tag{1.3}$$

and chooses (HL, HL) otherwise. We provide a complete characterization of the equilibrium in online Appendix D. □

Equilibrium slotting fees and profits We consider now equilibrium slotting fees and profits for each product assortment.

- **Local product M listed:** Whenever $\Pi^{HM}+\Pi^{ML} \geq 2\Pi^{HL}$, in equilibrium the small suppliers s_1 and s_2 are listed in their respective local market because (HM, ML) is more efficient than (HL, HL) for the industry. To ensure the listing of their products, they may have to pay a positive slotting fee, as the buying group decides to list M when the total amount of slotting fees offered by the two small suppliers satisfies the following constraints:

$$\begin{aligned} S_{s_1,1} + S_{s_2,2} &\geq \pi^{HL}_{r_1,1} + \pi^{HL}_{r_2,2} + \widehat{V}_{l,1} + \widehat{V}_{l,2} - \pi^{HM}_{r_1,1} - \pi^{ML}_{r_2,2} \\ S_{s_1,1} &\geq \widehat{V}_{s_2,1} \ (\geq 0) \\ S_{s_2,2} &\geq \widehat{V}_{s_1,2} \ (\geq 0) \end{aligned}$$

  The first constraint ensures that the buying group prefers to list product M, and the other two constraints ensure that, on each market, it is supplied by the local small supplier. As a result, there is a continuum of equilibria, in which the slotting fees jointly preclude the threat of replacement from the large supplier, and individually preclude the threat of replacement by the foreign small suppliers. The sum of the equilibrium fees is characterized as follows:

$$\begin{aligned} \widehat{S}^{ne}_{s_1,1} + \widehat{S}^{ne}_{s_2,2} \equiv \max \{ &\widehat{V}_{l,1} + \widehat{V}_{l,2} + \pi^{HL}_{r_1,1} + \pi^{HL}_{r_2,2} - \pi^{HM}_{r_1,1} - \pi^{ML}_{r_2,2} \ , \ \widehat{V}_{s_2,1} + \widehat{V}_{s_1,2} \} \\ \text{with } \ \pi^{HM}_{s_2,1} - E \leq \widehat{S}^{ne}_{s_1,1} \leq \pi^{HM}_{s_1,1} \ &\text{ and } \ \pi^{ML}_{s_1,2} - E \leq \widehat{S}^{ne}_{s_2,2} \leq \pi^{ML}_{s_2,2}, \end{aligned} \tag{1.4}$$

  where the superscript ne stands for "no exclusion of local supplier M" (that is, in both countries product M is sold and provided by the local supplier).

  Competition for slots leads the local small suppliers to pay slotting fees if and only if

retailer's bargaining power is low.[27] In this case, the retailers are left with the joint profit they would obtain by choosing the second best offer, which is the assortment (HL, HL) if the export cost is high[28], or the assortment (HM, ML) with M offered by at least one foreign supplier when the export cost is low.[29] Equilibrium profits can be written as follows, with $\widehat{\Pi}_r^e$ the aggregated profit of the two retailers and $\widehat{\Pi}_s^{ne}$ the aggregated profit of the two small suppliers:

$$\begin{aligned}
\widehat{\Pi}_r^{ne} &\equiv \widehat{\Pi}_{r_1,1}^{ne} + \widehat{\Pi}_{r_2,2}^{ne} \equiv \pi_{r_1,1}^{HM} + \pi_{r_2,2}^{ML} + \widehat{S}_{s_1,1}^{ne} + \widehat{S}_{s_2,2}^{ne} \\
\widehat{\Pi}_s^{ne} &\equiv \widehat{\Pi}_{s_1,1}^{ne} + \widehat{\Pi}_{s_2,2}^{ne} \equiv \pi_{s_1,1}^{HM} + \pi_{s_2,2}^{ML} - \widehat{S}_{s_1,1}^{ne} - \widehat{S}_{s_2,2}^{ne} \\
\widehat{\Pi}_l^{ne} &\equiv \widehat{\Pi}_{l,1} + \widehat{\Pi}_{l,2} \quad \equiv \pi_{l,1}^{HM} + \pi_{l,2}^{ML}
\end{aligned}$$

- **Product M excluded:** Whenever $\Pi^{HM} + \Pi^{ML} \leq 2\Pi^{HL}$, the retailers list the assortment (HL, HL), because (HL, HL) is more efficient than (HM, ML) for the industry. The large supplier has its two products listed in both markets and pays a positive slotting fee defined as follows:

$$\widehat{S}_l^e \equiv \max\{\pi_{r_1,1}^{HM} + \pi_{r_2,2}^{ML} - \pi_{r_1,1}^{HL} - \pi_{r_2,2}^{HL} + \widehat{V}_{s_1,1} + \widehat{V}_{s_2,2}, 0\}, \tag{1.5}$$

  where the superscript e stands for "exclusion" (that is, the local small supplier is excluded in both countries).

  Competition for slots leads the large supplier to pay a slotting fee if and only if the retailers' bargaining power is low.[30] In this case, the retailers are left with the joint profit they would obtain by choosing instead the assortment (HM, ML) with product M being supplied by the local producer. Equilibrium profits are as follows:

$$\begin{aligned}
\widehat{\Pi}_r^e &\equiv \widehat{\Pi}_{r_1,1}^e + \widehat{\Pi}_{r_2,2}^e \equiv \pi_{r_1,1}^{HL} + \pi_{r_2,2}^{HL} + \widehat{S}_l^e \\
\widehat{\Pi}_s^e &\equiv \widehat{\Pi}_{s_1,1}^e + \widehat{\Pi}_{s_2,2}^{ne} \equiv 0 \\
\widehat{\Pi}_l^e &\equiv \widehat{\Pi}_{l,1} + \widehat{\Pi}_{l,2} \quad \equiv \pi_{l,1}^{HL} + \pi_{l,2}^{HL} - \widehat{S}_l^e
\end{aligned}$$

Profitability of a partial buying group We now analyze whether it is profitable for retailers to create a partial buying group. A first remark that directly derives from

[27] Namely, *i.e.* $\alpha \leq \widehat{\alpha}^{ne} \equiv \max\{1 - \frac{E}{\Pi^{ML} - \Pi^L}, \frac{2\Pi^{HL} - \Pi^H - \Pi^L}{\Pi^{HM} - \Pi^H + \Pi^{ML} - \Pi^L}\}$. Indeed, if $\alpha \geq 1 - \frac{E}{\Pi^{ML} - \Pi^L}$, no positive fee is necessary to overcome the threat of replacement by the foreign local supplier. Similarly, if $\alpha \geq \frac{2\Pi^{HL} - \Pi^H - \Pi^L}{\Pi^{HM} - \Pi^H + \Pi^{ML} - \Pi^L}$, no positive fee is necessary to overcome the threat of replacement by the large supplier.

[28] *i.e.* $E > \max\{\frac{\Pi^{HM} + \Pi^{ML} - 2\Pi^{HL}}{2}, (1-\alpha)\Pi^{HM} + \alpha\Pi^H + \Pi^{ML} - 2\Pi^{HL}\}$

[29] The foreign small supplier is more threatening on the market in which ML is offered than in market where HM is offered, because the small supplier's profit is higher in the assortment ML. When the export cost decreases, both threats of importation become credible.

[30] Namely, *i.e.* $\alpha \leq \alpha^e \equiv \frac{2\Pi^M}{2\Pi^{HL} - \Pi^{HM} - \Pi^{ML} + 2\Pi^M}$

lemma 1 and Propositions 1 and 2 is that a partial buying group cannot be profitable without slotting fees. Indeed, in the absence of buying group, Proposition 1 shows that the efficient assortment HM is offered on each market. In contrast, Proposition 2 shows that the creation of a partial buying group leads to an inefficient assortment on at least one market. Hence from Lemma 1, in the absence of slotting fees, the creation of a partial buying group can only decrease the retailers' joint profits.

Second, we have seen that, for both types of equilibrium, slotting fees are positive if and only if the bargaining power of retailers is low enough. We thus obtain the following proposition:

Proposition 3. *A partial buying group is profitable for the retailers when they have a low bargaining power, the export cost is high, and the profitability of product M is not too close to that of H or L.*

Proof. We provide a complete proof in online Appendix D.2. □

Intuitively, the commitment on a joint listing decision regarding the products of the large supplier reinforces the competition for slots and therefore enables the retailers to capture a larger share of smaller total profit through higher slotting fees. As mentioned above, by creating a partial buying group, the retailers commit to not offering the efficient assortment (HM, HM). Suppliers thus compete to enforce their favorite product assortment between (HM, ML) and (HL, HL). If the small suppliers manage to have their products listed, the assortment is (HM, ML). As, from lemma 1, the gross profit of the small supplier is larger when the assortment is ML than when it is HM, one small supplier has the same gross profit than in the absence of buying group, while the other is better off: the total willingness to pay of the small suppliers to have their products listed is thus larger than in the absence of buying group. By contrast, the large supplier is worse off with the assortment (HM, ML) than with the assortment (HM, HM), so it is willing to pay more to avoid this assortment and secure (HL, HL). Competition for slots is therefore fiercer than in the absence of buying groups. Although the retailers' joint gross profit is lower, this increased competition leads to higher slotting fees in both types of equilibria (HM, ML) or (HL, HL) and may thus be profitable for retailers when their bargaining power is low as the weight of the slotting fee in their profit is then larger. This result displays common features with Inderst and Shaffer (2007), who find that a cross-border merger among retailers resulting in a commitment to a common sourcing strategy increases retailers profits; However, in their paper, it is through their bargaining with suppliers that the share of the industry profit the retailers are able to capture increases.

Consider now the role of the export cost on the profitability of partial buying groups. First, note that the partial buying group is never profitable when the threat of replacement comes from the foreign small supplier – this happens when the profitability of product M

is relatively large compared to the export cost E. Indeed, creating a partial buying group does not enable the retailers to increase competition between the local and the foreign small suppliers. To see that, suppose that the threat of replacement with a partial buying group is the importation of product M from a foreign small supplier. In that case, it is also the threat of replacement in the absence of buying group.[31] In equilibrium the local small supplier earns the same profit E with and without a partial buying group. By contrast, by creating a partial buying group, the retailers reduce the profit they leave to the large supplier: they save $(1-\alpha)(\Pi^{HM}-\Pi^{ML})$. However, the joint profit drops by $(\Pi^{HM}-\Pi^{ML})$, hence the net profit of the retailers also drops, and the partial buying group is not profitable. By contrast, when the slotting fee is determined by the competition between the local small supplier and the large supplier, then the creation of a partial buying group enables the retailers to strengthen that competition and to improve their profits.

More insight can be derived from Figure 1.1 which illustrates Proposition 2 with a numerical example that relies on the demand specification of Singh and Vives (1984): a representative consumer has a valuation for imperfect substitutes products $X \in \{H, M, L\}$ of respective weights $\{h, m, l\}$, which can be interpreted as a quality index (the full setup is presented in online Appendix H).[32] Figure 1.1 displays the areas in which a partial buying group is profitable for the retailers. On the horizontal axis, the bargaining power parameter α goes from zero to 1; on the vertical axis, the quality parameter m goes from l to h. A partial buying group is profitable in the blue areas, and not profitable in the white ones. The hatching indicates the nature of the threat of replacement in equilibrium (binding constraint): horizontal hatching signals that the threat of replacement comes from a local supplier (from M in the equilibrium with exclusion (HL, HL), and from L or H in the equilibrium with no exclusion, (HM, ML)), while vertical hatching signals that the threat comes from the foreign small supplier.

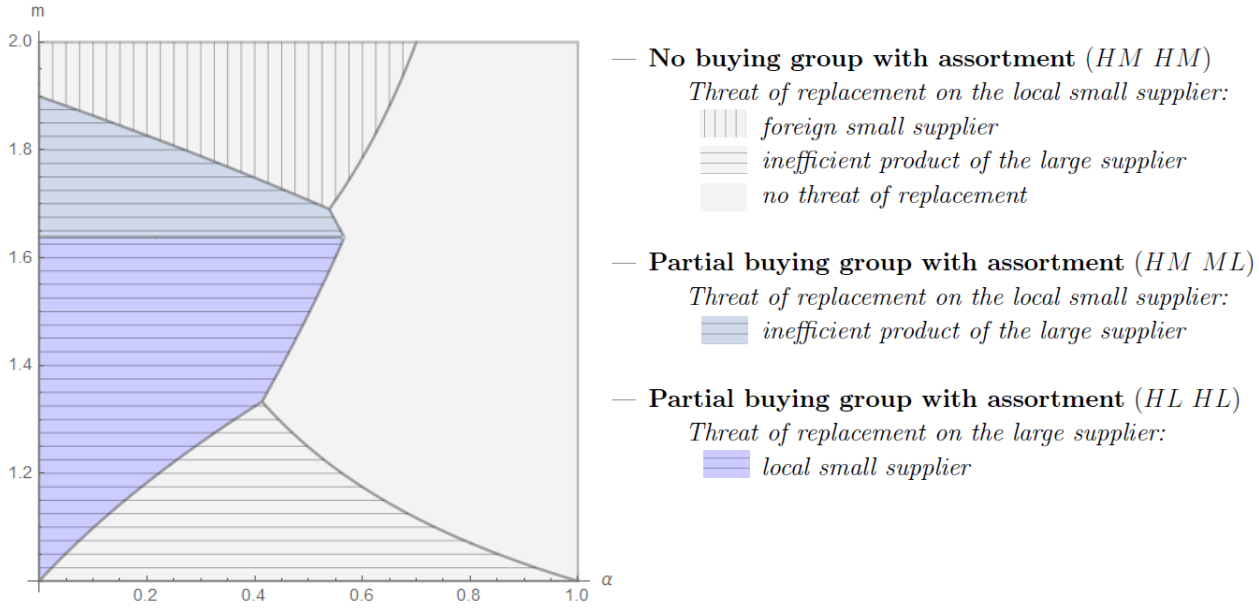
As predicted by Proposition 3, we observe that a partial buying group is profitable for relatively low values of α. Furthermore, the dark blue area represents the equilibrium with exclusion of small suppliers, whereas the light blue area represents the equilibrium with local small suppliers. The horizontal frontier $(\Pi^{HM}+\Pi^{HL}=2\Pi^{HL})$ is the limit between the two equilibria: exclusion arises only when the quality index of product M is relatively low. Finally, we can see that the export cost directly affects the upper frontier between the light blue area, in which a partial buying group is profitable and leads to an equilibrium without exclusion, and the grey area, in which a partial buying group is not profitable. The vertical hatching indicates that, in the latter, the threat of replacement

[31] See the complete characterization of equilibrium absent buying group and with a partial buying group in online Appendix C and D.

[32] We set $h=2$, $l=1$ $m \in [1,2]$ and $a \in [0;0.5]$; this calibration satisfies the assumptions 1-4 of the model. Equilibrium computations for the numerical example are available upon request.

comes from the foreign small supplier. When the quality index m is relatively high, the slotting fees that the small local supplier pays in equilibrium with a partial buying group is determined by the offer of the foreign small supplier. Therefore creating a partial buying group, which raises the slotting fee offered by l, has no effect on the slotting fee offered by the small local supplier: the buying group is not profitable. When the export cost decreases, the light blue area shrinks. In contrast, when the export cost is much higher, a partial buying group may be profitable even for larger values of m (when M and H are closer).

Figure 1.1: Profitability of a partial buying group



(a) Application with $E = 0.2$ and $a = 0.2$

Effect of a partial buying group on supplier's profits

Proposition 4. *When it is profitable, a partial buying group always (weakly) reduces the large and the small suppliers' profit.*

Proof. A complete proof is provided in online Appendix D.3. □

As a partial buying group leads to an inefficient equilibrium assortment when it is profitable, the suppliers' aggregated profit is negatively affected. Interestingly, although the small suppliers are out of the scope of such a buying group, both the large supplier's profit and the small suppliers' aggregated profit decrease. When the partial buying group leads to the assortment (HL, HL), small suppliers are excluded and the large supplier bears the loss of industry profit as it must pay a high slotting fee. When the assortment is (HM, ML), the large supplier does not pay a fee but its profit decreases because its bargaining position is weaker in the market, in which it sells product L. For the small

suppliers, two countervailing effects are operating. On the one hand, the assortment ML yields a higher gross profit in one of the markets, but on the other hand the increased competition for slots leads to higher slotting fees, and the latter effect dominates the former.[33]

Full buying group

Assume now that retailers r_1 and r_2 have opted for a full buying-group. This alliance strategy implies that the two retailers commit to listing the same two products in both markets. More precisely, if the retailers choose to list product B, they commit to selecting one of the two small suppliers to supply both markets, which generates a fixed export cost E for the selected small supplier.[34] Again, three types of listing decisions may arise in equilibrium, AB, BC or AC in both markets, hence we can restrict the analysis to the the buying group's choice between the assortments (HM, ML) and (HL, HL) without loss of generality.

Product assortment As with a partial buying group, the outcome of the competition for slots depends on the suppliers' willingness to pay to influence the retailers' listing decision. The candidate product assortments are the same than with a partial buying group, hence suppliers' willingness to pay to have their favorite listing decision are unchanged. The small supplier i is willing to pay up to $\widetilde{V}_{s_i,i} = \widehat{V}_{s_i,i}$ to ensure the listing of its product in market i and $\widetilde{V}_{s_i,j} = \widehat{V}_{s_i,j}$ in market j. Similarly, the large supplier is willing to pay $\widetilde{V}_{l,i} = \widehat{V}_{l,i}$ to ensure the listing of its product and the assortment (HL, HL).[35] The important change brought out by the full buying group, as compared to partial buying group, is that a symmetric Bertrand competition now arises between the two small suppliers. Indeed, they are perfectly symmetric in their ability to serve the two markets. Therefore in equilibrium the choice between (HM, ML) and (HL, HL) directly depends on the export cost, and we obtain the following proposition:

Proposition 5. *Under Assumption 1-4, with a full buying group two types of assortments may arise in equilibrium:*

- *When* $\Pi^{HM} + \Pi^{ML} - E \geq 2\Pi^{HL}$ *the efficient equilibrium assortment* HM *is offered on one market, but the inefficient assortment* ML *is offered on the other market. Product* M *is offered by a unique small supplier bearing an export cost* E*.*

[33] Note that, as there is then a continuum of equilibria, in which only the sum of slotting fees is fixed, one small supplier may obtain a larger profit than absent buying group. However, in this case the other supports a larger profit reduction.

[34] Note that buying groups often argue that, by doing so, they facilitate the access of small suppliers to foreign markets – See for instance the above mentioned quotes by Carrefour and Horizon in footnotes 6 and 7. Our results are qualitatively robust when we assume that a full buying group enables a small producer to access both markets, by reducing the export cost of SMEs (for instance through the help of a well established retail network) - see Allain et al. (2020).

[35] We report the complete proof in online Appendix E.

- *When* $\Pi^{HM}+\Pi^{ML}-E \leq 2\Pi^{HL}$ *the inefficient equilibrium assortment* HL *is offered in both markets.*

Proof. With a full buying group, when product M is listed, the same small supplier serves the two markets. The assortment chosen in equilibrium is the one that leaves the highest joint profit to the retailers. Hence the listing decision is (HM, ML) if the following condition is satisfied:

$$\underbrace{\pi^{HM}_{r_1,1}+\pi^{ML}_{r_2,2}+\widetilde{V}_{s_1,1}+\widetilde{V}_{s_1,2}}_{(HM,ML)\text{ with a unique small supplier}} \geq \underbrace{\pi^{HL}_{r_1,1}+\pi^{HL}_{r_2,2}+\widetilde{V}_{l,1}+\widetilde{V}_{l,2}}_{(HL,HL)}$$
$$\Leftrightarrow \ \Pi^{HM}+\Pi^{ML}-E \geq 2\Pi^{HL}, \tag{1.6}$$

and (HL, HL) otherwise.

We provide a complete characterization of the equilibrium with full buying group in online Appendix E. □

The equilibrium assortment is thus the same with a partial and with a full buying group. However, competition between the two small suppliers plays out differently in the two cases, and this affects the sharing of profits between the firms.

Equilibrium slotting fees and profits Consider now the slotting fees paid by the suppliers in the two possible equilibrium configurations.

- **Product M listed:** Whenever $\Pi^{HM}+\Pi^{ML}-E \geq 2\Pi^{HL}$, in equilibrium the retailers list the assortment (HM, ML) and a unique small supplier is chosen to supply the two markets. In equilibrium, the two small suppliers compete in a symmetric Bertrand game to be listed, and each of them offers a slotting fees that dissipate its total profit in the two markets:

$$\widetilde{S}^{pe}_{s_i} \equiv \widetilde{V}_{s_i,1}+\widetilde{V}_{s_i,2}, \tag{1.7}$$

  where the superscript *pe* stands for partial exclusion (exclusion of the local supplier in one country). Note that these fees are higher than with a partial buying group. Under Assumptions 1-4, this fee is positive when retailers bargaining power is not too large as compared to the export cost.[36]

  In this equilibrium the retailers' joint profit amounts to the profit they would obtain with the second best offer, that is the assortment (HM, ML) if M were offered by the rival small supplier (*i.e.* $\pi^{HM}_{r_1,1}+\pi^{ML}_{r_2,2}+\widetilde{V}_{s_i,1}+\widetilde{V}_{s_i,2}$). Equilibrium profits are as

[36] Namely, iff. $\alpha \leq \widetilde{\alpha}^{pe} \equiv 1-\frac{E}{\Pi^{HM}-\Pi^{H}+\Pi^{ML}-\Pi^{L}}$. Indeed, if $\alpha \geq \widetilde{\alpha}^{pe}$, no positive fee is necessary to overcome the threat of replacement by the large supplier.

follows:

$$\begin{aligned}
\widetilde{\Pi}_r^{pe} &\equiv \widetilde{\Pi}_{r_1,1}^{pe} + \widetilde{\Pi}_{r_2,2}^{pe} \equiv \pi_{r_1,1}^{HM} + \pi_{r_2,2}^{ML} + \widetilde{S}_{s_i}^{pe} \\
\widetilde{\Pi}_s^{pe} &\equiv \widetilde{\Pi}_{s_1,1}^{pe} + \widetilde{\Pi}_{s_2,2}^{pe} \equiv 0 \\
\widetilde{\Pi}_l^{pe} &\equiv \widetilde{\Pi}_{l,1} + \widetilde{\Pi}_{l,2} \equiv \pi_{l,1}^{HM} + \pi_{l,2}^{ML}.
\end{aligned}$$

- **Product M is excluded:** Whenever $\Pi^{HM} + \Pi^{ML} - E \leq 2\Pi^{HL}$, in equilibrium the retailers list the assortment HL in the two markets. The equilibrium slotting fee is as follows:

$$\widetilde{S}_l^e \equiv \max\{\pi_{r_i,i}^{HM} + \pi_{r_j,j}^{ML} - 2\pi_{r_i,i}^{HL} + \widetilde{V}_{s_i,i} + \widetilde{V}_{s_i,j}, 0\} \tag{1.8}$$

  Under Assumptions 1-4, competition for slots leads the large supplier to pay a positive slotting fee whenever the retailers' bargaining power is low compared to the export cost.[37] Again, the retailers obtain their outside option profit (the profit they would obtain by listing (HM, ML) and buying product M from a single supplier for both markets, that is, $\pi_{r_1,1}^{HM} + \pi_{r_2,2}^{ML} + \widetilde{V}_{s_i,1} + \widetilde{V}_{s_i,2}$). Equilibrium aggregated profits can be written as follows:

$$\begin{aligned}
\widetilde{\Pi}_r^e &\equiv \widetilde{\Pi}_{r_1,1}^e + \widetilde{\Pi}_{r_2,2}^e \equiv \pi_{r_1,1}^{HM} + \pi_{r_2,2}^{ML} + \widetilde{S}_l^e \\
\widetilde{\Pi}_s^e &\equiv \widetilde{\Pi}_{s_1,1}^e + \widetilde{\Pi}_{s_2,2}^e \equiv 0 \\
\widetilde{\Pi}_l^e &\equiv \widetilde{\Pi}_{l,1} + \widetilde{\Pi}_{l,2} \quad \equiv \pi_{l,1}^{HM} + \pi_{l,2}^{ML} - \widetilde{S}_l^e.
\end{aligned}$$

Note that when a positive slotting fee is paid, the retailers' joint profit is independent of the product assortment. Indeed for both listing decisions, the retailers' best outside option is the same: to choose the assortment (HM, ML) with a unique small supplier of product M for the two markets.

Profitability of a full buying group We now analyze whether it is profitable for retailers to create a full buying group. As with a partial buying group, the sum of the retailers' gross profits is lower with a full buying group than in the absence of buying group. Hence a full buying group can be profitable for the retailers only if the collected slotting fees increase sufficiently to offset this reduction. We thus obtain the following proposition:

Proposition 6. *A full buying group is profitable for the retailers when they have a low bargaining power, and for intermediate values of the export cost.*

[37] Namely iff. $\alpha \leq \widetilde{\alpha}^e \equiv \frac{2\Pi^M - E}{2\Pi^{HL} - \Pi^{HM} - \Pi^{ML} + 2\Pi^M}$. Indeed, when $\alpha \geq \widetilde{\alpha}^e$, no positive fee is necessary to overcome the threat of replacement by a small supplier.

Proof. We provide a complete proof in online Appendix E.3. □

With a full buying group, the retailers commit to a joint listing decision on all products. As with a partial buying group, suppliers compete to enforce their favourite listing decision between (HM, ML) and (HL, HL); the difference is that when product M is listed, a unique supplier is now selected for the two markets. The retailers may jointly benefit from creating a full buying group through two different channels: the increased competition between the large and the small suppliers, and the increased competition between the two small suppliers.

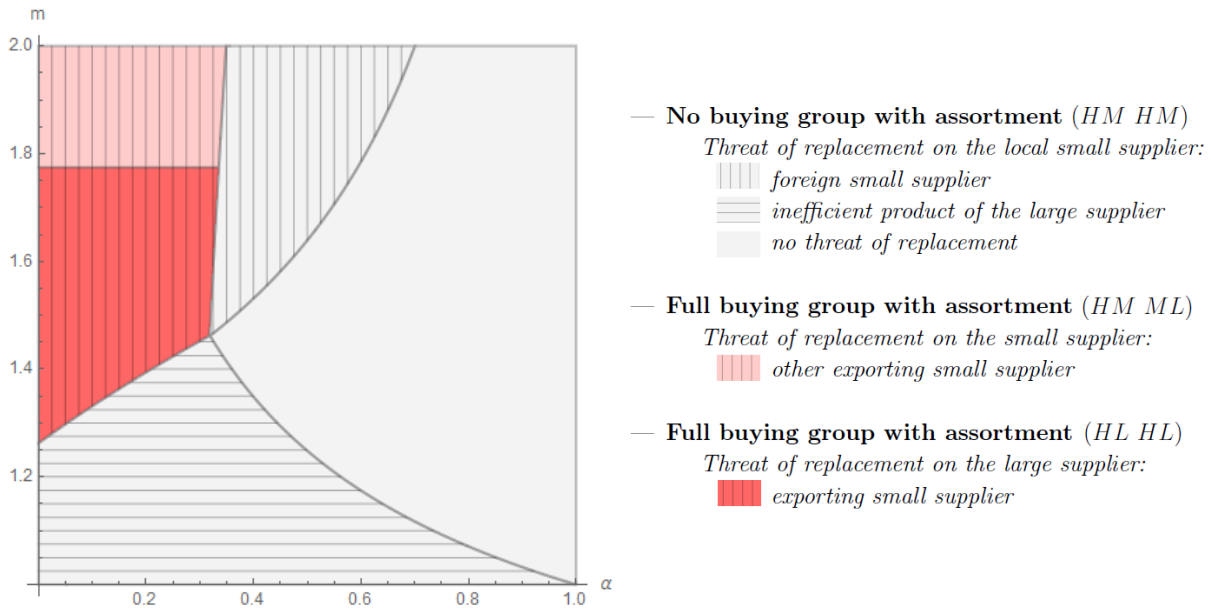
- First, competition for slots between the large and the small supplier is affected. Note that this profit extraction mechanism is not as effective as with a partial buying group, because when the assortment (HL, HL) is selected, the large supplier pays a larger fee with a partial than with a full buying group. Indeed, the small supplier still attempts to impose the assortment (HM, ML), whereas the large supplier instead pushes for (HL, HL), but the listed small supplier now incurs the export cost E, which reduces its profit and hence its total willingness to pay.

- Second, a full buying group generates perfect competition between the two small suppliers. They compete in a symmetric Bertrand game to be listed in the two markets, and in equilibrium they both make zero profit. This is particularly profitable when the profit of the small local suppliers is high without buying group, that is when M is highly profitable and E is relatively high (but not too high to ensure that the threat of replacement comes from the foreign small supplier).

Using the same demand specification as in Figure 1.1, we introduce Figure 1.2 to deliver more insight on the profitability of a full buying group. Areas in which building a full buying group is profitable for the retailers are represented in red. The dark red area represents the equilibrium in which the retailers list assortment (HL, HL), in this case the profitability comes from the first profit channel which is common with the partial buying group. The light red area represents the equilibrium in which the retailers list assortment (HM, ML) with a unique small supplier for the two markets, in this case the profitability comes from the second profit channel, that is from the perfect competition between the two small suppliers. The horizontal frontier between the light red and the dark red area represents the limit between the two equilibrium assortments ($\Pi^{HM} + \Pi^{ML} - E = 2\Pi^{HL}$): the equilibrium with exclusion arises when the quality index of product M is relatively low as compared to the export cost. In these two equilibria, the retailers have the same best outside option, which is to list a unique small supplier to serve the two markets (as indicated by the vertical hatching in these two cases). As a result, in both cases the retailers joint profit amounts to this unique outside option profit. When the export cost increases, this outside option profit decreases and the profitability of the buying group is

negatively affected: the right frontier separating the equilibrium with buying group from the no buying group equilibrium is moved to the left. Finally, note that the full buying group remains profitable when m is high, this is intuitive as it allows retailers to fully capture the small suppliers' contribution to the industry profit, which increases with m.

Figure 1.2: Profitability of a full buying group



(a) Application with $E = 0.2$ and $a = 0.2$

Effect of a full buying group on supplier's profits

Proposition 7. *When it is profitable for the retailers, a full buying group induces a reduction in suppliers' equilibrium profits. Whether they are excluded or not, small suppliers obtain zero profit.*

Proof. The proof is straightforward from the proof of Proposition 4 presented in online Appendix D.3. □

A full buying group leads to a perfect competition between small suppliers which make zero profit. The effect on the large supplier's profit is less clear. In fact, when the assortment is (HL, HL), a high export cost could reduce the threat of replacement from small suppliers and increase the large supplier's profit in comparison to the case absent buying group. However, in this case the buying group is not profitable for the retailers.

5. Alliance strategy and welfare effects

In this section, we compare the relative profitability of the different types of buying groups. We also provide some insights on their welfare effects and discuss implications for competition policy.

5.1. Comparing the alliance benefits for the retailers

We compare here the retailers' joint profit in the three different situations, that is: without buying group, with a partial buying group and with a full buying group. We do not explicitly model the strategic decision of creating a buying group, but it is clear that, as soon as the joint profit of the retailers is larger in one of the three scenarios, the preferred scenario may arise at the equilibrium of a non cooperative game, provided that some kind of transfer is possible between the buying group and the retailers. This may be the case, for instance, in the following setting: in a preliminary stage (stage 0) the retailers choose the nature of their buying alliance, and in stage 1 the buying group collects all the slotting fees and redistributes this amount to its members according to a predefined rule that guarantees each member its profit absent buying group (as seen in sections 4.2. and 4.2., the buying group is profitable whenever the amount of the fees is sufficient to compensate the total loss of gross profit by the retailers).[38]

Proposition 8. *Under Assumptions 1-4, when their bargaining power is relatively low and the export cost is relatively high, the retailers are better off with either a partial or a full buying group:*

- *a partial buying group when* $E \geq \Pi^{HM} + \Pi^{ML} - 2\Pi^{HL}$ *(either with or without exclusion of small suppliers).*
- *a full buying group when* $E < \Pi^{HM} + \Pi^{ML} - 2\Pi^{HL}$ *(in that case they always list the product of one of the small suppliers).*

Proof. We compare the profits of the retailers in the three situations in online Appendix F. □

First, assume that $\Pi^{HM} + \Pi^{ML} - 2\Pi^{HL} \leq 0$, which means that the overall industry profit (in both markets) is larger when product M is excluded. In that case, the retailers choose the assortment (HL, HL): the total gross profit of the retailers is thus the same with both types of buying group. Furthermore, with a partial buying group the sum of the slotting fees offered by the two local small suppliers (*i.e.* $\pi^{HM}_{s_i,i} + \pi^{ML}_{s_j,j}$) is higher than the total slotting fee offered by each small supplier with a full buying group (*i.e.* $\pi^{HM}_{s_i,i} + \pi^{ML}_{s_i,j} - E$), because with a full buying group the small supplier must pay the export cost E if it is selected. As a result, in equilibrium the large supplier pays a larger slotting fee with a partial buying group, and the retailers are always better off with a partial

[38] The issue of how a buying group can transfer money to its members is out of the scope of our model, as it depends on the legal and financial structure of the alliance. In practice, however, there is evidence that these transfers exist. For instance, buying groups collect slotting fees, they may also implement central billing (a process through which all payments to a supplier are aggregated and paid by the buying group), invoice services to their members, etc.

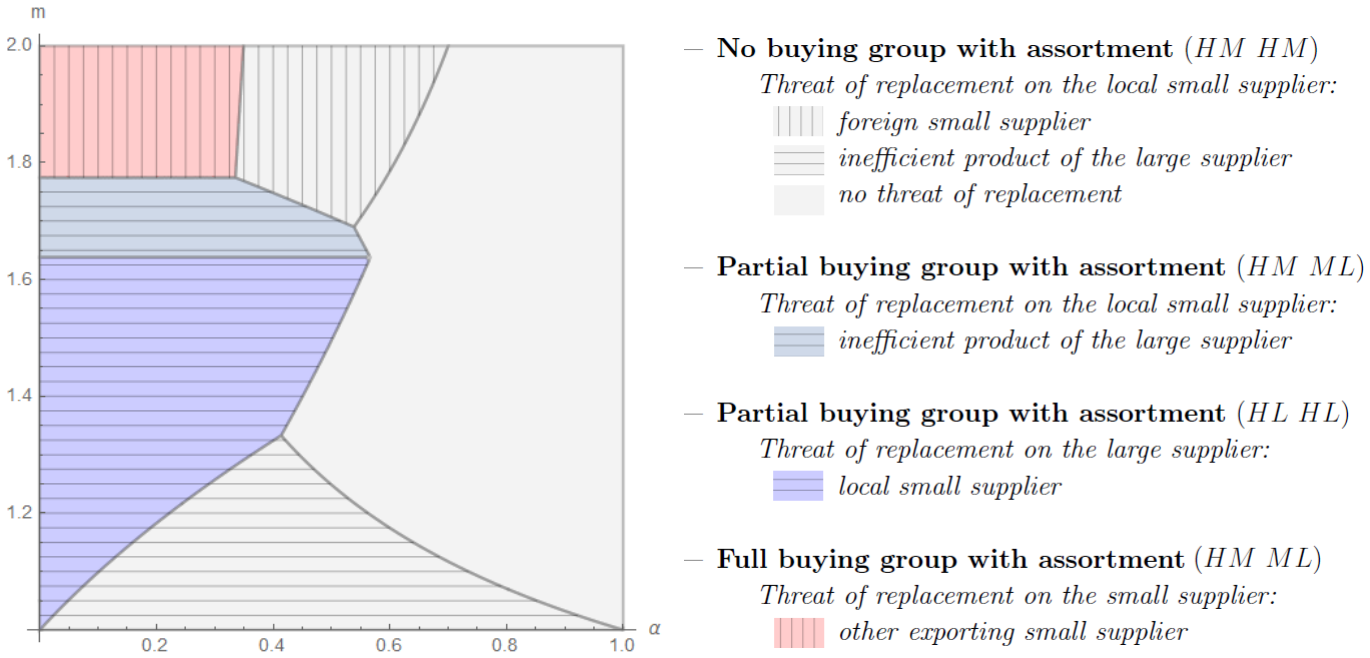
rather than with a full buying group. In this area, the industry profit is the same with the two types of buying group

Second, assume that $0 < \Pi^{HM} + \Pi^{ML} - 2\Pi^{HL} \leq E$. In that case, with a partial buying group, the retailers select the assortment (HM, ML). By contrast, with a full buying group, because of the export cost E, the assortment is (HL, HL) in both markets. Hence the retailers choose a partial rather than a full buying group. Indeed, as mentioned in the previous case, a full buying group with assortment (HL, HL) brings less profit to the retailers than the assortment (HL, HL) under partial buying group, because of the export cost; furthermore, with a partial buying group the equilibrium assortment (HM, ML) leads to a larger joint profit for the retailers than the assortment (HL, HL). In this area, the industry profit is lower with a full buying group than with a partial one.

Finally, suppose that $0 < E < \Pi^{HM} + \Pi^{ML} - 2\Pi^{HL}$. The assortment is now (HM, ML) under both types of buying groups. With a partial buying group, the retailers obtain their outside option profit (that is, their profit should they list the assortment (HL, HL)) and the small suppliers keep a positive profit; with a full buying group however, competition for slots induces the small suppliers to leave the retailers all of their profits: the retailers are then better off with a full buying group. In this case, the industry profit is lower with a full buying group than with a partial one, because the cost E is wasted in the former case.

Figure 1.3 illustrates these results in the numerical example, and displays the buying group strategy that gives the highest joint profit to the retailers. The retailers' bargaining power α is on the horizontal axis, and m, the consumers' relative preference for the variety M, on the vertical axis.

Figure 1.3: Most profitable alliance strategy



(a) Application with $E = 0.2$ and $a = 0.2$

5.2. Implications for Competition Policy

In this section, we analyze the effect of buying groups on the efficiency of the whole industry profit and consumer surplus, and we derive some implications for competition policy by analyzing the effect of a policy banning full buying groups.

The above analysis reveals that a first consequence of the creation of a buying group (whether full or partial) is the standardization of the assortment decision over the two countries, which, in our setup, is always inefficient from the industry perspective, as it dissipates part of the joint profit. To analyze the effects of buying groups on consumer surplus, we need additional assumptions. We denote C^{XY} the consumer surplus in the reduced form equilibrium with assortment XY on a market. Note that, as retailers and suppliers negotiate cost based tariffs, the buying group implementation has no effect on downstream prices for a given listing decision. Hence, consumer surplus is affected only by the product assortment. We make the following assumption:

Assumption 5. *Consumer surplus are ranked in the same way than industry profits:* $C^H > C^M > C^L$ *and* $C^{HM} > C^{HL} > C^{ML}$.

Assumption 5 is satisfied with usual demand systems such as the linear demand specification used in our numerical example, or with a model with vertical differentiation à la Shaked and Sutton (1983). A direct consequence of Assumption 5 is that the ranking of total welfare in the different assortment follows the ranking of industry profits.

We thus obtain the following proposition:

Proposition 9. *Under Assumptions 1-5, buying groups are always detrimental for industry profit, consumer surplus and welfare.*

Proof. See online Appendix G. □

We further investigate whether a policy aiming at limiting the scope of buying groups, which in our setting would be equivalent to banning full buying groups, would be efficient. We obtain the following proposition:

Proposition 10. *Under Assumption 1-5 a regulation limiting the scope of buying groups to partial buying groups increases industry profit, consumer surplus and welfare. However, such a regulation does not protect small suppliers from exclusion and does not fully prevent their profit losses.*

Proof. Straightforward given the ranking of industry profits previously found. □

The intuition for proposition 10 is as follows. Comparing the equilibrium outcomes under *laissez faire* (as illustrated in Figure 1.3) to the outcomes with a partial buying group (as in Figure 1.1), we see that a ban of full buying group may have two types of effects. Instead of a full buying group with the assortment (HM, ML) under *laissez faire*, the regulation may lead the retailers to:

- either form a partial buying group without exclusion. Under both the *laissez faire* and the regulation, there is a net loss in industry profit $\Pi^{HM} - \Pi^{ML}$, but the regulation saves the fixed export cost E. Such regulation increases industry profit but leaves the consumers surplus unchanged. In that case the regulation improves small suppliers' profit.

- or to give up creating a buying group. Instead of a net loss $\Pi^{HM} - \Pi^{ML} + E$ with the *laissez faire* the regulation restores the efficiency and therefore both industry profit and consumer surplus increase. The two small suppliers are better off with the regulation.

Finally, as exclusion of small suppliers always arises under partial buying group, the regulation has no effect on such exclusion and thus does not protect them from being excluded.

Partial buying groups thus appear to have adverse effects on welfare. In some cases, they may be profitable and thus lead to welfare distortions in situations, in which full buying groups would not, as seen by comparing Figures 1.2 and 1.3. Furthermore, in the areas where the two kind of buying groups are profitable and lead to the exclusion of small suppliers, partial buying groups are preferred by retailers. Partial buying groups then lead to less welfare distortions than full buying groups, because the export cost is saved, however, they are even more harmful for large supplier.

Applying the Chicago School logic to buying groups, it is worth noticing that if ex ante the retailers could threaten suppliers to create a joint listing decision, in theory, the sole threat would be sufficient to extract some rent from the suppliers to prevent such alliance, and alliances would not be created. However, this rent extraction relies on transfers that are likely to be illicit, as the retailers are not supposed to ask suppliers for advantages of any kind without performing a service related to this advantage.[39] Furthermore, this reasoning does not alleviate the need for a policy controlling such alliances, as such a control would also be efficient against the threat.

6. Conclusion

This article analyzes the impact of retailers' buying groups on product variety and profit sharing within a vertical chain, and we focus on the welfare effect of buying groups according to their scope (full or partial). By considering a multi-product setting with asymmetric suppliers, we are able to analyze the effects of buying groups on the selection of products and on profit sharing within the vertical chain, and especially to differentiate their effects on "large" versus "small" suppliers, for instance, the producers of national brands vs. those of private labels.

We show that creating a buying group reduces the overall variety of products, thereby harming consumer surplus and welfare. By committing themselves to a joint listing strategy, retailers may increase the competition between suppliers for being listed and capture a larger share of a smaller industry profit. Creating a buying group is thus profitable for retailers when their buyer power is limited. We show that when buying groups are created, both types of suppliers are worse off, and small suppliers can be excluded.

Our results have implications for competition policy. Although retailers argue that full buying groups may create an opportunity for SMEs to access new markets, we show that there is little benefit to expect for small suppliers in this instance. We confirm that restricting the scope of the buying group to the negotiation with large suppliers can reduce the harm for welfare. But we contradict the widespread argument in favor of partial buying groups stating that because small suppliers are outside of the scope of the buying group they are not harmed: on the contrary, we show that partial buying groups lead to a decrease in profit for the small suppliers, and does not prevent their exclusion from the market. Note that our paper is focused on joint listing alliances implemented by purchasing alliances, but our analysis also holds if the joint listing strategy follows a cross-border merger. Indeed, such a merger between non competing retailers does not affect the bargaining or the price setting stages. The above policy implications thus readily extend to cross-border mergers.

[39] "Report from the Commission to the European Parliament and the council on unfair business-to-business trading practices in the food supply chain", COM(2016)32.

By construction, we emphasize here the "dark side" of buying groups; in practice, their "bright side", highlighted in the literature, may also translate into lower final prices. The present analysis is designed to contribute to the evaluation of the overall impact of buying groups on welfare, so as to provide guidance for antitrust policy.

Avenues for future research encompass the analysis of retail competition to combine the effect of buying groups on product variety and prices, and that of more complex upstream market structure to explore the role of bundling in our analysis.

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Appendix 1.A Nash Bargaining equilibrium

1.A1. Assortment HL

Consider first the subgame where r_i has listed the assortment HL. There is a unique bilateral negotiation between r_i and l for both products. The retailer's profit when it succeeds in the negotiation is $\Pi^{HL} - F_{l,i}^{HL}$, while its status-quo profit in case of a breakdown is zero. The supplier's profit if the negotiation succeeds is $F_{l,i}^{HL}$, while its status-quo profit in case of a breakdown is zero.

The equilibrium outcome is derived from the bilateral Nash product (where the superscripts relate to the subgame equilibrium assortment on which we focus):

$$\max_{F_{l,i}^{HL}} (\Pi^{HL} - F_{l,i}^{HL})^{\alpha} (F_{l,i}^{HL})^{1-\alpha}$$
$$\Leftrightarrow (1-\alpha)(\Pi^{HL} - F_{l,i}^{HL}) = \alpha F_{l,i}^{HL}$$

Hence we have the following equilibrium values:

$$\begin{aligned} F_{l,i}^{HL} &= (1-\alpha)\Pi^{HL} \\ \pi_{r_i,i}^{HL} &= \Pi^{HL} - F_{l,1}^{HL} = \alpha\Pi^{HL} \\ \pi_{l,i}^{HL} &= F_{l,i}^{HL} = (1-\alpha)\Pi^{HL} \\ \pi_{s_i,i}^{HL} &= 0 \end{aligned}$$

1.A2. Assortment XM

Consider now the subgames where retailer r_i sells product M, that is, assortment is XM, with $X \in \{H, L\}$. Retailer r_i engages in a simultaneous bilateral negotiation with each of the two suppliers listed.

The retailer now has a positive status-quo profit in the bargaining because it negotiates with two different suppliers. Retailer r_i engages in a bilateral negotiation with each listed supplier.

Consider the negotiation between r_i and l. The retailer's profit when it succeeds in both negotiations is $\Pi^{XM} - F_{l,i}^{XM} - F_{s_i,i}^{XM}$, while its status-quo profit in case of a breakdown is $\Pi^{M} - F_{s_i,i}^{XM}$. The supplier's profit if the negotiation succeeds is $F_{l,i}^{XM}$, while its status quo profit in case of a breakdown is zero.

Consider now the negotiation between r_i and s_i. The retailer's profit when it succeeds in both negotiations is $\Pi^{XM} - F_{l,i}^{XM} - F_{s_i,i}^{XM}$, while its status-quo profit in case of a breakdown is $\Pi^{M} - F_{l,i}^{XM}$. The supplier's profit if the negotiation succeeds is $F_{s_i,i}^{XM}$, while its status-quo profit in case of a breakdown is zero.

We solve the following Nash bargaining :

$$\begin{aligned}
&\max_{F_{l,i}^{XM}}(\Pi^{XM} - F_{s_i,i}^{XM} - F_{l,i}^{XM} - (\Pi^{M} - F_{s_i,i}^{XM}))^{\alpha}(F_{l,i}^{XM})^{1-\alpha} \\
&\quad \Leftrightarrow (1-\alpha)(\Pi^{XM} - F_{l,i}^{XM} - F_{s_i,i}^{XM} - (\Pi^{M} - F_{s_i,i}^{XM})) = \alpha F_{l,i}^{XM} \\
&\max_{F_{s_i,i}^{XM}}(\Pi^{XM} - F_{s_i,i}^{XM} - F_{l,i}^{XM} - (\Pi^{X} - F_{l,i}^{XM}))^{\alpha}(F_{s_i,i}^{XM})^{1-\alpha} \\
&\quad \Leftrightarrow (1-\alpha)(\Pi^{XM} - F_{l,i}^{XM} - F_{s_i,i}^{XM} - (\Pi^{M} - F_{l,i}^{XM})) = \alpha F_{s_i,i}^{XM}
\end{aligned}$$

Hence we have the following equilibrium values:

$$\begin{aligned}
F_{l,i}^{XM} &= (1-\alpha)(\Pi^{XM} - \Pi^{M}) \\
\pi_{r_i,i}^{XM} &= \Pi^{XM} - F_{l,i}^{XM} - F_{s_i,i}^{XM} = (1-\alpha)(\Pi^{X} + \Pi^{M}) + (-1+2\alpha)\Pi^{XM} \\
\pi_{l,i}^{XM} &= F_{l,i}^{XM} = (1-\alpha)(\Pi^{XM} - \Pi^{M}) \\
\pi_{s_i,i}^{XM} &= F_{s_i,i}^{XM} = (1-\alpha)(\Pi^{XM} - \Pi^{X})
\end{aligned}$$

If instead s_j supplies M we assume that the fixed export cost is sunk and therefore the above stage-2 equilibrium gross profit are unchanged.

1.A3. Assortment X

Consider now the subgames where retailer r_i sells product X with $X \in \{H, M, L\}$. Retailer r_i engages in a bilateral negotiation with its unique supplier.

The retailer's profit when it succeeds in this negotiation is $\Pi^X - F_{k,i}^X$, while its status-quo profit in case of a breakdown is zero. The supplier's profit if the negotiation succeeds is $F_{k,i}^X$ while its status-quo profit in case of a breakdown is zero. The resolution of the Nash bargaining is as follows:

$$\begin{aligned}
&\max_{F_{k,i}^{X}}(\Pi^{X} - F_{k,i}^{X})^{\alpha}(F_{k,i}^{X})^{1-\alpha} \\
&\quad \Leftrightarrow (1-\alpha)(\Pi^{X} - F_{k,i}^{X}) = \alpha F_{k,i}^{X}
\end{aligned}$$

Hence we have the following equilibrium values:

$$\begin{aligned}
F_{k,i}^{X} &= (1-\alpha)\Pi^{X} \\
\pi_{r_i,i}^{X} &= \Pi^{X} - F_{k,i}^{X} = \alpha\Pi^{X} \\
\pi_{k,i}^{X} &= F_{l,i}^{XM} = (1-\alpha)\Pi^{X}
\end{aligned}$$

1.A4. Proof lemma 1

Lemma 1 states that under Assumptions 1-3 firms' profits gross of slotting fees can be ranked as follows:

$$\pi^{HM}_{r_i,i} \geq \max\{\pi^{HL}_{r_i,i}, \pi^{ML}_{r_i,i}\}, \text{ and } \min\{\pi^{HL}_{r_i,i}, \pi^{ML}_{r_i,i}\} \geq \pi^{H}_{r_i,i} \geq \pi^{M}_{r_i,i} \geq \pi^{L}_{r_i,i} \geq 0$$
$$\pi^{HL}_{l,i} \geq \pi^{H}_{l,i} \geq \max\{\pi^{HM}_{l,i}, \pi^{L}_{l,i}\}, \text{ and } \min\{\pi^{HM}_{l,i}, \pi^{L}_{l,i}\} \geq \pi^{ML}_{l,i} \geq 0$$
$$\pi^{M}_{s_i,i} \geq \pi^{ML}_{s_i,i} > \pi^{HM}_{s_i,i} \geq 0;$$

Under Assumption 3, on each market, supplier l sells product H and L and supplier s_i sells product M. We compare continuation profits obtained in stage 2 for each assortment.

- $\pi^{HM}_{r_i,i} \geq \max\{\pi^{HL}_{r_i,i}, \pi^{ML}_{r_i,i}\}$ & $\min\{\pi^{HL}_{r_i,i}, \pi^{ML}_{r_i,i}\} \geq \pi^{H}_{r_i,i} \geq \pi^{M}_{r_i,i} \geq \pi^{L}_{r,i} \geq 0$
  - $\pi^{HM}_{r_i,i} - \pi^{HL}_{r_i,i} = \alpha(\Pi^{HM} - \Pi^{HL}) + (1-\alpha)(\Pi^{H} + \Pi^{M} - \Pi^{HM}) \geq 0$ because $\Pi^{HM} - \Pi^{HL} > 0$ under Assumption 1 and $\Pi^{H} + \Pi^{M} - \Pi^{HM} > 0$ under Assumption 2.
  - $\pi^{HM}_{r_i,i} - \pi^{ML}_{r_i,i} = \alpha(\Pi^{HM} - \Pi^{ML}) + (1-\alpha)(\Pi^{ML} - \Pi^{L} - (\Pi^{HM} - \Pi^{H})) \geq 0$ because $\Pi^{HM} - \Pi^{ML} > 0$ under Assumption 1 and $(\Pi^{ML} - \Pi^{L} - (\Pi^{HM} - \Pi^{H}))$ under Assumption 4.
  - Under assumption 1 it is straightforward that $\pi^{HL}_{r_i,i} \geq \pi^{H}_{r_i,i} \geq \pi^{M}_{r_i,i} \geq \pi^{L}_{r,i} \geq 0$. Moreover $\pi^{ML}_{r_i,i} - \pi^{H}_{r_i,i} = \alpha(\Pi_{ML} - \Pi_{H}) + (1-\alpha)(\Pi^{M} + \Pi^{L} - \Pi^{ML}) \geq 0$ because $\Pi^{ML} - \Pi^{H} > 0$ under Assumption 1 and $\Pi^{M} + \Pi^{L} - \Pi^{ML} > 0$ under Assumption 2.

- Second, $\pi^{HL}_{l,i} \geq \pi^{H}_{l,i} \geq \max\{\pi^{HM}_{l,i}, \pi^{L}_{l,i}\} \geq \pi^{ML}_{l,i} \geq 0$
  - $\pi^{HL}_{l,i} - \pi^{H}_{l,i} = (1-\alpha)(\Pi^{HL} - \Pi^{H}) \geq 0$ under Assumption 1.
  - $\pi^{H}_{l,i} - \pi^{HM}_{l,i} = (1-\alpha)(\Pi^{H} - (\Pi^{HM} - \Pi^{H})) \geq 0$. Under Assumption 2, $\Pi^{HM} - \Pi^{H} < \Pi^{M}$, and under Assumption 1, $\Pi^{H} > \Pi^{M}$. $\pi^{H}_{l,i} - \pi^{L}_{l,i} = (1-\alpha)(\Pi^{H} - \Pi^{L}) \geq 0$ under Assumption 1.
  - $\pi^{HM}_{l,i} - \pi^{ML}_{l,i} = (1-\alpha)(\Pi^{HM} - \Pi^{ML} > 0)$ under Assumption 1. $\pi^{L}_{l,i} - \pi^{ML}_{l,i} = (1-\alpha)(\Pi^{L} - (\Pi^{ML} - \Pi^{M}) > 0)$ under Assumption 2.

- Third, $\pi^{M}_{s_i,i} \geq \pi^{ML}_{s_i,i} \geq \pi^{HM}_{s_i,i} \geq 0$.
  - $\pi^{M}_{s_i,i} - \pi^{ML}_{s_i,i} = (1-\alpha)(\Pi^{M} - (\Pi^{ML} - \Pi^{L}) \geq 0$ under Assumption 2.
  - $\pi^{ML}_{s_i,i} - \pi^{HM}_{s_i,i} = (1-\alpha)((\Pi^{ML} - \Pi^{L}) - (\Pi^{HM} - \Pi^{H}))) \geq 0$ under Assumption 4.

Appendix 1.B Proof of lemma 2

(i) Under Assumptions 1 - 4, retailers always prefer to list two products. Indeed, lemma 1 shows that listing any combination of two products (weakly) increases retailers' profit gross of slotting fees as compared to listing only one product. Moreover, for any menu of slotting fees, listing two products (weakly) increases slotting-fees paid by suppliers as slotting fees are not conditional on the other suppliers' product listed.

(ii) Under Assumptions 1 - 4, for any alliance strategy, supplier l is never willing to pay a positive slotting fee to sell only one product.

- **Absent buying group** Assume that r_i decides to list M. From lemma 2 *(i)* it then chooses between listing HM or ML, hence supplier l knows that one of its products is listed for sure. From lemma 1, in the continuation equilibrium supplier l obtains a higher gross profit with the assortment HM than with ML and is thus not wiling to pay a positive fee for L to be listed. Besides, under Assumptions 2 and 3, in the continuation equilibrium r_i also obtains a higher gross profit with the assortment HM. Hence, l does not need to pay a positive slotting fee to convince the retailer to list product H because their incentives are aligned.

- **With a partial/full buying group** Whenever the buying group decides to list M, it must choose to list the assortment HM on one market and ML on the other. Under Assumption 1, l makes a higher gross profit by selling the two products H and L in both markets rather than by selling only one product on each market. Hence, it is never profitable for l to pay a positive slotting fee for selling only one product. Furthermore, it is not willing to pay a positive fee to convince the buying group to choose one product rather than the other, because it obtains the same profit regardless of the product that is selected (A or C).

Appendix 1.C Equilibrium absent buying group

Under Assumptions 1-4, absent buying group, in equilibrium the efficient assortment HM is sold on each market (*i.e.* AB in market 1 and BC in market 2), the retailer accepts the corresponding slotting fees.[40]
Equilibrium slotting fee offers are: $\overline{S}_{s_i,i} = \max\{\pi^{HL}_{r_i,i} - \pi^{HM}_{r_i,i} + \overline{V}_{l,i}, \overline{V}_{s_j,i}, 0\}$, $\overline{S}_{s_j,i} = \max\{\overline{V}_{s_j,i}, 0\}$ and $\overline{S}_{l,i} \equiv \left(0, 0, \overline{V}_{l,i}\right)$

[40]Note that in stage 1, there is a continuum of profiles of slotting fees that sustain an equilibrium where both suppliers offer higher fees and the retailer selects the assortment HM. This profile is selected by trembling-hand perfection. All equilibria display the same assortment HM.

$$\overline{S}_{s_i,i} \equiv \begin{cases} (\Pi^{HL} - \Pi^H) - \alpha(\Pi^{HM} - \Pi^H) & \text{if } \alpha \leq \overline{\alpha}_1 \text{ and } E \geq \Pi^{HM} - \Pi^{HL} \\ (1-\alpha)(\Pi^{HM} - \Pi^H) - E & \text{if } \alpha \leq \overline{\alpha}_2 \text{ and } E \leq \Pi^{HM} - \Pi^{HL} \\ 0 & \text{otherwise} \end{cases}$$

$$\overline{S}_{s_j,i} \equiv \begin{cases} (1-\alpha)(\Pi^{HM} - \Pi^H) - E & \text{if } \alpha \leq \overline{\alpha}_2 \text{ and } E \leq \Pi^{HM} - \Pi^{HL} \\ 0 & \text{otherwise} \end{cases}$$

$$\overline{S}_{l,i} \equiv \big(0, 0, (1-\alpha)(\Pi^{HL} - \Pi^{HM} + \Pi^M)\big)$$

with $\overline{\alpha}_1 \equiv \frac{\Pi^{HL} - \Pi^H}{\Pi^{HM} - \Pi^H}, \overline{\alpha}_2 \equiv \frac{\Pi^{HM} - \Pi^H - E}{\Pi^{HM} - \Pi^H}$.
Equilibrium profits are: $\overline{\Pi}_{r_i,i} = \max\{\pi^{HL}_{r_i,i} + \overline{V}_{l,i}, \pi^{HM}_{r_i,i} + \overline{V}_{s_j,i}, \pi^{HM}_{r_i,i}\}$, $\overline{\Pi}_{s_i,i} = \min\{\pi^{HM}_{s_i,i} - (\pi^{HL}_{r_i,i} - \pi^{HM}_{r_i,i} + \overline{V}_{l,i}), \pi^{HM}_{s_i,i} - \overline{V}_{s_j,i}, \pi^{HM}_{s_i,i}\}$ and $\overline{\Pi}_{l,i} = \pi^{HM}_{l,i}$.

$$\overline{\Pi}_{r_i,i} \equiv \begin{cases} \overline{\Pi}^1_{r_i} = \Pi^{HL} - (1-\alpha)(\Pi^{HM} - \Pi^M) & \text{if } \alpha \leq \overline{\alpha}_1 \text{ and } E \geq \Pi^{HM} - \Pi^{HL} \\ \overline{\Pi}^2_{r_i} = \Pi^{HM} - (1-\alpha)(\Pi^{HM} - \Pi^M) - E & \text{if } \alpha \leq \overline{\alpha}_2 \text{ and } E \leq \Pi^{HM} - \Pi^{HL} \\ \overline{\Pi}^3_{r_i} = \Pi^{HM} - (1-\alpha)\big[(\Pi^{HM} - \Pi^H) + (\Pi^{HM} - \Pi^M)\big] & \text{otherwise} \end{cases}$$

$$\overline{\Pi}_{s_i,i} \equiv \begin{cases} \Pi^{HM} - \Pi^{HL} & \text{if } \alpha \leq \overline{\alpha}_1 \text{ and } E \geq \Pi^{HM} - \Pi^{HL} \\ E & \text{if } \alpha \leq \overline{\alpha}_2 \text{ and } E \leq \Pi^{HM} - \Pi^{HL} \\ (1-\alpha)(\Pi^{HM} - \Pi^H) & \text{otherwise} \end{cases}$$

$$\overline{\Pi}_{s_j,i} \equiv 0$$

$$\overline{\Pi}_{l,i} \equiv (1-\alpha)(\Pi^{HM} - \Pi^M)$$

Appendix 1.D Equilibrium with a partial buying group

1.D1. Characterization of the equilibrium

Under Assumptions 1-4, with a partial buying group complete efficiency never arises in equilibrium. Two types of equilibria may arise:
Equilibrium with exclusion when $2\Pi^{HL} > \Pi^{HM} + \Pi^{ML}$, the retailers choose to list the two products of the large supplier (the assortment is AC) and thus exclude small suppliers in both markets. Small suppliers offer $\widehat{S}^e_{s_i,i} = \pi^{HM}_{s_i,i}$ and $\widehat{S}^e_{s_j,j} = \pi^{ML}_{s_j,j}$ and the large supplier offers $\widehat{S}^e_l \equiv \max\{\pi^{HM}_{r_i,i} + \pi^{ML}_{r_i,i} - 2\pi^{HL}_{r_i,i} + \widehat{S}^e_{s_i,i} + \widehat{S}^e_{s_j,j}, 0\}$.
Equilibrium slotting fees:

- The large supplier may offer a positive slotting fee only to have its two products listed:

$$\widehat{S}_l^e \equiv \begin{cases} \alpha(\Pi^{HM} + \Pi^{ML} - 2\Pi^{HL}) + 2(1-\alpha)\Pi^M \ if \ \alpha \leq \widehat{\alpha}^e \\ 0 \ if \ \alpha > \widehat{\alpha}^e \end{cases}$$

- The two small suppliers offer:[41]

$\widehat{S}^e_{s_i,i} \equiv (1-\alpha)(\Pi^{HM} - \Pi^H)$, and $\widehat{S}^e_{s_j,i} \equiv \max\{(1-\alpha)(\Pi^{HM} - \Pi^H) - E, 0\}$ in market i
$\widehat{S}^e_{s_i,j} \equiv \max\{(1-\alpha)(\Pi^{ML} - \Pi^L) - E, 0\}$ and $\widehat{S}^e_{s_j,j} \equiv (1-\alpha)(\Pi^{ML} - \Pi^L)$ in market j

The resulting total profits in both markets are such that $\widehat{\Pi}^e_r = \max\{\pi^{HM}_{r_i,i} + \pi^{ML}_{r_i,i} + \widehat{S}^e_{s_i,i} + \widehat{S}^e_{s_j,j}, 2\pi^{HL}_{r_i,i}\}$, $\widehat{\Pi}^e_{s_i} = 0$ and $\widehat{\Pi}^e_l = \min\{\Pi^{HL} - \pi^{HM}_{r_i,i} - \pi^{ML}_{r_i,i} - \widehat{S}^e_{s_i,i} - \widehat{S}^e_{s_j,j}, 2\pi^{HL}_{l,i}\}$

$$\begin{aligned} \widehat{\Pi}^e_r &\equiv \begin{cases} \widehat{\Pi}^1_r = \alpha(\Pi^{HM} + \Pi^{ML}) + 2(1-\alpha)\Pi^M & \text{if } \alpha \leq \widehat{\alpha}^e \\ \widehat{\Pi}^2_r = 2\alpha\Pi^{HL} & \text{if } \alpha > \widehat{\alpha}^e \end{cases} \\ \widehat{\Pi}^e_s &= \widehat{\Pi}^e_{s_1,1} \equiv \widehat{\Pi}^e_{s_2,2} = 0 \\ \widehat{\Pi}^e_l &\equiv \begin{cases} \alpha 2\Pi^{HL} - \alpha(\Pi^{HM} + \Pi^{ML}) - 2(1-\alpha)\Pi^M & \text{if } \alpha \leq \widehat{\alpha}^e \\ 2(1-\alpha)\Pi^{HL} & \text{if } \alpha > \widehat{\alpha}^e \end{cases} \end{aligned} \tag{1.9}$$

With $\widehat{\alpha}^e \equiv \frac{2\Pi^M}{2\Pi^{HL} - \Pi^{HM} - \Pi^{ML} + 2\Pi^M}$.

Equilibrium without exclusion of the local small suppliers: when $\Pi^{HM} + \Pi^{ML} \geq 2\Pi^{HL}$, there are two mirror equilibria where the retailers list the product of the local small supplier with one product of the large supplier (the assortment is either AB or BC in both markets). Let's consider that the product listed of the large supplier is H in market i and L in market j.
Equilibrium slotting fees:

- The large supplier offers its maximum willingness to pay to impose its two products in the two markets:[42]
$\widehat{S}^{ne}_l \equiv \widehat{V}_{l,1} + \widehat{V}_{l,2} \equiv (1-\alpha)(2\Pi^{HL} - \Pi^{HM} - \Pi^{ML} + 2\Pi^M)$.

- Small suppliers offers are such that:
$\widehat{S}_{s_j,i} \equiv \widehat{V}_{s_j,i} \leq \widehat{S}^{ne}_{s_i,i} \leq \widehat{V}_{s_i,i}$ and $\widehat{S}_{s_i,j} \equiv \widehat{V}_{s_i,j} \leq \widehat{S}^{ne}_{s_i,j} \leq \widehat{V}_{s_j,j}$ and,

[41] Again, we select this equilibrium among a continuum by the trembling-hand criterion.
[42] The large supplier offer to have only one product listed (A or C) is zero.

$$\widehat{S}^{ne}_{s1,1} + \widehat{S}^{ne}_{s2,2} \equiv \begin{cases} 2\Pi^{HL} - (1-\alpha)(\Pi^{H} + \Pi^{L}) - \alpha(\Pi^{HM} + \Pi^{ML}) & \text{if } E \geq \max\{\widehat{E}_1, \widehat{E}_2\} \text{ and } \alpha \leq \widehat{\alpha}_1 \\ (1-\alpha)(\Pi^{ML} - \Pi^{L}) - E & \text{if } \widehat{E}_3 \leq E \leq \widehat{E}_2 \text{ and } \alpha \leq \widehat{\alpha}_2 \\ (1-\alpha)(\Pi^{HM} - \Pi^{H} + \Pi^{ML} - \Pi^{L}) - 2E & \text{if } E \leq \min\{\widehat{E}_1, \widehat{E}_3\} \text{ and } \alpha \leq \widehat{\alpha}_3 \\ 0 & \text{otherwise} \end{cases}$$

$$\widehat{\Pi}^{ne}_{r} \equiv \begin{cases} \widehat{\Pi}^{3}_{r} = 2\Pi^{HL} - (1-\alpha)(\Pi^{HM} + \Pi^{ML} - 2\Pi^{M}) & \text{if } E \geq \max\{\widehat{E}_1, \widehat{E}_2\} \text{ and } \alpha \leq \widehat{\alpha}_1 \\ \widehat{\Pi}^{4}_{r} = \alpha(\Pi^{HM} + \Pi^{ML}) + 2(1-\alpha)\Pi^{M} - (1-\alpha)(\Pi^{HM} - \Pi^{H}) - E & \text{if } \widehat{E}_3 \leq E \leq \widehat{E}_2 \text{ and } \alpha \leq \widehat{\alpha}_2 \\ \widehat{\Pi}^{5}_{r} = -2E + \alpha(\Pi^{HM} + \Pi^{ML}) + 2(1-\alpha)\Pi^{M} & \text{if } E \leq \min\{\widehat{E}_1, \widehat{E}_3\} \text{ and } \alpha \leq \widehat{\alpha}_3 \\ \widehat{\Pi}^{6}_{r} = (1-\alpha)(\Pi^{H} + \Pi^{L} + 2\Pi^{M}) - (2\alpha - 1)(\Pi^{HM} + \Pi^{ML}) & \text{otherwise} \end{cases}$$

$$\widehat{\Pi}^{ne}_{s} \equiv \begin{cases} \Pi^{HM} + \Pi^{ML} - 2\Pi^{HL} & \text{if } E \geq \max\{\widehat{E}_1, \widehat{E}_2\} \text{ and } \alpha \leq \widehat{\alpha}_1 \\ (1-\alpha)(\Pi^{HM} - \Pi^{H}) + E & \text{if } \widehat{E}_3 \leq E \leq \widehat{E}_2 \text{ and } \alpha \leq \widehat{\alpha}_2 \\ 2E & \text{if } E \leq \min\{\widehat{E}_1, \widehat{E}_3\} \text{ and } \alpha \leq \widehat{\alpha}_3 \\ (1-\alpha)((\Pi^{HM} - \Pi^{H}) + (\Pi^{ML} - \Pi^{L})) & \text{otherwise} \end{cases}$$

$$\widehat{\Pi}^{ne}_{l} \equiv (1-\alpha)(\Pi^{HM} + \Pi^{ML} - 2\Pi^{M})$$

Resulting profits are:

with $\widehat{E}_1 \equiv \frac{\Pi^{HM}+\Pi^{ML}-2\Pi^{HL}}{2}$, $\widehat{E}_2 \equiv (1-\alpha)\Pi^{H} + \alpha\Pi^{HM} + \Pi^{ML} - 2\Pi^{HL}$, $\widehat{E}_3 \equiv (1-\alpha)(\Pi^{HM} - \Pi^{H})$, $\widehat{\alpha}_1 \equiv \frac{2\Pi^{HL}-\Pi^{H}-\Pi^{L}}{\Pi^{HM}-\Pi^{H}+\Pi^{ML}-\Pi^{L}}$, $\widehat{\alpha}_2 \equiv 1 - \frac{E}{\Pi^{ML}-\Pi^{L}}$ $\widehat{\alpha}_3 \equiv 1 - \frac{2E}{\Pi^{HM}-\Pi^{H}+\Pi^{ML}-\Pi^{L}}$.

1.D2. Profitability of a partial buying group (Proof of Proposition 3)

First, note that because a partial buying group leads to listing inefficiency it can be profitable only if the threat of replacement is active (*i.e.* equilibrium slotting fees are positive).

- When $\Pi^{HM} + \Pi^{ML} \leq 2\Pi^{HL}$, the listing decision is (HM, HM) without buying group and (HL, HL) with a partial buying group. A partial buying group can be profitable only if the equilibrium slotting fee is positive, that is: $\alpha \leq \widehat{\alpha}^{e}$.
  - if $E \geq \Pi^{HM} - \Pi^{ML}$ the threat of replacement absent buying group comes from l.
    - When $\alpha < \overline{\alpha}_1$, this threat of replacement is binding. The partial buying group is profitable when: $\widehat{\Pi}^{1}_{r} > 2\overline{\Pi}^{1}_{r_i} \Leftrightarrow \alpha < \frac{2(\Pi^{HM}-\Pi^{HL})}{\Pi^{HM}-\Pi^{ML}}$.
    - When $\alpha \geq \overline{\alpha}_1$ there is no slotting fee paid absent buying group. The partial buying group is profitable when: $\widehat{\Pi}^{1}_{r} > 2\overline{\Pi}^{3}_{r_i} \Leftrightarrow \alpha < \frac{2(\Pi^{HM}-\Pi^{H})}{3\Pi^{HM}-2\Pi^{H}-\Pi^{ML}}$.

It is straightforward that $\frac{2(\Pi^{HM}-\Pi^{HL})}{\Pi^{HM}-\Pi^{ML}} < \frac{2(\Pi^{HM}-\Pi^{H})}{3\Pi^{HM}-2\Pi^{H}-\Pi^{ML}} \Leftrightarrow \alpha < \overline{\alpha}_1$.
To sum-up if $\alpha \leq \min\{\frac{2(\Pi^{HM}-\Pi^{HL})}{\Pi^{HM}-\Pi^{ML}}, \frac{2(\Pi^{HM}-\Pi^{H})}{3\Pi^{HM}-2\Pi^{H}-\Pi^{ML}}\}$ the partial buying group is profitable and leads to exclusion of small suppliers. Otherwise, partial buying group is not profitable.

– if $E < \Pi^{HM} - \Pi^{ML}$, the threat of replacement absent buying group comes from the small foreign supplier.

  * When $\alpha < \overline{\alpha}_2$ this threat is binding. The partial buying group is profitable when $\widehat{\Pi}_r^1 > 2\overline{\Pi}_{r_i}^2 \Leftrightarrow \alpha < \frac{2E}{\Pi^{HM}-\Pi^{ML}}$.
  * There is no slotting fee when $\alpha \geq \overline{\alpha}_2$. In that case, the partial buying group is profitable when $\widehat{\Pi}_r^1 > 2\overline{\Pi}_{r_i}^3 \Leftrightarrow \alpha < \frac{2(\Pi^{HM}-\Pi^{H})}{3\Pi^{HM}-2\Pi^{H}-\Pi^{ML}}$.

  It is straightforward that $\frac{2E}{\Pi^{HM}-\Pi^{ML}} < \frac{2(\Pi^{HM}-\Pi^{H})}{3\Pi^{HM}-2\Pi^{H}-\Pi^{ML}} \Leftrightarrow \alpha < \overline{\alpha}_2$. To sum-up if $\alpha \leq \min\{\frac{2E}{\Pi^{HM}-\Pi^{ML}}, \frac{2(\Pi^{HM}-\Pi^{H})}{3\Pi^{HM}-2\Pi^{H}-\Pi^{ML}}\}$ the partial buying group is profitable and leads to exclusion of small suppliers. Otherwise, no buying group is created.

To sum-up when $\Pi^{HM} + \Pi^{ML} \leq 2\Pi^{HL}$, the partial buying is profitable for

$$\alpha \leq \min\{\tfrac{2E}{\Pi^{HM}-\Pi^{ML}}, \tfrac{2(\Pi^{HM}-\Pi^{H})}{3\Pi^{HM}-2\Pi^{H}-\Pi^{ML}}, \tfrac{2(\Pi^{HM}-\Pi^{HL})}{\Pi^{HM}-\Pi^{ML}}\},$$

and it is not profitable otherwise.

- When $\Pi^{HM} + \Pi^{ML} \geq 2\Pi^{HL}$, a necessary condition for the buying group to be profitable is that slotting fees must be positive.

  – If $E > \Pi^{HM} - \Pi^{ML}$, it is straightforward that $E > \max\{\widehat{E}_1, \widehat{E}_2\}$. Absent buying group and with partial buying group, the threat of replacement comes from the large supplier.

    * When $\alpha < \overline{\alpha}_1$ this threat of replacement is binding in the absence of buying groups. The partial buying group is always profitable because $\widehat{\Pi}_r^3 > 2\overline{\Pi}_{r_i}^1$ is always satisfied.
    * When $\alpha \geq \overline{\alpha}_1$, there is no slotting fee in the absence of buying group. The partial buying group is profitable when $\widehat{\Pi}_r^3 > 2\overline{\Pi}_{r_i}^3 \Leftrightarrow \alpha < \frac{\Pi^{HM}+2\Pi^{HL}-2\Pi^{H}-\Pi^{ML}}{3\Pi^{HM}-2\Pi^{H}-\Pi^{ML}}$.

  – If $\Pi^{HM} - \Pi^{ML} > E > \max\{\widehat{E}_1, \widehat{E}_2\}$, with a partial buying group the threat of replacement comes from the large supplier. Absent buying group the threat of replacement comes from the foreign small suppliers.

    * When $\alpha < \overline{\alpha}_2$, the threat of replacement is active without buying group. In that case the partial buying group is profitable when $\widehat{\Pi}_r^4 > 2\overline{\Pi}_{r_i}^2 \Leftrightarrow \alpha < \frac{2E+2\Pi^{HL}-\Pi^{HM}-\Pi^{ML}}{\Pi^{HM}-\Pi^{ML}}$.

∗ When $\alpha \geq \overline{\alpha}_2$, there is no slotting fee without buying group. The partial buying group is profitable when $\widehat{\Pi}_r^4 > 2\overline{\Pi}_{r_i}^2 \Leftrightarrow \alpha < \frac{2\Pi^H - 2\Pi^{HL} - \Pi^{HM} + \Pi^{ML}}{2\Pi^H - 3\Pi^{HM} + \Pi^{ML}}$.

It is straightforward that $\frac{2E + 2\Pi^{HL} - \Pi^{HM} - \Pi^{ML}}{\Pi^{HM} - \Pi^{ML}} < \frac{2\Pi^H - 2\Pi^{HL} - \Pi^{HM} + \Pi^{ML}}{2\Pi^H - 3\Pi^{HM} + \Pi^{ML}} \Leftrightarrow \alpha < \overline{\alpha}_2$. To sum-up if $\alpha \leq \min\{\frac{2E + 2\Pi^{HL} - \Pi^{HM} - \Pi^{ML}}{\Pi^{HM} - \Pi^{ML}}, \frac{\Pi^{HM} - 2\Pi^H + 2\Pi^{HL} - \Pi^{ML}}{3\Pi^{HM} - 2\Pi^H - \Pi^{ML}}\}$ the partial buying group is profitable and leads to exclusion of small suppliers. Otherwise, no buying group is created.

– If $\widehat{E}_3 < E \leq \widehat{E}_2$ then $\alpha > \overline{\alpha}_2$ and there is no slotting fees absent buying group. With a partial buying group, the threat of replacement comes only from the foreign small supplier with assortment ML. A partial buying group could be profitable for $\widehat{\Pi}_r^5 > 2\overline{\Pi}_{r_i}^2 \Leftrightarrow \alpha < \frac{\Pi^{HM} - \Pi^H - E}{2\Pi^{HM} - \Pi^H - \Pi^{ML}}$. However, it is straightforward to show that $\frac{\Pi^{HM} - \Pi^H - E}{2\Pi^{HM} - \Pi^H - \Pi^{ML}} < \overline{\alpha}_2$ and therefore a partial buying group is never profitable.

– If $E \leq \min\{\widehat{E}_1, \widehat{E}_3\}$ then $\alpha < \overline{\alpha}_2$ and there is no slotting fees absent buying group. With a partial buying group the threat of replacement comes from the small suppliers trying to exports their products. However it is straightforward to show that a buying group is never profitable in that case.

To sum-up when $\Pi^{HM} + \Pi^{ML} > 2\Pi^{HL}$ a buying group is profitable when $E > \max\{\widehat{E}_1, \widehat{E}_2\}$ and when $\alpha \leq \min\{\frac{2E + 2\Pi^{HL} - \Pi^{HM} - \Pi^{ML}}{\Pi^{HM} - \Pi^{ML}}, \frac{\Pi^{HM} - 2\Pi^H + 2\Pi^{HL} - \Pi^{ML}}{3\Pi^{HM} - 2\Pi^H - \Pi^{ML}}\}$.

1.D3. Effect of a partial buying group on suppliers profit (Proof of Proposition 4).

To asses the effect of a profitable buying group on suppliers profit we have to consider the two possible assortments (HL, HL) and (HM, ML).

Recall that, without buying group, the equilibrium assortment is (HM, HM), the local small suppliers are listed and may have to pay a positive slotting fee. Retailers' joint profit can be written as the difference between the industry profit and suppliers' profit:

$$\begin{aligned} \overline{\Pi}_r &= \Pi^{HM} + \Pi^{HM} - (\pi_l^{HM} + \pi_l^{HM}) - \overline{\Pi}_s \\ \Leftrightarrow \overline{\Pi}_r &= 2(\alpha\Pi^{HM} - (1-\alpha)\Pi^M) - \overline{\Pi}_s \end{aligned}$$

Consider first a profitable partial buying group with assortment (HM, ML). In this case slotting fee(s) are paid by the small suppliers, retailers' joint profit can be written

as:

$$\widehat{\Pi}_r^{ne} = \Pi^{HM} + \Pi^{ML} - (\pi_l^{HM} + \pi_l^{ML}) - \widehat{\Pi}_s$$
$$\Leftrightarrow \widehat{\Pi}_r^{ne} = \alpha(\Pi^{HM} + \Pi^{ML}) - 2(1-\alpha)\Pi^{M} - \widehat{\Pi}_s$$

We have $\widehat{\Pi}_r^{ne} > \overline{\Pi}_r \Leftrightarrow \alpha(\Pi^{ML} - \Pi^{HM}) + (\widehat{\Pi}_s - \overline{\Pi}_s) > 0$. From Assumption 4 $\Pi^{ML} - \Pi^{HM} < 0$, hence small suppliers' joint profit must be negatively affected if the partial buying group is profitable. Moreover, it is straightforward that the large supplier is negatively affected because it sells an inefficient product on one of the two markets.

Consider now the case of a partial buying group with assortment (HL, HL). Small suppliers are excluded, hence it is straightforward their profit is reduced. Large supplier have their two products listed but obtain a lower profit than absent buying group. Indeed, without buying group, the minimum fee they have to pay to impose their two products is lower than with a partial buying group and they prefer to sell only one product.

Appendix 1.E Equilibrium with a full buying group

1.E1. Maximum willingness to pay of suppliers in Stage 1

- In market 1, the suppliers' willingness to pay are the same than with a partial buying group or without buying group, because the listing decisions are either HM or HL. Again, the large supplier is willing to impose the listing of product L too; the maximum amount it is ready to pay for this leaves him indifferent between the assortments HL and HM: $\widetilde{V}_{l,1} \equiv \pi_{l,1}^{HL} - \pi_{l,1}^{HM} = \widehat{V}_{l,1} = \overline{V}_{l,1}$. To ensure the listing of their product, the small suppliers are willing to pay up to $\widetilde{V}_{s_1,1} \equiv \pi_{s_1,1}^{HM} = \widehat{V}_{s_1,1} = \overline{V}_{s_1,1}$ and $\widetilde{V}_{s_2,1} \equiv \pi_{s_2,1}^{HM} - E = \widehat{V}_{s_2,1} = \overline{V}_{s_2,1}$.

- In market 2, the two competing listing decisions are unchanged compared to the situation with partial buying group (*i.e.* either ML or HL). The large supplier is willing to pay up to $\widetilde{V}_{l,2} \equiv \pi_{l,2}^{HL} - \pi_{l,2}^{ML} = \widehat{V}_{l,2} \geq \overline{V}_{l,2}$ to secure the assortment HL, while the local supplier s_2 is willing to pay up to $\widetilde{V}_{s_2,2} \equiv \pi_{s_2,2}^{ML} = \widehat{V}_{s_2,2} \geq \overline{V}_{s_2,2}$, and the foreign supplier s_1 up to $\widetilde{V}_{s_1,2} \equiv \pi_{s_1,2}^{ML} - E = \widehat{V}_{s_2,2} \geq \overline{V}_{s_2,2}$, to secure the product M in assortment ML.

1.E2. Characterization of the equilibrium

Under Assumptions 1-4, with a full buying group complete efficiency never arises in equilibrium. Two types of equilibria may arise:

Equilibrium with exclusion: If $2\Pi^{HL} > \Pi^{HM} + \Pi^{ML} - E$, the retailers choose to list the two products of the large supplier (the assortment is (HL, HL)) and thus exclude

the small suppliers in both markets. Each small supplier bids its willingness to pay to have its product listed in both markets: $\widetilde{S}^e_{s_i} = \widetilde{V}_{s_i,j} + \widetilde{V}_{s_i,i} \equiv \max\{\pi^{HM}_{s_i,i} + \pi^{ML}_{s_i,j} - E, 0\}$. To ensure that its two products are listed, the large supplier offers a fee that leaves the buying group with the outside option profit (listing a small supplier), that is $\widetilde{S}^e_l \equiv \max\{\pi^{HM}_{r_i,i} + \pi^{ML}_{r_j,j} - 2\pi^{HL}_{r_i,i} + \widetilde{S}^e_{s_i}, 0\}$.
Consider now the equilibrium slotting fees:

- The large supplier may offer a positive slotting fee only to have its two products listed:

$$\widetilde{S}^e_l \equiv \begin{cases} \alpha(\Pi^{HM} + \Pi^{ML} - 2\Pi^{HL}) + 2(1-\alpha)\Pi^M - E \text{ if } \alpha \leq \widetilde{\alpha}^e \\ 0 \text{ if } \alpha > \widetilde{\alpha}^e \end{cases}$$

- Each small supplier offers:[43]

$$\widetilde{S}^e_{s_i} = \max\{(1-\alpha)(\Pi^{HM} + \Pi^{ML} - \Pi^M - \Pi^L) - E, 0\}$$

The resulting profits are such that $\widetilde{\Pi}^e_r = \max\{\pi^{HM}_{r_i,i} + \pi^{Ml}_{r_j,j} + \widetilde{S}^e_{s_i}, 2\pi^{HL}_{r_i,i}\}$, $\widetilde{\Pi}^e_{s_i} = 0$ and $\widetilde{\Pi}^e_l = \min\{2\Pi^{HL} - \pi^{HM}_{r_i,i} - \pi^{ML}_{r_j,j} - \widetilde{S}^e_s, 2\pi^{HL}_{l,i}\}$.

$$\widetilde{\Pi}^e_r \equiv \begin{cases} \widetilde{\Pi}^1_r = 2(1-\alpha)\Pi^M + \alpha(\Pi^{ML} + \Pi^{HM}) - E \text{ if } \alpha \leq \widetilde{\alpha}^e \\ \widetilde{\Pi}^2_r = 2\alpha\Pi^{HL} \text{ if } \alpha > \widetilde{\alpha}^e \end{cases}$$
$$\widetilde{\Pi}^e_s = \widetilde{\Pi}^e_{s_1} = \widetilde{\Pi}^e_{s_2} \equiv 0$$
$$\widetilde{\Pi}^e_l \equiv \begin{cases} 2\Pi^{HL} - 2(1-\alpha)\Pi^M - \alpha(\Pi^{HM} + \Pi^{ML}) + E \text{ if } \alpha \leq \widetilde{\alpha}^e \\ 2(1-\alpha)\Pi^{HL} \text{ if } \alpha > \widetilde{\alpha}^e \end{cases}$$

With, $\widetilde{\alpha}^e \equiv \frac{2\Pi^M - E}{2\Pi^{HL} - \Pi^{HM} - \Pi^{ML} + 2\Pi^M}$.
Equilibrium with a partial exclusion a local small supplier: When $\Pi^{HM} + \Pi^{ML} - E \geq 2\Pi^{HL}$, there are two mirror equilibria where the retailers list the product of a unique small supplier with one product of the large supplier (the assortment is either AB or BC in both markets). Let's consider that the product listed of the large supplier is H in market i and L in market j. Equilibrium slotting fees:

- The large supplier offers its maximum willingness to pay to impose its two products in the two markets:[44]

$$\widetilde{S}^{pe}_l \equiv (0, 0, \widetilde{V}_{l,1} + \widetilde{V}_{l,2}) = (0, 0, (1-\alpha)(2\Pi^{HL} - \Pi^{HM} - \Pi^{ML} + 2\Pi^M))$$

[43] we select the equilibrium among a continuum by the trembling-hand criterion.
[44] Again, the large supplier' slotting fees to have only product A or C listed is zero.

- Each small supplier s_i's offer is such that the buying group is indifferent as when buying the two products from l:

$$\widetilde{S}^{pe}_{s_i} \equiv \widetilde{V}_{s_i,i} + \widetilde{V}_{s_i,j} = \begin{cases} (1-\alpha)((\Pi^{HM} - \Pi^{H}) + (\Pi^{ML} - \Pi^{L})) - E \text{ if } \alpha \leq \widetilde{\alpha}^{pe} \\ 0 \text{ if } \alpha > \widetilde{\alpha}^{pe} \end{cases}$$

Resulting profits are such that $\widetilde{\Pi}^{pe}_{r} = \max\{\pi^{HM}_{r_i,i} + \pi^{ML}_{r_i,i} + \widetilde{S}^{pe}_{s_i}, \pi^{HM}_{r_i,i} + \pi^{ML}_{r_i}\}$, $\widetilde{\Pi}^{pe}_{s_i} = 0$ and $\widetilde{\Pi}^{pe}_{l} = \pi^{HM}_{l,i} + \pi^{ML}_{l,j}$.

$$\widetilde{\Pi}^{pe}_{r} \equiv \begin{cases} \widetilde{\Pi}^{3}_{r} = 2(1-\alpha)\Pi^{M} + \alpha(\Pi^{HM} + \Pi^{ML}) - E \text{ if } \alpha \leq \widetilde{\alpha}^{pe} \\ \widetilde{\Pi}^{4}_{r} = (1-\alpha)(2\Pi^{M} + \Pi^{L} + \Pi^{H}) + (2\alpha - 1)(\Pi^{HM} + \Pi^{ML}) \text{ if } \alpha > \widetilde{\alpha}^{pe} \end{cases}$$
$$\widetilde{\Pi}^{pe}_{s} = \widetilde{\Pi}^{pe}_{s_1} = \widetilde{\Pi}^{pe}_{s_2} \equiv 0$$
$$\widetilde{\Pi}^{pe}_{l} \equiv (1-\alpha)((\Pi^{HM} - \Pi^{M}) + (\Pi^{ML} - \Pi^{M}))$$

With $\widetilde{\alpha}^{pe} \equiv 1 - \frac{E}{\Pi^{HM} - \Pi^{H} + \Pi^{ML} - \Pi^{L}}$.

1.E3. Profitability of a full buying group (Proof of Proposition 6)

Similarly to the proof of Proposition 1.D2., a full buying group leads to listing inefficiency and thus can be profitable only if the threat of replacement is active (*i.e.* it leads to positive slotting fees). Note also that although there are two types of equilibrium listing decisions with a full buying group, the joint profit of the retailers is uniquely defined when suppliers pay a positive slotting fee (*i.e.* $\widetilde{\Pi}^{1}_{r} = \widetilde{\Pi}^{3}_{r}$) because there is perfect competition among small suppliers.

- If $E \geq \Pi^{HM} - \Pi^{ML}$ the threat of replacement absent buying group comes from the large supplier.
  - When $\alpha < \overline{\alpha}_1$, this threat is binding. A full buying group is profitable when $\widetilde{\Pi}^{1}_{r} > 2\overline{\Pi}^{1}_{r_i} \Leftrightarrow \alpha < \frac{2(\Pi^{HM} - \Pi^{HL}) - E}{\Pi^{HM} - \Pi^{ML}}$.
  - When $\alpha \geq \overline{\alpha}_1$ there is no slotting fee without buying group. A full buying group is profitable when $\widetilde{\Pi}^{1}_{r} > 2\overline{\Pi}^{3}_{r_i} \Leftrightarrow \alpha < \frac{2(\Pi^{HM} - \Pi^{H}) - E}{3\Pi^{HM} - 2\Pi^{H} - \Pi^{ML}}$

  It is straightforward that $\frac{2(\Pi^{HM} - \Pi^{HL}) - E}{\Pi^{HM} - \Pi^{ML}} < \frac{2(\Pi^{HM} - \Pi^{H}) - E}{3\Pi^{HM} - 2\Pi^{H} - \Pi^{ML}} \Leftrightarrow \alpha < \overline{\alpha}_1$.

  To sum-up if $\alpha \leq \min\{\frac{2(\Pi^{HM} - \Pi^{HL}) - E}{\Pi^{HM} - \Pi^{ML}}, \frac{2(\Pi^{HM} - \Pi^{H}) - E}{3\Pi^{HM} - 2\Pi^{H} - \Pi^{ML}}\}$ the full buying group is profitable and leads to exclusion of small suppliers. Otherwise, full buying group is not profitable.

- if $E < \Pi^{HM} - \Pi^{ML}$, the threat of replacement absent buying group comes from the foreign small suppliers.

  - When $\alpha < \overline{\alpha}_2$, this threat is binding. A full buying group is profitable when $\widetilde{\Pi}_r^1 > 2\overline{\Pi}_{r_i}^2 \Leftrightarrow \alpha < \frac{E}{\Pi^{HM}-\Pi^{ML}}$
  - When $\alpha \geq \overline{\alpha}_2$, there is no slotting fee without buying group. In that case, the full buying group is profitable when $\widetilde{\Pi}_r^1 > 2\overline{\Pi}_{r_i}^3 \Leftrightarrow \alpha < \frac{2(\Pi^{HM}-\Pi^{H})-E}{3\Pi^{HM}-2\Pi^{H}-\Pi^{ML}}$

  It is straightforward that $\frac{E}{\Pi^{HM}-\Pi^{ML}} < \frac{2(\Pi^{HM}-\Pi^{H})}{3\Pi^{HM}-2\Pi^{H}-\Pi^{ML}} \Leftrightarrow \alpha < \overline{\alpha}_2$. Hence, if $\alpha \leq \min\{\frac{E}{\Pi^{HM}-\Pi^{ML}}, \frac{2(\Pi^{HM}-\Pi^{H})}{3\Pi^{HM}-2\Pi^{H}-\Pi^{ML}}\}$ the full buying group is profitable and leads to exclusion of small suppliers. Otherwise, no buying group is created.

To sum-up the full buying group is profitable for

$$\alpha \leq \min\{\tfrac{E}{\Pi^{HM}-\Pi^{ML}}, \tfrac{2(\Pi^{HM}-\Pi^{H})-E}{3\Pi^{HM}-2\Pi^{H}-\Pi^{ML}}, \tfrac{2(\Pi^{HM}-\Pi^{HL})-E}{\Pi^{HM}-\Pi^{ML}}\}$$

and is not profitable otherwise.

Appendix 1.F Retailers' best strategy (Proof of Proposition 8)

We now compare the retailers' joint profit for each of the three buying strategies (no buying group, partial buying group and full buying group). Again a buying group can be profitable only if the threat of replacement is binding (*i.e.* equilibrium slotting fees are positive).

- When $0 < \Pi^{HM} + \Pi^{ML} \leq 2\Pi^{HL}$ and $\forall E$, the listing decision is (HM, HM) without buying group and (HL, HL) with a buying group. A simple comparison of equilibrium profit gives that: $\widetilde{\Pi}_r^1 < \widehat{\Pi}_r^1$. Hence, a partial buying group is always preferred to a full buying group. From proof 1.D2., we thus have that a partial buying group is created when

  $$\alpha \leq \min\{\tfrac{2E}{\Pi^{HM}-\Pi^{ML}}, \tfrac{2(\Pi^{HM}-\Pi^{H})}{3\Pi^{HM}-2\Pi^{H}-\Pi^{ML}}, \tfrac{2(\Pi^{HM}-\Pi^{HL})}{\Pi^{HM}-\Pi^{ML}}\}$$

  and no buying group is created otherwise.

- When $0 < \Pi^{HM} + \Pi^{ML} - 2\Pi^{HL} \leq E$, the listing decision is (HM, HM) without buying group, (HM, ML) with a partial buying group and (HL, HL) with a full buying group. In this case, $E \geq \max\{\widehat{E}_1, \widehat{E}_2\}$. A simple comparison of equilibrium profit gives that: $\widetilde{\Pi}_r^1 < \widehat{\Pi}_r^3 \Leftrightarrow \Pi^{HM} + \Pi^{ML} - 2\Pi^{HL} \leq E$. Hence, a partial buying

group is always preferred to a full buying group. From proof 1.D2., a partial buying group is created when

$$\alpha \leq \min\{\tfrac{2E+2\Pi^{HL}-\Pi^{HM}-\Pi^{ML}}{\Pi^{HM}-\Pi^{ML}}, \tfrac{\Pi^{HM}-2\Pi^{H}+2\Pi^{HL}-\Pi^{ML}}{3\Pi^{HM}-2\Pi^{H}-\Pi^{ML}}\}$$

and otherwise no buying group is created.

- When $0 < E < \Pi^{HM} + \Pi^{ML} - 2\Pi^{HL}$, the listing decision is (HM, HM) without buying group, (HM, ML) with a buying group. A simple comparison of profit gives that $\widetilde{\Pi}_r^1 > \max\{\widehat{\Pi}_r^3, \widehat{\Pi}_r^4, \widehat{\Pi}_r^5\}$ and therefore a full buying group is always preferred to a partial buying group. Because $\Pi^{HM} - \Pi^{ML} > \Pi^{HM} + \Pi^{ML} - 2\Pi^{HL}$, from online Appendix E.3. we know that a full buying group is created when

$$\alpha \leq \min\{\tfrac{E}{\Pi^{HM}-\Pi^{ML}}, \tfrac{2(\Pi^{HM}-\Pi^{H})}{3\Pi^{HM}-2\Pi^{H}-\Pi^{ML}}\}$$

and no buying group is created otherwise.

Appendix 1.G Proof of proposition 9

- If $\Pi^{HM} + \Pi^{ML} - 2\Pi^{HL} \leq 0$, then both types of buying groups lead to the same equilibrium assortment (HL in both markets), and joint profit is thus the same with the two types of buying groups. Compared to no buying group, joint profit is lower, because $2\Pi^{HL} \leq 2\Pi^{HM}$.

- If $0 < \Pi^{HM} + \Pi^{ML} - 2\Pi^{HL} < E$, then in equilibrium the assortment is HL in both markets with a full buying group, while with a partial buying groups it is HM on one market and ML on the other. In that case, a partial buying group inflicts less losses to the industry profit than a full buying group: the loss created by the assortment distortion is lower. However, both types of buying groups create distortions in the assortment that reduce industry profit.

- If $E \leq \Pi^{HM} + \Pi^{ML} - 2\Pi^{HL}$, then in equilibrium the assortment is HM on one market and ML on the other with both types of buying groups. Again, both types of buying groups create distortions in the assortment that reduce industry profit, but a partial buying group is less harmful.

Under Assumption 5, these results extend to consumer surplus and welfare.

Appendix 1.H Numerical application

We use the demand specification of Singh and Vives (1984). We consider that in each market, there are three differentiated products H, M, L, and as the retailers have limited capacity, only two products are available on each market. When the two products X, Z are available, the representative consumer's utility is defined as follows for $x, z \in \{h, m, l\}$ & $x \neq z$, where h, m, l represents intrinsic preference for products H, M, L:

$$\nu + U_{x,z} = \nu + xq_x + zq_z - \frac{1}{2}(q_x^2 + q_z^2) - aq_x \times q_z.$$

The parameter ν is a numeraire ($p_\nu = 1$), and a represents the degree of substitutability between products x and z. Maximizing the utility of the representative consumer under the budget constraint leads to the following linear demand functions:

$$q_x = \frac{x - az - p_x + ap_z}{1 - a^2}$$
$$q_z = \frac{z - ax - p_z + ap_x}{1 - a^2}$$

We set $h = 2$, $l = 1$ $m \in [1, 2]$ and $a \in [0; 0.5]$; this calibration satisfies the assumptions 1-4 of the model.

Chapter 2

Markups and Markdowns in the French Dairy Market

Note: This chapter is co-authored with Etienne Guigue.[1]

Abstract

This paper quantifies upstream and downstream market power of French dairy manufacturers. Buyer power is present on the upstream side due to high transportation costs of raw milk and asymmetric concentration, atomistic farmers facing highly concentrated manufacturers. Downstream, dairy firms also exploit seller power, when trading more or less differentiated dairy products. The analysis is based on a plant-level database covering French dairy firms for the 2003-2018 period, which provides quantities and prices of raw milk input by origin and of outputs by product. We rely on a production function approach exploiting the technical relationship between raw milk and dairy products to assess manufacturers' total margins. Using the existence of a competitive product, we can disentangle both sources of market power and estimate firm-origin-level markdowns and firm-product-level markups. Our results indicate that dairy firms on average purchase raw milk at a price 15% below its marginal contribution to their profits and sell dairy products at a price exceeding their marginal costs by 45%. These markdowns and markups aggregate to generate global margin rates of 62% on average. We document substantive variations in the exploitation of buyer and seller power across firms, products, and time. Overall, our findings thus call for estimating approaches authorizing these heterogeneity dimensions and both sources of market power.

Keywords: Vertical chain; market power; Production function.

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1. Introduction

Market power has many detrimental consequences for economies. It reduces consumers' welfare, generates resource misallocation, and distorts value-added sharing in supply chains. Market power may come from firms' ability to sell output at a high price (*i.e., imposing a markup*) as well as their ability to purchase input at a low price (*i.e., imposing a markdown*).
Economists and public authorities need to fully understand market power to tackle this issue and design efficient policies. However, the economic literature has most of the time only partially analyzed it, allowing for market power upstream *or* downstream and assuming perfect competition on the other side. This assumption - often made for practical concerns and not testable - may be misleading even when ending up with a consistent estimate. On the one hand, if markup *or* markdown is well estimated while the other is present but disregarded, then the total magnitude of market power is understated. On the other hand, if total market power is well quantified but falsely attributed to markup *or* markdown only, then attention is diverted from the true inefficiency causes.

This paper focuses on French dairy manufacturers' market power during the 2003-2018 period. Manufacturers are central in the dairy supply chain: they purchase raw milk from farmers to process it in various products sold to retailers (final products) or to the food industry (intermediary products). In this setting, dairy manufacturers' buyer power has long been a major concern and a recurrent discussion topic in the French public debate for various reasons. First, raw milk supply remains highly atomistic (54,000 raw milk farmers in France) while the 300 French dairy groups are relatively concentrated, the top 5 alone representing 63% of raw milk purchases. Moreover, the raw material is very costly to transport, creating *local* milk markets, which further reduce the number of potential buyers available to a given farmer. Conversely, as dairy manufacturers are often multi-plants, they can purchase raw milk on multiple markets and thus face a high number of potential independent suppliers. Downstream, the extent to which dairy firms may exploit seller power arguably is highly product-specific. The nature of competition varies across dairy products, as some are very differentiated (yoghurts, cheese) while others appear to be relatively homogeneous, such as the intermediates products (milk powder, bulk butter, bulk cream). Guided by these features of the French dairy market, we build a model of multi-source and multi-product dairy firms, potentially exploiting buyer and seller power.

Our model allows us to identify firm-product-origin level margins, and to decompose them into firm-product level markups and firm-origin level markdowns. This decomposition relies on three definitions. The margin is the wedge between the price of a given product and its marginal cost of production using milk from a given origin. The markup is the wedge between the price of a product and its economic marginal cost. Finally, the markdown is the wedge between the net revenue generated by milk and its remuneration.

In order to estimate the model, we exploit a *cost-side approach*, building on pioneer work by Hall (1988) and De Loecker and Warzynski (2012) who analyze markups assuming no markdowns. In line with recent papers by Morlacco (2019) and Rubens (2021), we incorporate in this framework the possibility of buyer power on inputs markets. Similarly to Rubens (2021), we assume perfect complementarity in the production process between the raw material and its processing. We enrich this framework by introducing multi-source and multi-product firms. We view this setting as suitable for studying market power in industries where manufacturers process raw materials. This is especially a salient feature of agri-food industries (beer, chocolate, coffee, pasta, dairy products...) where a specific input is necessary (hop, beans, wheat, milk...) but one could also think to other industries. In most of them, there are concerns about buyer power (Sexton, 2012), due to a vertical market structure characterized by asymmetric and increasing concentration, with granular manufacturers sourcing raw materials from relatively numerous and small producers. Downstream, wholesalers and retailers' structures as well as product differentiation opportunities vary across these industries, shaping the ability of manufacturers to exploit seller power.

The empirical analysis relies on three main datasets: production, balance sheet, and technical data. Our production data provide prices and quantities at the firm-product level regarding the output side and at the firm-department level for raw milk inputs[1]. We observe labor and capital costs at the firm-level in the balance sheet data. In the technical data, we observe the dry matter content at the product-level for milk inputs and outputs, which allows us to affect milk inputs to outputs. Our estimates are based on an estimation of marginal costs. Marginal costs of production are decomposed into milk-input purchasing costs and processing costs. We use production and technical data to estimate milk-input buying costs at the firm-origin-product level. We use production and balance sheet data to estimate marginal processing costs at the firm-level, following seminal papers estimating production functions (Olley and Pakes, 1996; Levinsohn and Petrin, 2003; Wooldridge, 2009; Ackerberg et al., 2015). Having quantity and price data on both the input and the output side help us in confronting issues highlighted by the literature, such as the revenue data bias (Bond et al., 2020), input price bias (De Loecker et al., 2016), or prices endogeneity in the context of market power upstream and downstream (Morlacco, 2019; Rubens, 2021).

In order to solve the challenge of separately identifying multi-dimensional markdowns and markups, we complement the production function approach mentioned above by leveraging the existence of an arguably competitive product, which dairy firms either purchase or produce without buyer or seller power. This competitive product, namely whole milk powder, is an intermediary dairy product sold (and purchased) on global markets where

[1] A raw milk market/origin will correspond in the analysis to a French department. To fix ideas, France counts around 85 milk-producing departments.

buyer and seller power of French dairy firms can safely be assumed away. In this particular aspect, our work connects to Smith and Thanassoulis (2015), who use similar commodity prices to study market power and profit sharing along the differently organized UK dairy supply chain[2]. This identifying procedure however differs from Rubens' (2021) who estimates an input supply, imposing additional structure. Conversely, our estimating framework remains agnostic on the exact competition structures, both upstream and downstream. This is particularly suitable for the study of the French dairy supply chain between 2003 and 2018, as the regulatory context drastically changed over this period. Upstream, the industry was liberalized following several Common Agricultural Policy reforms which decided the removals of production quotas (progressively achieved from 2008 to 2015), of raw milk price recommendations (2008), and of intervention prices on intermediary dairy products markets. Downstream, relations between manufacturers and retailers were modified by the mergers of important players, the formations of purchasing alliances, and by regulatory changes such as the Economic Modernization Act (2008). These changes, described in Section 2.2., together with the inherent heterogeneity across dairy products markets, motivate our approach remaining agnostic on competition structures both up- and downstream.

Our results indicate that, on average over the period, dairy firms enjoy a margin rate of 62%. This margin comes from the aggregation of a markup rate of 45% and a markdown rate of 18%. This implies that, on average, dairy firms purchase raw milk at a price 15% ($1/1.18 \approx 0.85$) below its marginal contribution to their profits, while selling a dairy product at a price exceeding its economic marginal cost by 45%. The weighted averages (presented here) are driven by bigger firms enjoying relatively higher market power, both upstream and downstream. Though the total average margin is quite stable over time, we also find that the relative contributions of markups and markdowns vary a lot over the period. The markdown rates fluctuates between 4% and 40% while average markup rates lie between 27% and 61%. Our results also indicate that the product dimension is not negligible, even when focusing on a specific sector as we do, since we find an average markup of 68% on final products, whereas the markup on intermediary products is close to unity.

The most direct contribution of this paper is to quantify both buyer and seller power in the French dairy industry. As previously mentioned, it constitutes a significant concern for regulating authorities but has not been yet estimated in a unified framework, at least to the best of our knowledge. Our results demonstrate that dairy firms exploit both buyer and seller power and none of them is negligible. Our estimates imply that we

[2]Smith and Thanassoulis (2015) find that farmers' profits are highly dependent on these dairy commodities prices, in a context where farmers have a direct access to this market. In France, farms have exclusive relations with processors, which in turn have access to the commodities market. This eventually connects prices of French raw milk and of dairy commodities, through a channel extensively explained in our paper.

would have overestimated markups rates by 38%, had we ignored buyer power, as is often done in the production function approach literature. Though the magnitude of this bias is highly context-specific, our findings more broadly suggest that *markups* estimated in the production function literature while ignoring buyer power shall be more safely reinterpreted as *margins*, as soon as the reader suspects the existence of buyer power in the studied sector. Indeed, these margins can result from the joint exploitation of buyer and seller power.

Our second contribution is to build a flexible theory to derive and estimate *multidimensional* market power on both inputs and outputs markets. Our framework indeed allows us to identify markdowns and markups at the firm-origin-time and the firm-product-time level respectively. In this aspect, we view our work as extending and complementing Morlacco (2019) and Rubens (2021). Acknowledging and considering the heterogeneity of situations across products markets in particular appear important as our average estimated markups rate range between 0% for bulk or poorly differentiated products and above 100% for highly differentiated goods such as yoghurts or cheeses. As mentioned above, markdowns and markups contributions to the margins also highly fluctuate across firms and time. Overall, our results thus confirm the importance of theoretical and estimating approaches allowing different sources of market power and variations of their levels across firm, market and time dimensions.

Our work also relates to a more general literature identifying market power. Regarding oligopsony power, the literature has essentially focused on labor markets rather than intermediates markets, as Berger et al. (2019); Card et al. (2018); Hershbein et al. (2021) or Wong (2019), among many others, do. Another strand of the literature has focused on the markups side, adopting a *demand approach* in line with Berry et al. (1995). This method necessitates stronger theoretical (and identifying) assumptions on competition than required in our framework and suitable in our setting, which lead economists relying on it to focus on specific industries[3], as (non-exhaustively) reviewed by Berry et al. (2019). A recent economic development literature (Cajal-Grossi et al., 2019; Brooks et al., 2021; Bartkus et al., 2021; Leone et al., 2021) also studies market power issues, relying on natural experiments and focusing on one source of market power (oligopoly or oligopsony) in specific contexts. Finally, Zavala (2020) also closely relates to us, as he structurally estimates buyer power exerted by exporters on farmers in Ecuador. He however methodologically differs from us by imposing more structure on farmers' behaviors than we do, since we rather rely on the manufacturers' production function.

The rest of the paper is structured as follows. Section 2 presents the data, the industry context and some reasons to suspect market power exploitation by dairy manufacturers.

[3]We also focus on a specific industry for which we have rare data, but our framework allows us to remain agnostic on the underlying competition structures and their evolutions, making it suitable to study other industries.

Section 3 introduces our model, while Section 4 details its estimation. Section 5 displays the results - discussed in Section 6 - and Section 7 concludes.

2. Key Facts on the French Dairy Market

We first detail here general facts and recent trends on the French dairy market[4], before coming to the motivating facts relative to the existence of market power in this industry, and introducing our data.

2.1. Industry Setting

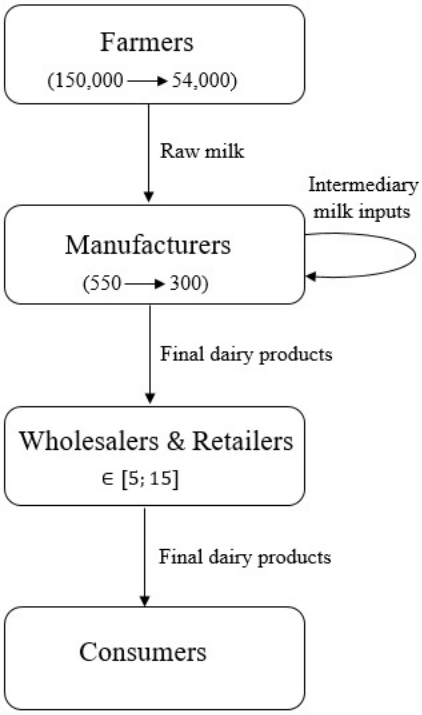
The French dairy industry remains an important industry within the French economy, generating around 40 billions euros of revenues in 2018, which represents to fix ideas one fifth of the whole French agricultural sector, or as much as the more renowned French aircraft manufacturing sector. As such, France is the 2^{nd} milk producer in Europe (after Germany), and 8^{th} in the world. Throughout the empirical analysis, we only consider cow milk, which represents 97% of the overall milk production. We also exclude PDO and organic milk which represent respectively 10% and 3.5% of the overall production in 2018[5]. We do so essentially because our estimations are based on the assumption that milks from different origins are substitutable, which is not the case for these two labeled products (see Section 4.3.).

[4]Figures presented in this Section relies on our own computations and figures from the CNIEL website

[5]The share of PDO milk is constant during the period whereas organic milk share increases from 0.5% in 2000 to 3.5% in 2018.

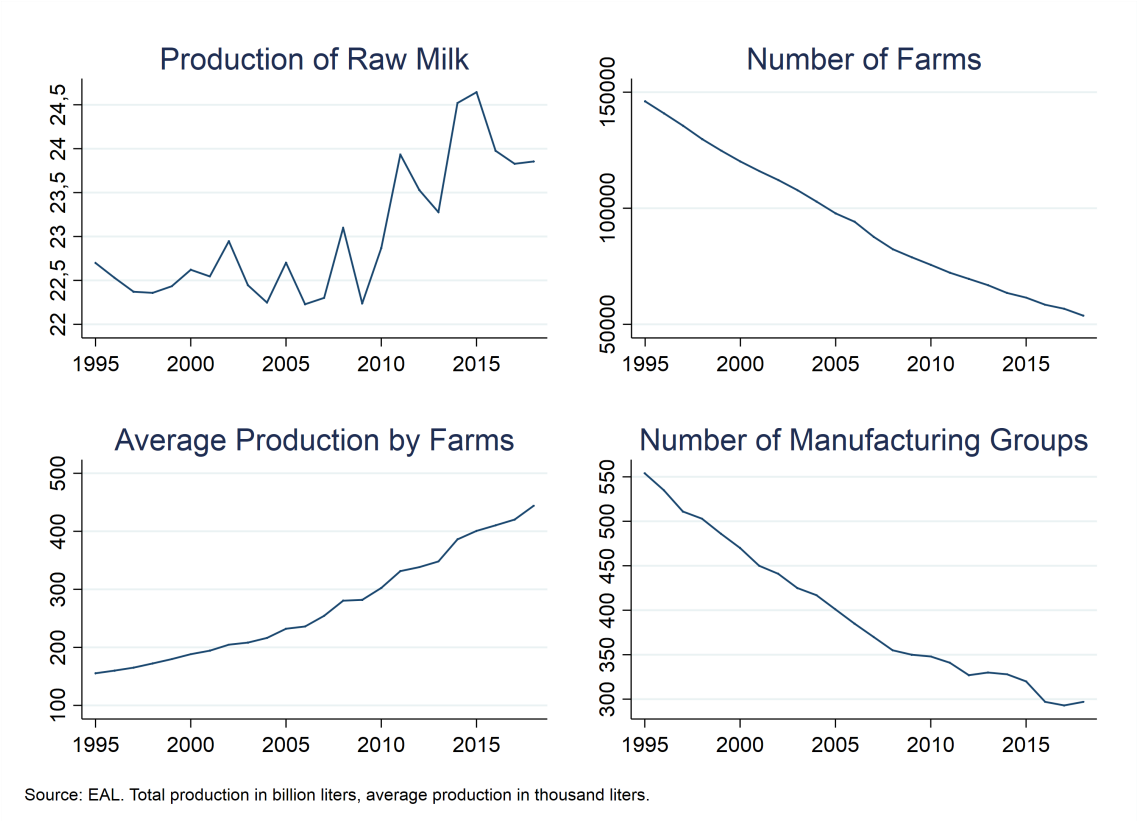
The French dairy supply chain is typically organized along a vertical structure described by Figure 1. At the top of the chain, atomistic farmers (54,000 in 2018) produce raw milk. They sell milk to manufacturers which process milk and other dairy intermediates (bulk products like cream, butter or skimmed and whole milk powder) to produce final dairy products. Though the industry still counts 300 manufacturing groups, this stage of the chain is dominated by a handful of them. Manufacturers then reach final consumers through wholesalers and retailers. Both manufacturers and distributors are thus necessary intermediaries for most farmers to value their production, the direct sales of dairy products by integrated structures remaining marginal.

Figure 2.1: The Dairy Value Chain



Trends The number of farms producing raw milk has decreased a lot since 1995, dropping from around 150,000 to 54,000. In the same time, and naturally reflecting the increase of the national production, the yearly milk production of the average farm increased from 150,000 to 450,000 liters. Despite this evolution, this average farm remains relatively small (66 cows) and mostly organized around a familial nucleus. On the contrary, the processing of raw milk into dairy products is made by increasingly concentrated - 550 in 1995 to 300 in 2018 - manufacturing groups. 4 of them are among the top 15 groups at the world level, including the world leading dairy group.

Figure 2.2: Dairy Industry Trends



Source: EAL. Total production in billion liters, average production in thousand liters.

Raw Milk Collection Farmers generally milk cows twice a day and store raw milk in a cooling tank up to the collection by the manufacturing plant which owns the tank. The manufacturer is in charge of the collection which is done using a refrigerated truck every day or two. The same truck is used to collect raw milk from several farms. Due to conservation constraints of raw milk, this operation is costly, which explains why raw milk is always collected from farms closed to the manufacturing plant, located on average at less than 60 kilometers.

Processing of Raw Milk into Dairy Products Raw milk is processed by manufacturers to produce dairy products using capital, labor and other intermediate inputs. Dairy products can be either final goods (milk, cheese, butter, cream, yoghurts) for consumers (75% of processed milk) or intermediate products (milk powder, butter, cream) reused in the dairy industry or in other food industries (25 %). 99% of the milk processed in France was produced within the country, while 40% of it ends up being exported. Dairy manufacturers are either private (45% of processed milk) of cooperative (55%) companies. While most of the private firms are gathered into important groups, some cooperatives have also become prominent actors in this industry[6].

[6]The 2^{nd} leading French groups representing 20% of French milk collection is for instance a cooperative.

2.2. Regulatory Context

During the 2003-2018 period, the French dairy industry's regulatory context has known multiple changes. Upstream, the market has long been highly regulated before being liberalized during the period. Downstream, commercial negotiation frameworks between manufacturers and retailers have also known notable changes.

Raw Milk Quantities and Prices

From 1984 to 2015, the European Union (EU) raw milk market was regulated by production quotas. Each member state was endowed with a maximum amount of production decided at the EU level, which it could freely allocate among its national farmers. In 2003, the Common Agricultural Policy officially engaged towards a progressive liberalization of the dairy industry, following a so-called *soft landing* (Bouamra-Mechemache et al., 2008) strategy in order to leave the quotas regime and foster greater competition. Quotas were increased by 2% (2008) and 1% (2009-2015) every year before being completely removed in 2015. Consequently, as regards France, the production of raw milk by farms is since then not administratively determined anymore but the result of bilateral contracts linking manufacturers and farmers. Moreover, raw milk prices have also been liberalized. Up to spring 2008, the CNIEL (National Interprofessional Center for the Dairy Economy) was regularly publishing a recommended price resulting from negotiations between farmers and manufacturer representatives, a recommendation in practice closely followed by manufacturers. This functioning was abandoned after the French regulation authority declared the practice as anti-competitive. There are concerns that these institutional changes may have been to the detriment of farmers, rarely organized and less used to bargain than manufacturing groups[7].

Bulk Products Prices Liberalization

The European dairy industry was supported through *intervention prices* on bulk products (milk powder, butter). When a commodity price dropped below a certain threshold level (the *intervention price*), the European Union purchased the necessary quantity to maintain a decent price. Purchased quantities were then stored and later resold and/or exported at a loss. Following the Common Agricultural Policy (CAP) reforms of 1999 and 2003, these intervention levels were progressively reduced, until progressively becoming in practice ineffective. More generally, after the 2003 CAP reform, price support policies - because pushing to more production - were progressively replaced by less-distortive direct subventions to farmers.

[7]See for instance this study summary: Study of Measures against Market Imbalance:What Perspectives after Milk Quotas in the European Dairy Sector?.

Commercial Relations between Manufacturers and Retailers

In France, the 2000's were marked by debates about the regulation of the retail sector. In 2008, the Economic Modernization Act (*Loi de Modernisation de l'Economie*, in French) removed the non-discriminatory price obligation imposed on manufacturers since the *Galland Act* (1996). The Galland Act was constraining manufacturers to sell a given product to different retailers at a similar price, which in practice had effects akin to prices floors (Biscourp et al., 2013). More recently, two waves of purchasing alliances formations (2014, 2018) have been scrutinized by competition authorities and economists for their possible anti-competitive effects (Caprice and Rey, 2015; Allain et al., 2020).

Overall, these regulatory changes soundly modified commercial relations and bargaining power along the entire dairy supply chain, *i.e* between farmers and manufacturers on the upstream side, and between manufacturers and retailers further downstream. We acknowledge and take into account these important policy changes in our analysis by remaining the most agnostic possible on competition structures both up- and downstream.

2.3. Key Facts Suggesting the Existence of Buyer and Seller Power

We extensively describe here the various features of the French dairy industry fostering the existence of unbalanced commercial relationships between raw milk producers and dairy firms.

Buyer Power: Producers Atomicity, Buyers Concentration, and Local Markets

First, the production of milk remains very dispersed in France, with around 54,000 farms in 2018. One stage downstream in the value-added chain, the number of firms processing milk to produce dairy products is much smaller, with about 300 dairy firms. Furthermore, this stage is dominated by a handful of big groups, the top 3 representing 52% of the raw milk purchased in 2018, while the top 10 represents 75%.

Table 2.1: Competition on the Raw Milk Market (2018)

	Number of …		Collection Share (%) of Top …					
	Buyers	Farms	1	2	3	4	5	10
At the national level								
	300	54,000	21	41	52	58	63	75
At the departmental level								
Median	8	406	46	73	88	95	98	100
Average[a]	13	1,588	43	67	81	89	93	98

[a] Quantity weighted average.

Due to the specificities of milk transportation mentioned above, farmers typically sell to only one manufacturer, while a dairy firm buys raw milk to 180 farms on average. The French dairy value-added chain is thus characterized by a highly atomistic raw milk supply, facing a demand emanating from very concentrated actors, thus favoring the emergence of buyer power.

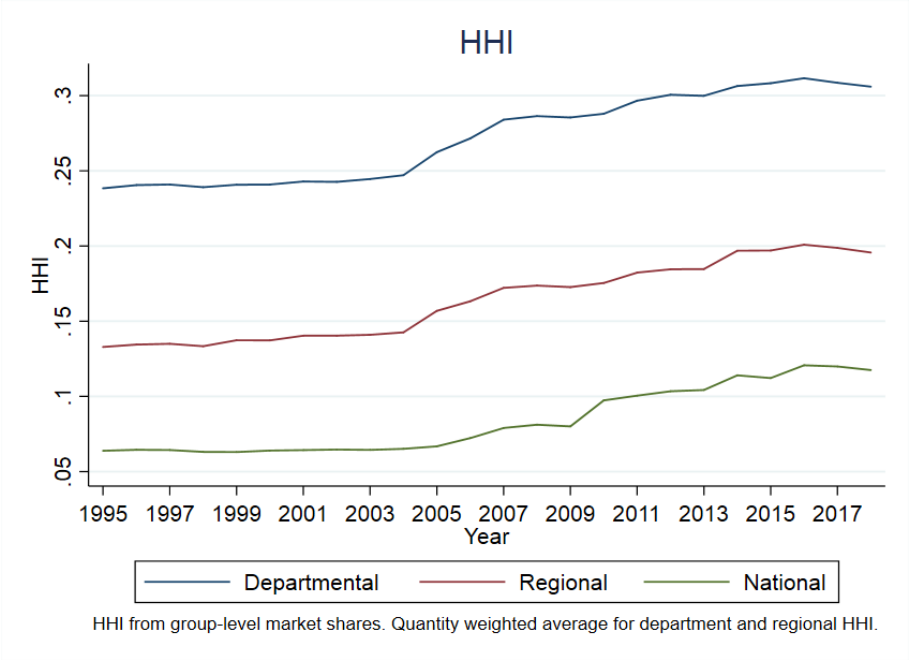
Furthermore, due to its transportation costs, raw milk is most often transformed at less than 60 kilometers from where its production took place. The French raw milk market must thus be considered as a collection of local markets, where buyer power is exacerbated, as the table above demonstrates.

A farmer within a department is facing a restrained number of potential buyers, 13 on average at the group-level. This department-level quantity-weighted average is an imperfect approximation of the relevant potential buyers' set for a given seller, in reality function of (among other things) the distance to the plant of each of the surrounding buyers in the department and in the neighboring ones. It remains however instructive on the order of magnitude of buyers' competition at the local level. More strikingly, the local dairy markets are most of the time dominated by a handful of buyers. The table above shows that the locally biggest group represents 46% of the median market, the top 2 constituting 73% of it, while the 4 biggest buyers typically represents 95% of the local raw milk collection.

While somewhat restrained by the quotas regulation, and as previously mentioned, the raw milk market has kept concentrating over the 20 last years, and this concentration has sped up over the last years. This results from a structural trend but also from various events, such as the mergers of big dairy firms or the relocation of the milk activity following the quotas removal. The declining number of manufacturing groups reflects in the Herfindahl-Hirschman Indexes (HHI), growing at national but also at regional scales since 2006[8], to attain substantially high levels, especially at the local (department)

[8]The increasing concentration at both local and national levels was not obvious, see for instance

level. Since 2005, the department-based HHI is above 0.25 and local markets can thus be considered as *highly concentrated*, according to standards of the US Antitrust Department for instance.



Seller Power

Table 2.2: Competition on the Dairy Products Market (2018)

	Number of ...	Market Share (%) of Top ...					
	Sellers	1	2	3	4	5	10
At the national level							
	300	21	41	52	59	66	79
At the product-level							
Median	40	24	42	56	65	72	92
Average[a]	58	25	44	56	66	74	89

[a] Revenue weighted average.

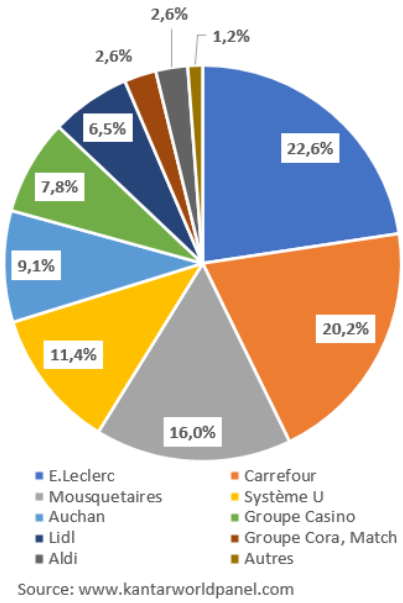
Unsurprisingly, since reflecting their importance on the raw milk market, dairy manufacturers also represent highly concentrated *sellers*, the top 5 manufacturers alone representing between two third of the national market, and 72% of the median (though broadly defined[9]) product market.

Rossi-Hansberg et al. (2020).

[9]We aggregate here NC8 products into seven broad categories: cheese, butter, cream, milk, milk powder, yoghurt.

As French dairy firms are very concentrated and for some represent big actors even at a global level[10], they may exploit their market power when selling differentiated dairy products. This seller power can however be mitigated by the existence of an additional stage in the value chain between manufacturers and final consumers: retailers. As striking on Figure 4, these retailers themselves are highly concentrated in France, with the 7 dominating players representing 94% of the food market, and may thus have *countervailing* buyer power. Bringing our theory to the data on *factory-gate* prices (and not final prices) available to us, we are able to quantify manufacturers' seller power when selling to retailers. Underlying negotiations between these two types of actors can take various complex forms and are beyond the scope of this paper[11]. We circumvent this limitation (due in part to the data available to us) by remaining fully agnostic on the demand faced by a given manufacturer when selling a given product to a retailer. In any case, the existence of buyer and seller power, be it manufacturers' one alone or reinforced by retailers', can only harm final consumers as it decreases total quantities exchanged.

Figure 2.3: Food Retail Shares - 2018



2.4. Data

Our analysis rests on the exploitation of several datasets.

We first use data provided by the French Ministry of Agriculture[12]: the *Enquête Annuelle Laitière* (EAL, 1995-2018), the *Enquête Mensuelle Laitière* (EML, 2013-2018), and the PRODCOM data for dairy products (20003-2018). They contain firm-level data regarding the production of dairy products and the collection of raw milk.

In the EAL, and regarding the output side, we observe for each dairy firm in France the quantities of dairy products produced, by product (slightly thinner than NC8). Thanks to our *PRODCOM* data, we are able to observe *factory-gate* prices at the firm-NC8-year level, for French dairy firms with more than 10 employees. These price data are only available for the 20003-2018 period, which will as a consequence be our period of analysis.

Regarding the input side, we observe also in the EAL the quantity of raw milk collected by each firm and in every department. Thanks to the EML, we are able to observe firm-

[10]The biggest French group, Lactalis defines itself as the first world leading dairy company.

[11]We refer interested readers to Villas-Boas (2007); Allain et al. (2020) among many other papers.

[12]We are particularly thankful to Corinne Prost and FranceAgrimer for making this data available to us through the CASD.

department prices paid for raw milk, for a subsample of firms and only for the 2013-2018 period. To complement this firm-level (but incomplete) raw milk prices, we use data from a survey made by *FranceAgrimer*, which gives us average raw milk prices by French regions, covering the period 2000-2018.

We also use *dry matter content* (DMC) data jointly produced by the *Centre national interprofessionnel de l'économie laitière* (CNIEL), *FranceAgrimer* and the *Institut de l'élevage* (Idele), three institutes in charge of elaborating statistics on the French dairy market[13]. This information allows us to build an input-output matrix, by retrieving the quantity of milk needed to produce a dairy product, for each dairy input-product pair.

Finally, we complement this production and raw milk collection data by the use of balance sheet data for French dairy firms, coming from FICUS and FARE databases of the French Institute of National Statistics (INSEE). We find in particular in these data the firm-level expenses on labor and capital (among others) needed for the production function estimation.

[13] We are particularly grateful to Jean-Noël Depeyrot for providing us these data.

3. A Theory of Markups and Markdowns in a Multi-Input-Output Setting

3.1. Production Function

Technology Assumptions

To produce y_{fj} kilograms of dairy product j, a dairy firm[14] f combines milk inputs m_{fij} from various markets i with its processing technology. The production function is given by:

$$y_{fj} = \min \left\{ \underbrace{\sum_{i \in \mathcal{I}_f} e_{ij} m_{fij}}_{\text{required mil inputs}} \; , \; \underbrace{F_j\left(L_f, K_f, Y_{f-j}; \Omega_{fj}\right)}_{\text{processing capacity}} \right\} \tag{2.1}$$

Through the Leontief form, we assume perfect complementarity between the required milk inputs and the processing capacity. We define $e_{ij} \equiv \frac{e_i}{e_j}$, the required quantity of milk input i to produce a kilogram of dairy product j. Outputs heterogeneity in milk input contents is product-specific and captured by the scalar e_j, whereas input quality is market-specific and denoted e_i. We assume milk inputs to perfectly substitute between them. The processing technology is common to all manufacturers and represented by the function $F_j(.)$ which is assumed to be twice differentiable in each argument. For now we assume a multi-product processing function $F_j(.)$ as general as possible, defined as a function of firm's aggregate labor L_f and capital K_f expressed in quantities and of the vector Y_{f-j} of firm's physical quantities of outputs other than j. This expression developed by Diewert (1973), Lau (1976) and used by Dhyne et al. (2021) allows for *economies of scope* when processing several goods. Finally, Ω_{fj} characterizes firm's f ability to process good j.

Inputs Assumptions

A dairy firm sources milk inputs from various markets i in its accessible set $\mathcal{I}_f$. It encompasses direct purchases of raw milk from farmers on local markets and/or intermediary dairy products from other manufacturers[15]. We assume milk inputs to be variable in the sense that sourcing and processing occur at the same period. This rules out the possibility for the manufacturer to store milk inputs, which is a natural assumption for perishable raw milk, but a stronger one for intermediary dairy products. We also assume milk inputs to be static, to the extent that they only affect current profits, thus ruling out adjustment costs. Similarly we assume labor to be variable and static, implying costless

[14] Throughout the paper, a *dairy firm* or a *manufacturer* indifferently refers to any firm processing milk inputs to produce dairy products.

[15] Through global markets, as we extensively explain later.

labor adjustment[16]. Finally and as standard in this literature, capital is assumed to be dynamic and fixed, which means that the capital stock at time t K_{ft} is determined in $t-1$ by investments I_{ft-1} and depreciation of the capital stock of t-1 K_{ft-1}. Formally, we have :

$$K_{ft} = (1-\delta)K_{ft-1} + I_{ft-1}$$

with δ the depreciation rate of capital.

Note that we ignore non-milk intermediary inputs (e.g energy, fruits for yoghurt...) which would enter the production function function as perfect complements. We argue that they are small in comparison to milk inputs cost. Including them would not affect estimated processing coefficients but could increase marginally the estimation of marginal costs of production. We discuss this point in Appendix 2.B1..

3.2. Profit Maximization and Equilibrium Concept

Our theory aims to limit as much as possible the hypotheses made on competition to measure firms' margins and disentangle markups and markdowns. The only assumption we make on firms' behavior is that they maximize their current variable profit, observing perfectly which individual supply and demand curves they face. These two elements of course depend on the equilibrium strategies of all other firms but we do not need to make any assumption on these.

To be more explicit, let us consider a timing that could microfound this hypothesis. In the first stage, dairy firms take long term decisions which determine the competitive environments for their purchases of each input i and for the sales of each output j. On the downstream side, these decisions encompass for example, the choice of dairy products produced by the firm $\mathcal{J}_f$, the corresponding qualities and distribution networks. On the upstream side, among other choices, firms decide the set of markets in which they source their milk-input $\mathcal{I}_f$. In the second stage, dairy firms maximize their current variable profit, competing upstream and downstream. On both sides, competition can take any usual form (Cournot, Bertrand, Monopolistic competition, etc). A Nash equilibrium of these two-stage game defines all the relevant information that affects firms' individual supply and demand curves (quantities, prices, varieties, etc...), respectively denoted by A_{fj} and A_{fi}. Then, in equilibrium, each firm maximizes its variable profit knowing which individual demand and supply curves it faces, anticipating that all other firms play Nash equilibrium. This two-stage game yields first order conditions linking firm's marginal cost, markups and markdowns.

[16]Dairy processing mainly requires low skilled work which reduces hiring cost, firing costs, and ease turnover.

3.3. Variable Profit Maximization

A manufacturer f maximizes its current variable profit. The firm potentially is multi-source and multi-product: milk inputs i's are sourced from a markets set $\mathcal{I}_f$ and products sold j's belong to $\mathcal{J}_f$. Firm f optimally chooses for each pair (i,j) which quantity m_{fij} of input i to dedicate to product j. Firm also chooses the optimal quantity of labor L_f to hire to process these products [17]. This yields the following program:

$$\begin{aligned} \max_{\{m_{fij}\}_{(i,j)\in\mathcal{I}_f\times\mathcal{J}_f},\, L_f} \quad & \Pi_f = \sum_j p_{fj}(y_{fj}, Y_{f-j}, A_{fj}) y_{fj} - \sum_i w_{fi}(m_{fi}, A_{fi}) m_{fi} - z_f L_f \\ \text{s.t.} \quad & y_{fj} = \min\left\{ \sum_i e_{ij} m_{fij}\,,\, F_j\left(L_f, K_f, Y_{f-j}; \Omega_{fj}\right) \right\},\ \forall\, j \end{aligned}$$

where $m_{fi} = \sum_j m_{fij}$. At the optimum, both terms of the Leontief production function are equalized such that:

$$y_{fj} = \sum_{i=1}^{I} e_{ij} m_{fij} = F_j\left(L_f, K_f, Y_{f-j}; \Omega_{fj}\right),$$

and the program above is thus equivalent to:

$$\begin{aligned} \max_{\{m_{fij}\}_{(i,j)\in\mathcal{I}_f\times\mathcal{J}_f}} \quad & \Pi_f = \sum_j p_{fj}\left(y_{fj}, Y_{f-j}, A_{fj}\right) y_{fj} - \sum_i w_{fi}(m_{fi}, A_{fi}) m_{fi} - \sum_j c_{fj}(y_{fj}, Y_{f-j}) \\ \text{s.t.} \quad & y_{fj} = \sum_i e_{ij} m_{fij}\,,\ \forall\, j \end{aligned}$$

where $c_{fj}\left(y_{fj}, Y_{f-j}\right)$ is firm f's processing cost for product j, which is obtained by the minimization of the total processing cost, and z_f is the cost of one unit of labor. Firm f's inverse demand for product j is denoted by $p_{fj}\left(y_{fj}, Y_{f-j}, A_{fj}\right)$ and firm f's inverse supply curve is denoted by $w_{fi}(m_{fi}, A_{fi})$.

As mentioned in section 3.2., competitive environments on demand and supply are taken as given and captured by arguments A_{fj} and A_{fi}. Firm's problem thus amounts to optimize its production taking into that it is multi-product, multi-source, and (possibly) has market power. A firm has market power when selling product j (resp. purchasing input i) if it faces a decreasing inverse demand (resp. an increasing supply) curve. Multi-product aspects affects production decisions through costs because of possible complementarities in the processing of different products and through demand via potential intra-brand substitutability. Direct effects are taken into account by argument y_{fj} and indirect effects by Y_{f-j}.

[17] Capital is assumed to be fixed at this stage.

Assuming concavity of the variable profit function, optimal purchases and production decisions are given by a first order condition with respect to m_{fij} for every (i,j), which yields:

$$\begin{aligned}\left(\frac{\partial p_{fj}(.)}{\partial y_{fj}} y_{fj} + p_{fj} + \sum_{j \neq j'} \frac{\partial p_{fj'}(.)}{\partial y_{fj}} y_{fj'}\right) &= \frac{1}{e_{ij}}\left(\frac{\partial w_{fi}(m_{fi})}{\partial m_{fij}} m_{fi} + w_{fi}\right) + \frac{\partial c_{fj}(.)}{\partial y_{fj}} + \sum_{j' \neq j} \frac{\partial c_{fj'}(.)}{\partial y_{fj}} \\ \underbrace{\left(1 + {\varepsilon^D_{fjj}}^{-1}\right) p_{fj} + \sum_{j' \neq j} {\varepsilon^D_{fj'j}}^{-1} p_{fj'} \frac{y_{fj'}}{y_{fj}}}_{\text{marginal revenue } MR_{fj}} &= \underbrace{\frac{1}{e_{ij}}\left(1 + {\varepsilon^S_{fi}}^{-1}\right) w_{fi} + \lambda_{fj}}_{\text{economic marginal cost } EMC_{fj}}. \end{aligned} \tag{2.2}$$

We define the marginal processing cost (MPC) of product j as

$$\lambda_{fj} \equiv \sum_{j'} \frac{\partial c_{fj'}(.)}{\partial y_{fj}},$$

the own (cross) demand price-elasticity of j for $j = j'$ (for $j \neq j'$) as

$$\varepsilon^D_{fj'j} \equiv \frac{\partial y_{fj}}{\partial p_{fj'}} \frac{p_{fj'}}{y_{fj}},$$

and the supply price-elasticity as

$$\varepsilon^S_{fi} \equiv \frac{\partial y m_{fi}}{\partial w_{fi}} \frac{w_{fi}}{m_{fi}}.$$

Note that first order conditions implies equality between the marginal revenue of producing an additional unit of product j (MR_j), and the economic marginal cost of sourcing and processing the required milk from market i EMC_{fij} for each market i. Thus for every i, we have: $EMC_{fij} = EMC_{fj}$.

3.4. Margins, Markups and Markdowns

In this section, we define markups, markdowns and their respective contributions to total margins.

Markups

The markup measures the ability of a firm to set a price above its marginal cost. Using equation (2.2), we define the markup of firm f on product j as follows :

$$\mu_{fj} \equiv \frac{p_{fj}}{EMC_{fj}} = \frac{1}{1 + \sum_{j'} {\varepsilon^D_{fj'j}}^{-1} \frac{p_{fj'} y_{fj'}}{p_{fj} y_{fj}}}. \tag{2.3}$$

This expression is quite similar to the classical single product markup expression which links the price to marginal cost of production ratio with the demand elasticity : the more inelastic is the demand (higher ε^D_{fjj}) the higher is the markup. Because we consider a multi-product setting, the markup must also take into account intra-brand competition (through $\varepsilon^D_{fjj'}$ for $j \neq j'$) which affects the marginal revenue of selling an extra unit of product j. Whenever product j and j' are substitutes (resp. complements), a reduction of p_{fj} to sell an extra unit of j decreases (resp. increases) the demand for product j'.

Markdowns

In line with Rubens (2021), we think about markdowns as measuring the gap between the *marginal available revenue* of using an additional input unit and its remuneration. Using equation (2.2), we define the markdown of firm f on input i used for producing j as follows :

$$\nu_{fi} \equiv e_{ij} \frac{MR_{fj} - \lambda_{fj}}{w_{fi}} = 1 + \varepsilon^{S\,-1}_{fi}. \tag{2.4}$$

As expected, firm's upstream market power depends on the supply elasticity : the more inelastic is the supply, the higher is the markdown. Due to perfect complementarity between milk and other inputs, the production of an additional unit of output j requires an extra processing cost λ_{fj}. This marginal processing cost amputates what is left to remunerate milk input i. Hence, $MR_{fj} - \lambda_{fj}$ is the *marginal available revenue* of an additional unit of *output* j. Adjusting by e_{ij}, we finally have at the numerator the *marginal available revenue* of an additional unit of *input* i to product j. Note that despite the multi-product setting, firms' optimizing behavior requires markdowns on a given market i to be product-invariant.

Using our definitions of markups and markdowns in (2.2) yields :

$$\forall (i,j), \quad \mu_{fj} = \frac{p_{fj}}{\nu_{fi} \dfrac{w_{fi}}{e_{ij}} + \lambda_{fj}}. \tag{2.5}$$

Equation (2.5) makes more apparent how the firm's efficiency, and its market powers upstream and downstream are intertwined. We see for instance here how the markup μ_{fj} depends on the markdown ν_{fi}, as the latter directly enters the *economic* marginal cost $\left(\nu_{fi} \dfrac{w_{fi}}{e_{ij}} + \lambda_{fj}\right)$, which additionally features the marginal processing cost λ_{fj}, embedding firm's f efficiency.

Margins

The (total) margin measures the ability of a firm to set a price above its *accounting* marginal cost (AMC). We define the margin of firm f on product j sourcing milk from input market i as:

$$M_{fij} \equiv \frac{p_{fj}}{AMC_{fij}} = \frac{p_{fj}}{\frac{w_{fi}}{e_{ij}} + \lambda_{fj}}$$

Using our definitions of markups and markdowns, the margin can be rewritten:

$$M_{fij} = \left(\theta_{fij}\nu_{fi} + (1 - \theta_{fij})\right)\mu_{fj} \tag{2.6}$$

where $\theta_{fij} \equiv \frac{w_{fi}}{w_{fi}+e_{ij}\lambda_{fj}}$ is the share of milk from i in the *accounting* marginal cost of producing j. The total margin on a unit of milk i used in product j thus relies more or less on the markdown on milk i depending on the importance of milk i in the total marginal cost of processing product j. Note that the term $(1 - \theta_{fij})$ enters without any multiplicative term as we assumed no market power on labor (the only other variable input).

Special Cases

- If $\theta_{fij} = 1$, we have $M_{fij} = \nu_{fi}\mu_{fj}$, implying that the margin is equal to the product of the markdown and the markup. This is the result of Morlacco (2019) who assume substitutability between materials and labor and capital. As a consequence, the markdown proportionally scales up the total margin, just like the markup.

- In the absence of upstream market power ($\nu_{fi} = 1$), the margin reduces to:

  $$M_{fij} = \mu_{fj}$$

  The total margin equalizes the markup. This is the classical result of various papers (De Loecker and Warzynski, 2012; De Loecker et al., 2016; Dobbelaere and Mairesse, 2013) ignoring buyer power on intermediates/materials.

- In the absence of downstream market power (μ_{fj}=1), the margin is equal to:

  $$M_{fij} = \nu_{fi}\theta_{fij} + (1 - \theta_{fij})$$

  which tends towards ν_{fi} when θ_{fij} is closer to unity.

4. Estimation

We are ultimately interested in estimating margins, markups and markdowns. To do so we need to get all parameters of the model which are : p_{fj}, w_{fi}, e_i, e_j, μ_{fj}, ν_{fi}, λ_{fj} and M_{fij}. We directly observe prices p_{fj} and w_{fi} in the data. In section 4.1., we argue that milk input quality e_i and milk output contents e_j can be summarized by their dry matter contents. We thus need to retrieve markdowns ν_{fi}, markups μ_{fj}, margin M_{fij} and the marginal costs of processing milk λ_{fj}. Equation 2.6 links M_{fij}, ν_{fi} and μ_{fj} whereas equation 2.5 links μ_j, ν_i and λ_{fj}. Hence, among the three unobserved objects of Equation 2.5, we need to retrieve two of them to get all objects of interest. Several ways of doing it are possible, based on different assumptions:

- A first option would be to identify markups and markdowns based on dairy product demand and milk supply estimation. This would require to make assumptions on the competition structures on both sides of the market.
- A second possibility is to model and estimate only one side of the market to get markups or markdowns, and impose further assumptions on the processing function to get the processing marginal cost.
- A third option is again to impose and estimate a processing function to get marginal processing costs, and then use the existence of a competitive product, to disentangle both sources of market power. We define a competitive product as a product on which a firm is price-taker and can substitute with other products when optimizing its profit. A competitive product can thus be an input or an output.

We choose this last option, using bulk whole milk powder as a competitive product. We do so for several reasons. First, as we explain in section 4.3., we think that dairy firms have no market power when purchasing or selling bulk whole milk powder. Moreover, this product is massively traded, *i.e* purchased as an input and sold as an output, in the industry. Second, we have rich production data in which we observe prices and quantities of inputs and outputs. A proper supply and demand estimation would ideally require firm-to-firm trade data, which we do not have, *i.e.* we do not observe the identity of the seller or of the buyer. Third, as we explain in section 2.2. dairy firm regulatory and competitive environments have changed a lot during the period, which leads us to put the less structure possible on the competitive environments.

The rest of the estimation section is organized as follows. We first detail how we retrieve firms' marginal costs of production, which is decomposed in two parts: milk-input costs on one side and processing costs on the other side. This allows to find total margins. Then, we present and discuss how the hypotheses of competitive products allow us to disentangle markups and markdowns.

4.1. Dry Matter Contents of Milk Inputs and Outputs

We explain here how we identify e_i and e_j and thus $e_{ij} = \frac{e_i}{e_j}$, the quantity of milk input i needed to produce a unit of output j. In practice, raw milk and dairy intermediates are bundles of multiple sub-inputs (water, fat, protein, lactose, minerals) which are present in different proportions in various dairy outputs j. The two main sub-inputs are fat and proteins. We treat them indifferently by summing them to get the *dry matter contents* e_i *and* e_j. This methodology is commonly used by practitioners in the industry, which guarantees the quality and the availability of the data. On the output side, we observe dry matter contents at the NC8-level (or even thinner). On the input side, we observe it at the department-year level for raw milk and at the NC8-level for dairy intermediates.

Table 2.3: Example of Dry Matter Contents in Dairy Inputs and Outputs

DMC data	Butter	Comté	Yoghurt	Raw Milk (i =*Doubs, 2018*)
Content (in g/100g)				
Fat	82.00	31.20	2.69	3.95
Proteins	0.75	27.97	3.60	3.38
Dry Matter (e_j or e_i)	82.75	59.17	6.29	7.33
Quantity of milk needed (in g/g)				
e_{ij}	11.29	8.07	0.85	

Table 2.3 shows concrete examples of the measurement of e_i and e_j. For example, 100 grams of butter contain 82 grams of fat and 0.75 grams of proteins so that $e_{butter} = 82.75$, whereas 100 grams of yoghurt contain 2.69 grams of fat and 3.6 grams of proteins so that $e_{yoghurt} = 6.29$. Similarly, in 2018 in the Doubs department, $e_{Doubs} = 7.33$. Using these characteristics, producing a kilogram of butter would require 11.29 kilograms (82.75/7.33) of milk from the *Doubs* department, while producing a kilogram of *Comté* cheese would require 8.07 kilograms (59.17/7.33) of such milk.

Note that by using these data, we assume here that there is no waste of dry matter contents in the production process. This assumption is credible as manufacturers use fat or proteins leftovers from the production of a given product in the production of other products. Doing so, they exploit complementarities in the production of several dairy products regarding the use of milk. Assuming an optimal use seems on average reasonable as we have a good match between the reconstituted demand for French raw milk and the actual raw milk collection. We underestimate the demand for raw milk by 2 to 8% over the period, as shown in Appendix 2.B3.). This gap can be explained by wastes in the production process that we do not allow for.

4.2. Milk Processing Cost Estimation

We describe here our identification and estimation methodology for milk processing costs. In the theoretical part of the paper, we assume processing costs to be firm-product specific. In this section we consider instead a firm-level processing function assuming that $\forall j, \lambda_{fj} = \lambda_f$. Hence, the estimated firm f's marginal cost of producing an additional unit of product j relies on a firm-product milk-input cost and a firm-level processing cost. We discuss the choice of this assumption before moving to the estimation procedure and estimates.

Processing Function Specification

It is very challenging to estimate marginal processing cost at the product-level. There are very few papers dealing with multi-product production function estimation[18]. The main issue is that inputs are generally declared at the firm-level. Papers coping with multi-product production function estimation rely on two different sets of assumptions. On the one hand, some affect inputs observed at the firm-level to several products (see De Loecker et al. (2016) and Valmari (2016)). Despite their methodological differences, these papers ultimately consider multi-product production function as a sum of mono-product production functions, once having allocated inputs to the different products. This amounts to assuming no complementarity in producing various products, an assumption that does not seem well-suited for our analysis. As we mentioned before, milk inputs are a bundle of a sub-inputs split during the processing of different products. Moreover, we cannot implement De Loecker et al.'s (2016) methodology as it relies on mono-product firms, which are very rare in the French dairy industry context, even at a relatively aggregated product category-level (see Appendix 2.B2.). On the other hand, Dhyne et al. (2017, 2021) develop a very general multi-product production function which presents the advantage of not having to allocate inputs to be estimated. We base our theory on this production function specification but cannot use it for marginal processing cost estimation. The drawback of this specification indeed is that it requires at least as many variable inputs as products to identify marginal costs at the product-level, something we do not have. Overall, it is reasonable to assume a firm-level processing function in our case. Our paper is already limited to the industry of "Operation of Dairies and Cheese Making" (NC4-level), which is the level at which De Loecker et al. (2016) define products. Within this industry, firms seem to have a very similar mix in labor and capital regardless of their product specialization, as we show in Appendix 2.B2.. Labor cost shares in firms' total processing costs (defined as labor and capital costs) indeed turn out to be very close to 0.8 for each product-group we consider. Finally, in our estimates, processing costs

[18]In this paragraph, we follow the literature's vocabulary talking about production function, but the reader shall keep in mind that we consider for this paper's purposes a processing function.

(estimated at the firm-level) on average only represent 20% of firms' accounting marginal costs, raw milk purchases at the firm-origin-*product*-level constituting the remaining 80%.

Processing Function and Milk Processing Marginal Costs λ_f

Hence, we assume that a firm f processes milk using variable labor l_f, and fixed or dynamic capital k_f, in log terms. Firms differ in their ability to process milk ω_f. In our favorite specification, we assume the following translog milk processing function[19]:

$$\ln y_f = \ln F(.) = \beta_l l_f + \beta_k k_f + \beta_{ll} l_f^2 + \beta_{kk} k_f^2 + \beta_{kl} k_f.l_f + \omega_f.$$

The output elasticity of labor under a translog specification is equal to:

$$\varepsilon_{YLmt} = \beta_l + 2 \times \beta_{ll} \times l_{mt} + \beta_{kl} \times k_{mt} \tag{2.7}$$

This implies that this elasticity is firm- and time-specific, which is why it is our preferred specification. The minimization of the variable cost function given the desired processing level of Y_f gives:

$$\begin{aligned} \min_{L_f} \quad & Z_f L_f \\ \text{s.t.} \quad & F(L_f, K_f, \Omega_f) - Y_f^* \geq 0, \end{aligned}$$

At the optimum, we have:

$$\lambda_f = \frac{Z_f}{\dfrac{\partial F(L_f^*, K_f^*, \Omega_f)}{\partial L_f}} = \frac{L_f Z_f}{\varepsilon_{YL} Y_F^*}. \tag{2.8}$$

The marginal processing cost is thus equal to the expenditure on labor L_f divided by the labor elasticity of output ε_{YL} times the quantity of output produced. Identifying the firm-product-specific marginal costs thus requires estimating ε_{YL}. We describe our procedure in the next paragraph.

Estimation Procedure

In this section, we fully follow the seminal literature, *i.e.* Olley and Pakes (1996), Levinsohn and Petrin (2003) and Ackerberg et al. (2015). We also incorporate methodologies of De Loecker et al. (2016) and Rubens (2021) to deal with unobserved exogenous input prices and quantities, and with (observed) endogenous prices upstream and downstream, *ie* firms exploiting market power on both sides of the market.

[19] In the Results section, we compare the resulting estimated elasticities with the ones obtained with a Cobb-Douglas specification and to the empirical labor shares.

Adding time subscript t, and dropping f subscript for simplicity, the estimating equations thus are :

$$\begin{aligned} y_t &= \beta_l l_t + \beta_k k_t + \beta_{ll} l_t^2 + \beta_{kk} k_t^2 + \beta_{kl} k_t.l_t + \epsilon_t \,, \\ &= \beta_l l_t + \beta_k k_t + \beta_{ll} l_t^2 + \beta_{kk} k_t^2 + \beta_{kl} k_t.l_t + \omega_t + \eta_t \end{aligned} \tag{2.9}$$

where the technical efficiency term ϵ_t is assumed to split in two parts:

$$\epsilon_t = \omega_t + \eta_t \,. \tag{2.10}$$

η_t is an i.i.d. error which the firm does not influence (e.g., measurement or specification errors). ω_t reflects firm-specific technical efficiency and is observed by the firm but not by the econometrician.

We now sequentially describe how we deal with the three issues we encounter in this context : (i) unobserved firm-specific technical efficiencies, (ii) unobserved exogenous input prices and quantities, and (iii) (observed) endogenous milk and dairy products prices, *i.e.* endogenous prices upstream and downstream.

(i) Unobserved Firm-Specific Efficiencies

ω_t is assumed to be first-order Markov and is the source of the well-known simultaneity problem as firms observe it before choosing labor l_t. By assumption, k_t responds to ω_t with a lag as investments made in period $t-1$ take effects in period t. Thus, k_t is possibly correlated with expected value of ω_t given ω_{t-1} ($E[\omega_t|\omega_{t-1}]$) - but this assumption guarantees that the innovation in the productivity shock, $\xi_t = \Omega_t - E[\omega_t|\omega_{t-1}]$ is unknown at time $t-1$ the investment was made and therefore uncorrelated with current k_t.

Following Olley and Pakes (1996) and Levinsohn and Petrin (2003) we use the existence of a proxy variable h_t for the technical efficiency shock, which is assumed to be a function of unobserved productivity ω_t, capital k_t, and other variables z_t, which we denote $h_t(k_t, \omega_t, z_t)$. Assuming this function is a bijection in ω_t - conditional on k_t and other variables z_t - we can then invert the proxy variables to get $\omega_t = g(k_t, h_t, z_t)$. We thus include a function of k_t, h_t and z_t in the estimation to control for ω_t. We define z_t later as it will also address problems (ii) and (iii), among others. Following Wooldridge (2009), and as commonly done in the literature, we use a single index restriction so that:

$$\omega_t = g(k_t, h_t, z_t) = c(k_t, h_t, z_t)'\gamma, \tag{2.11}$$

where we choose $c(.)$. In practice we use multivariate 2^{nd} order polynomials. We can now rewrite $E[\omega_t|\omega_{t-1}] = f\left(c(k_t, h_t, z_t)'\gamma\right)$, where we impose a similar single index restriction

on $f(.)$. Using our assumptions to re-express (2.9) yields:

$$y_t = \beta_l l_t + \beta_k k_t + \beta_{ll} l_t^2 + \beta_{kk} k_t^2 + \beta_{kl} k_t.l_t + E[\omega_t|\omega_{t-1}] + \xi_t + \eta_t, \tag{2.12}$$

where remember that $\xi_t = \omega_t - E[\omega_{jt}|\omega_{t-1}]$. For a given set of parameters $\beta = (\beta_l, \beta_k, \beta_{ll}, \beta_{kk}, \beta_{kl})$ to be estimated, the error is:

$$[\xi_t + \epsilon_t](\beta) = y_t - \beta_l l_t + -\beta_k k_t - \beta_{ll} l_t^2 - \beta_{kk} k_t^2 - \beta_{kl} k_t.l_t - f\left(c(k_t, h_t, z_t)'\gamma\right) \tag{2.13}$$

Denoting $\tilde{\beta}$ the true parameters values, the conditional moment restriction $[\xi_t + \epsilon_t]\left(\tilde{\beta}\right) = 0$ identifies β.

(ii) Unobserved Exogenous Input Prices and Quantities

Following De Loecker et al. (2016), we acknowledge the existence of a potential input price bias, as we use labor and capital in monetary terms. To reduce this bias, we use industry-level labor and capital deflators. We further include average wage per worker (a proxy for labor quality) and downstream market shares in the control function $g(.)$. The insight for including downstream market shares is that there are good proxies for output quality, positively correlated with input quality in a large class of theoretical models. We refer to De Loecker et al. (2016) for a more formal explanation[20].

(iii) Endogenous Prices Upstream and Downstream

We choose firm's milk demand as our proxy for ω_t, as both are, of course, positively correlated. With endogenous prices downstream and upstream, high milk input demand can, however, be the result of other things than high productivity, namely low markups and/or low markdowns.[21]. As highlighted by De Loecker et al. (2016) and Rubens (2021), a very large class of competition models can deliver markdowns and markups as functions of markets shares[22] on the corresponding market, upstream and downstream, respectively. We thus incorporate these variables in the control function z_{ft}[23] for ω_t and define:

$$z_{ft} = \left(s_{ft}^m, s_{ft}^y\right) \tag{2.14}$$

where s_{ft}^m and s_{ft}^y are firm's f average market shares in input markets i and output markets j respectively.

[20]Contrary to De Loecker and Warzynski (2012), we do not include downstream prices here, as it would reduce the estimating sample and time window, which spans from 1995 to 2018 while we observe prices only from 2003.

[21]As pointed out by Rubens (2021) in the context of leaf demand in the production of cigarettes.

[22]And of prices, plus an additional elasticity parameter. For the reasons already mentioned, we do not include prices, as they would drastically reduce the estimating sample. Given that we use quantities of products and milk in the estimation, we think it is not a major concern.

[23]Using again a 2^{nd} order polynomial for flexibility concerns.

Estimates

We present in Table 2.4 our processing functions estimates for several specifications. Assuming a translog production function, the average estimate of the output elasticity of labor is 0.79, and the average output elasticity of capital is 0.14. These estimates are close to the Cobb-Douglas estimates (0.74 for labor and 0.14 for capital). Moreover, all quantiles of the distribution of elasticities resulting align well with their counterparts in the empirical distributions of labor, and capital shares in total processing costs (labor and capital costs), as shown in Table 2.12 (Appendix section 2.B2.). Correcting for endogeneity seems to be important as GMM Cobb-Douglas elasticities differ significantly from those obtained by plain OLS regressions with firm and year fixed effects.

Table 2.4: Processing Function Estimates - firm-level

	OLS	GMM - CD	GMM - TL
β_l	0.534***	0.739***	0.585***
	(0.035)	(0.035)	(0.145)
β_k	0.252***	0.138***	0.121
	(0.027)	(0.021)	(0.083)
β_{ll}			0.098***
			(0.029)
β_{kk}			0.066***
			(0.018)
β_{kl}			-0.149***
			(0.044)
Obs.	7,996	7,996	7,996
R2	0.974		
Labor Quality corr.	No	Yes	Yes
Market Power corr.	No	Yes	Yes
Firm and Year F.E.	Yes	Yes	Yes

Notes: For comparison purposes, OLS sample is restricted to be the same as GMM samples, further reduced due to the presence of lagged variables. Labor quality is corrected for by introducing firm-level average wage control. Market power is controlled by introducing upstream and downstream market shares.

Table 2.5: Distribution of Elasticities obtained with a Translog Specification

	Average	Median	P5	P25	P75	P95	Obs.
Labor Elasticity	0.79	0.79	0.65	0.73	0.86	0.95	2,736
Capital Elasticity	0.14	0.14	0.01	0.09	0.19	0.24	2,736

Notes: Distributions winsorized at 1% and 99%.

The median labor elasticity of output is above the one found by Rubens (2021) (0.591) - who assume a similar Leontief production function, though applied in different context - and De Loecker and Scott (2016) (0.75), who have a Cobb-Douglas specification. Capital elasticities are less stable in the literature and ours differs from Rubens (2021)' (0.59) but are closer to De Loecker and Scott (2016)' (0.30)[24].

4.3. Identification of Markups and Markdowns

We show that having marginal processing costs estimates in hands, firm f's markups and markdowns are identified when it sources a least a competitive input or sells at least a competitive output. Then, we present and discuss the choice of bulk whole milk powder as a competitive product.

Identification

Competitive Input

Suppose it exists at least one input market $i = b$ on which firm f sources milk input and does not have any buyer power, *ie* where ${\varepsilon^S_{fb}}^{-1} = 0$, or equivalently $\nu_{fb} = 1$. Then Equation (2.5) simplifies and we get:

$$\mu_{fj} = \frac{p_{fj}}{\frac{w_{fb}}{e_{bj}} + \lambda_{fj}}, \qquad \forall\ j, \tag{2.15}$$

which conditionally to λ_{fj}, allows us to identify markups for each output j. Then, using Equation (2.5), which holds for each i, and having μ_{fj} and λ_{fj} in hand, we retrieve markdowns:

$$\nu_{fi} = \frac{e_i}{e_b}\frac{w_{fb}}{w_{fi}}, \qquad \forall\ i. \tag{2.16}$$

Note that when firm f sources a competitive input b, $M_{fbj} = \mu_{fj}$. The total margin made on product j by sourcing a competitive input b is equal to the markup because $AMC_{fbj} = EMC_{fbj}$. Moreover, markdown on market i is just the ratio of the prices of

[24]Our estimates of the capital elasticity may be downward biased due to measurement error, which may call for correction such as the one proposed by Collard-Wexler and De Loecker (2016) we will try to implement. Note that this capital elasticity does not directly affect subsequent results as estimating marginal processing costs only requires knowledge of the labor elasticity. In the translog production function, capital measurement, however, can contaminate our measured labor elasticity.

dry matter contents from input b over input i. Firm f prefers to buy the competitive input at a price higher than the price of raw milk on market $i \neq b$ because it takes into account that $EMC_{fij} \geq AMC_{fij}$ for every j. Indeed, purchasing an additional unit of raw milk i requires paying a higher price to increase the supply.

Competitive Output

Suppose now it exists at least one output $j = b$ sold by firm f without seller power, *ie* where $\varepsilon_{fb}^{D\,-1} = 0$, or quivalently $\mu_{fb} = 1$. Then Equation (2.5) simplifies to:

$$\nu_{fi} = e_{ib}\frac{p_{fb} - \lambda_{fb}}{w_{fi}}, \quad \forall\, i. \tag{2.17}$$

Thus conditionally to λ_{fb}, we directly identify markdowns for each input i. Using Equation (2.5), which holds for each j, and having ν_{fi} and λ_{fb} in hand, we retrieve markups:

$$\mu_{fj} = \frac{p_{fj}}{\frac{e_j}{e_b}(p_{fb} - \lambda_{fb}) + \lambda_{fj}}, \quad \forall\, j. \tag{2.18}$$

Note that when firm f sells a competitive output b, then $M_{fib} = \nu_{fi}$. The total margin made on competitive output b sourcing raw milk from market i is equal to the markdown on input i, because $MR_{fb} = p_{fb}$. The expression of markup is $\mu_{fj} = \frac{p_{fj}}{EMC_{fj}}$, with $EMC_{fj} = (p_{fb} - \lambda_{fb})\frac{e_j}{e_b} + \lambda_{fj}$. The economic marginal cost of producing an additional unit of product j amounts to the processing cost plus the opportunity cost of not allocating this milk to the competitive output b.

Bulk Whole Milk Powder

We assume that bulk whole milk powder (WMP) is a competitive product because:

- we can credibly assume no seller nor buyer power on this product. As with other bulk dairy products (butter, cream, or skimmed milk powder), bulk WMP is sold on global markets at a price fixed by a quotation. WMP is the most internationally traded intermediary product in the world, and the European Union market share is only about 11% in 2018[25]. It is thus reasonable to believe that every french dairy firm is price taker on this market.

- it is used as a substitute for raw milk in the production process, as it enters the composition of many dairy products like yoghurts, milk or cheese. Finally, among other bulk products used in the dairy industry, WMP is the most similar (in terms of fat and protein contents) to raw milk, since it is basically dry raw milk.

[25]Source: FranceAgrimer

The Competitive Product Assumption in Practice

The competitive product assumption allows us to identify markups and markdowns when firm use at least a competitive product. In our theoretical framework, a firm can either be a seller or a buyer of intermediary inputs, or none of the two. A firm cannot be both a seller and a buyer because it would imply losses on this trading activity. Firm selling intermediary inputs are the ones for which the economic marginal cost of purchasing raw milk and processing it into intermediary input is lower than the world price of this product. In practice, we observe when firms sell WMP, but we do not observe if they purchase it as an input, as we only observe raw milk purchases. Our estimation procedure is to use the competitive output identification when we observe that the firm sells WMP, and use the competitive input identification otherwise. We further assume a constant price of bulk milk inputs ($ie\ w_{fb} = w_b\,,\ \forall\, m$) and use market prices for France provided by the European Commission[26]. Similarly to what we do for local markets i, we define $e_{bj} = \frac{e_b}{e_j}$ using dry matter content information on bulk milk inputs from the CNIEL.

Discussion of the Competitive Input and competitive Output Assumptions

We think that the competitive output assumption is quite natural. WMP is the adjustment output used by dairy firms to dispose of short term overproduction. The drawback of this assumption is that WMP is generally not produced by small and medium producers. We use instead the competitive input assumption in that case. This assumption relies on WMP as a perfect substitute for raw milk. In practice, intermediary inputs can (almost) always be replaced by raw milk, but the reverse is not always true (for raw milk cheese, for example). In the theoretical part of the paper, we assume that this perfect substitution is valid for processing every output. In fact, the competitive input assumption is relevant as long as WMP is a perfect substitute for raw milk used for at least one product processed by the firm, which is a much less restrictive assumption. In order to avoid concerns on the substitutability between inputs, we exclude PDO and organic milk of our analysis.

5. Results: Margins, Markdowns and Markups

In this section, we show that dairy manufacturers exploit both markups and markdowns. On average, dairy firms' margins mostly come from markups but the relative contributions significantly vary across time and products. We show that neglecting the markdown and assuming that the entire margin comes from the markup would have lead to a substantial bias in the markups estimates.

[26]These data can be found here: Bulk commodities prices.

5.1. Overview of the Entire Period

Average and Median Estimates

Using our estimates of the output elasticities of labor and Equation (2.8), we can retrieve total margins. Together with the competitive input and output first-order conditions from Equation (2.16) and Equation (2.17), we can decompose these margins to retrieve markups and markdowns. Table 2.6 displays their average and median levels over the whole period of analysis (2003-2018)[27].

Table 2.6: Margins, Markdowns and Markups - Estimates

	Markdown	Markup		Margin	
Sample	All	All prod.	Final prod.	All prod.	Final prod.
Average	1.18	1.21	1.55	1.51	1.91
Weighted Average	1.18	1.45	1.68	1.62	1.87
Median	1.15	1.04	1.44	1.38	1.89
Observations	8,049	8,142	4,831	71,899	43,505

Notes: Sample restricted to firms for which we manage to link raw milk collection and production. Markdowns computed based on raw milk prices at the regional level. Weighted averages based on quantity (dry matter content) shares upstream and downstream. Markdowns at the firm-department-time level, markups at the firm-product-time level, margins at the firm-department-product-time level.

- We find that the industry's weighted average margin amounts to 1.62. It means that, on average, the price of a processed unit of milk input dry matter sold by a French dairy exceeds the accounting marginal cost of 62%. This weighted average margin goes up to 87% if we focus only on final products.
- The weighted average markup equals 1.45. It implies that, on average, the price of a processed unit of milk input dry matter sold by French dairy firms exceeds the economic marginal cost by 45%. This weighted average markup when we restrict to final products inflates to 68%. Both of these weighted averages are significantly higher than the corresponding median and simple averages, implying that bigger firms tend to enjoy higher markups, suffering relatively less than smaller sellers from the existence of countervailing buyer power emanating from concentrated retailers.
- The weighted average markdown is 1.18. It means that, on average, a unit of raw milk dry matter produced by a French dairy farm is paid 85% ($1/1.18 \approx 0.85$) of the marginal value it generates for the purchasing dairy firm.

[27]For all aggregated statistics in this section, we use raw milk prices at the regional level, which we have over the entire period. Using individual raw milk prices for the subsample of firms and years (2013-2018 deliver similar aggregated results for the corresponding period.

These results suggest that, on average, markdowns are relatively low compared to markups and that dairy firms' margins mainly come from the exploitation of seller power, especially for bigger firms having more seller power. We discuss and compare these results in Section 6..

Margin Decomposition

In this subsection, we seek to attribute markups and markdowns' contributions to the deviation from perfect competition defined by $M_{fij} = \mu_{fj} = \nu_{fi} = 1$. To do so, we define margin rates $\tilde{M}_{fij}$, markup rates $\tilde{\mu}_{fj}$ and markdown rates $\tilde{\nu}_{fj}$ with $\tilde{x} = x - 1$ for $x = \{\nu_{fi}, \mu_{fj}, M_{fij}\}$. We can then rewrite Equation (2.6) and get:

$$\tilde{M}_{fij} = \underbrace{\tilde{\mu}_{fj}}_{\text{Markup contrib.}} + \underbrace{\theta_{fij}\tilde{\nu}_{fi}}_{\text{Markdown contrib.}} + \underbrace{\tilde{\mu}_{fj}\theta_{fij}\tilde{\nu}_{fi}}_{\text{Joint contrib.}} \tag{2.19}$$

This decomposition shows that the difference between total margins and markups comes from two terms. First, markdown contributes directly to the margin rate up to $\theta_{fij}\tilde{\nu}_{fi}$, *i.e.* proportionally to the share of milk in total marginal costs[28]. Second, markdowns also indirectly contribute, by interacting with the markups.
In the French dairy industry context, falsely assuming that manufacturer only have one source of market power (*i.e.* either markup or markdown), generates four types of errors, with varying magnitudes:

(i) A total margin that is well estimated - with a production function approach, for example - but falsely attributed to the sole markup would have lead us to assess a markup rate of 62% (instead of 45%) leading to an overestimation of 38%.

(ii) If the total margin was again well estimated but (conversely) falsely attributed to markdown only, then markdown would have been overestimated by 244%.

(iii) A markup that is well estimated - with a demand estimation approach, for example - but falsely interpreted as a total margin could have lead us to underestimate the global market power by 27%.

(iv) A markdown that is well estimated - with a supply estimation approach, for example - but falsely interpreted as a total margin, could have conducted us to underestimate total market power by 70%.

Markups and markdowns have similar first order consequences on welfare. They lead to a reduction of quantities, an increase of prices faced by final consumers, and a decrease

[28] Remind that we defined $\theta_{fij} = \frac{w_{fi}}{w_{fi}+e_{ij}\lambda_{fj}}$, which is the share of milk input i in the accounting marginal cost of producing j.

of price perceived by farmers[29]. Hence, the total margin appears to be the appropriate measure of distortion[30]. Nevertheless, it is essential to disentangle the origins of market power to efficiently tackle the issue. Errors (i) and (ii) would on the contrary bias the policy recommendations by misnaming the origin of inefficiency. Errors (iii) and (iv) would understate the magnitude of the distortion.

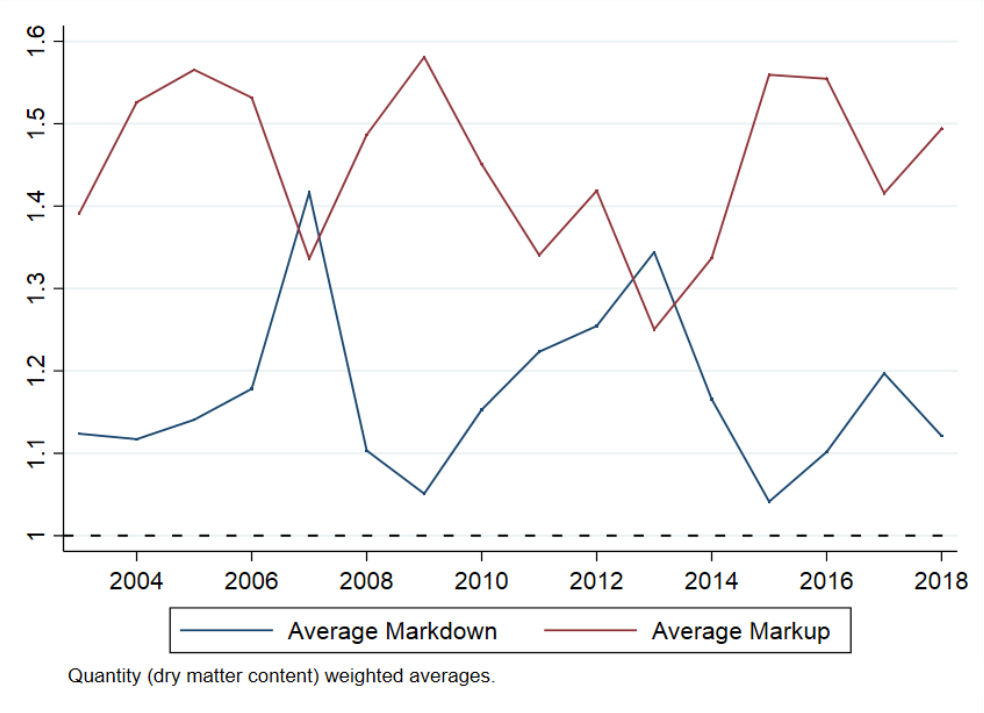
5.2. Trends and Fluctuations

In this section, we show that while dairy manufacturers' margins are relatively stable over time, markups and markdowns contributions significantly vary.

Markdowns and Markups Fluctuations

Markups and markdowns vary over time, as shown in Figure 2.4. Over the period, the average markdown rate fluctuates between 4% and 40%, while the average markup rate lies between 27% and 61%. Our estimates indicate that markdowns are higher than markups for two years during the period of analysis (2007 and 2013).

Figure 2.4: Markdowns and Markups - Estimated Weighted Averages



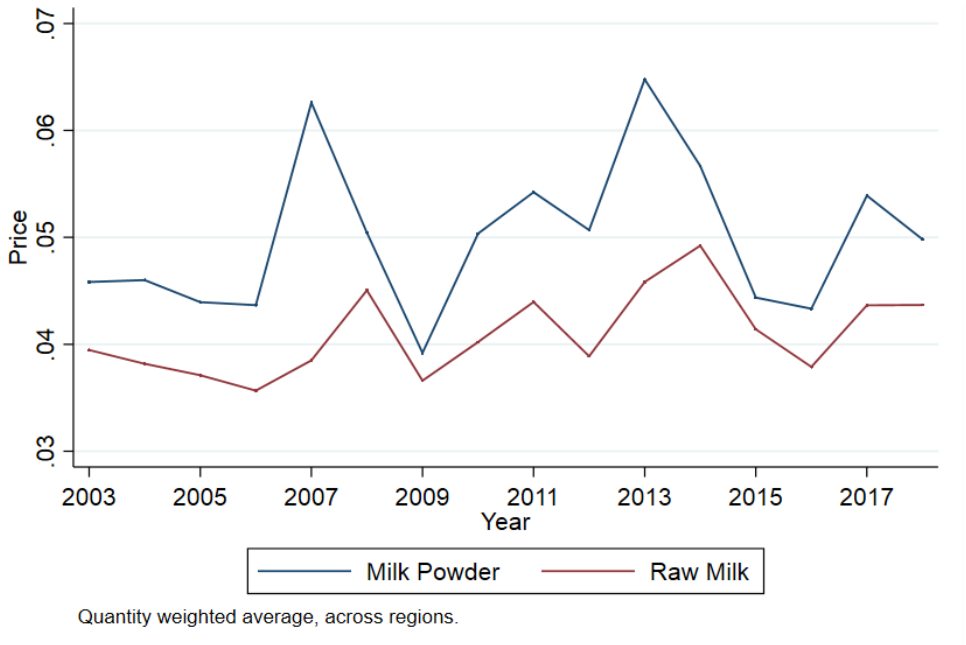
Markups and markdowns are negatively correlated. As shown by Figure 2.5, markdowns fluctuations follow the variations of the competitive input price (whole milk powder, henceforth WMP). Under perfect competition, the markdown (and the markup) would

[29] See Appendix 2.A for a simple example and graphical representations.

[30] Note however that deadweight losses depend on the true elasticity of supplies and demands and not only on the magnitude of the margin.

be stable and equal to 1. Raw milk price variations would perfectly reflect *WMP* price variations. Our data show instead that the markdown varies across time due to an *incomplete pass-through*. When the *WMP* price increases, raw milk price increases but less than proportionally. A possible explanation is that above a given threshold level, raw milk supply becomes inelastic as farmers' productions reach their total capacity constraints. Manufacturers thus do not have any reason to increase more raw milk prices, and markdowns increase to reach relatively high levels (1.42 in 2007, 1.34 in 2013). Conversely, when the *WMP* price decreases, raw milk price decreases as well but again less than proportionally. During dairy industry crises, markdown comes even close to unity: 1.05 in 2009 or 2015. This incomplete pass-through appears as it may be necessary to maintain a sufficient supply from farmers, reflecting the fact that dairy firms take into account long-term consequences when exploiting short-term buyer power (Crespi et al., 2012). Doing so, manufacturers internalize their effect on *local* supply *on the long run*. Manufacturers do not want to see their local suppliers exiting the market given the important raw milk transportation costs or sunk fixed costs in plants location. Overall, these manufacturers' behaviors smooth raw milk prices. It explains why the markdown levels are close to their competitive level (1) during dairy market downturn phases (2009, 2015) and remarkably high when the dairy market thrives (2007, 2013).

Figure 2.5: Whole Milk Powder Price and Average Raw Milk Price

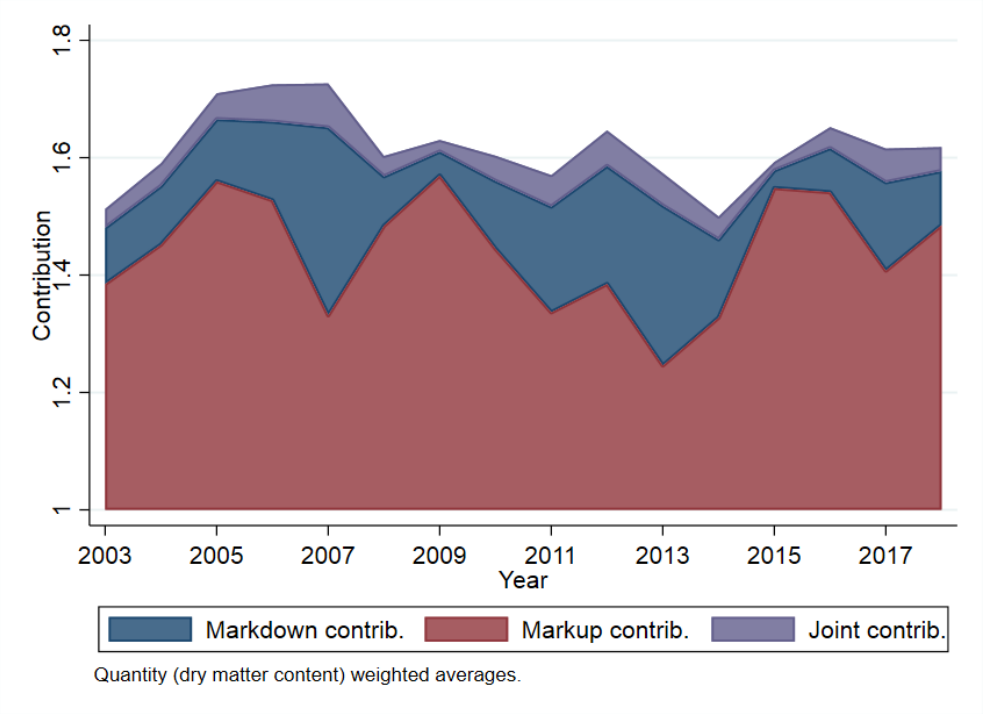


Margin Decomposition over Time

Figure 2.6 shows that the average margin rate is relatively stable, around 60% over the period, but the relative contribution of markups and markdowns vary during the period.

If we had disregarded buyer power exerted by dairy manufacturers on raw milk farmers and attributed the entire margin to seller power, we would have overestimated the markup rate by a factor lying between 6% in 2015 and 129% in 2013.

Figure 2.6: Average Markdowns and Markups Contributions to the Total Margin



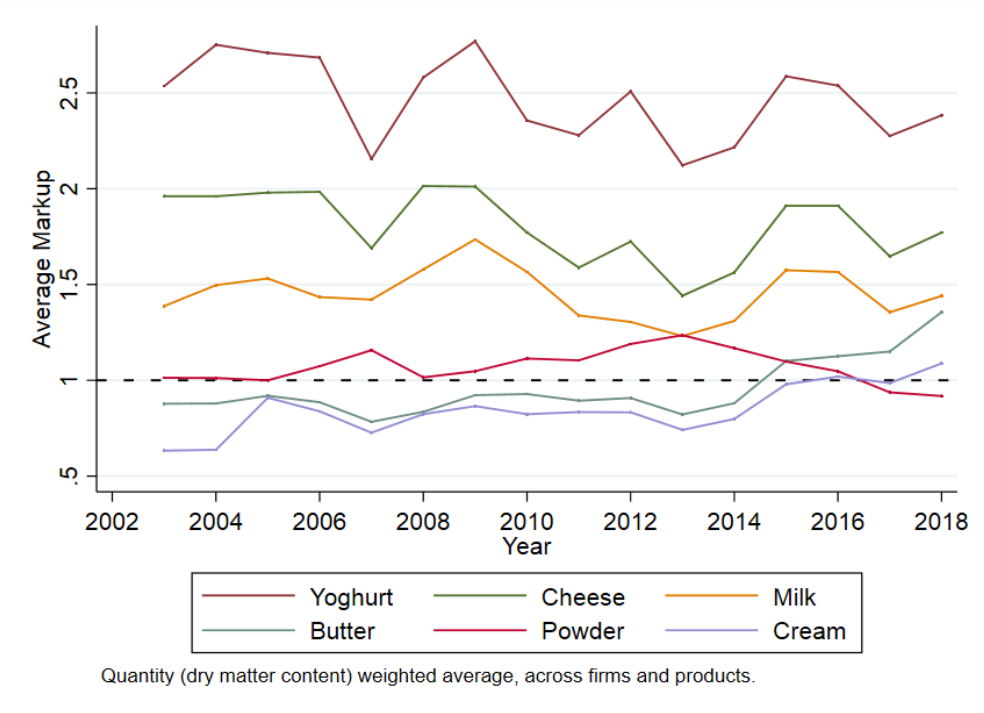
Sources of market power can drastically vary over time, while the overall level of market power (buyer *and* seller power) can remain constant. In particular, the underlying raw milk supply and demand elasticities may have changed over the period of analysis. Any estimating framework relying on estimating reduced-form elasticities would have on the contrary required fixing the elasticities, for some time-window at least, and constrained the markdowns and markups estimates to more stability across time (and firms). Our results thus argue against constant price elasticities assumptions, at least in our context.

5.3. Products Heterogeneity

Computing weighted average by product category shows how markups vary across products and the importance of taking this dimension into account. Figure 2.7 shows that the average markup broadly lies between 1.5 and 2.5 for final products (yoghurt, cheese, conditioned milk), whereas products mainly sold in bulk (milk powder, cream, butter) have relatively low markups, close to or lower than unity. Among final products, markups are higher for more differentiated products such as yoghurts and cheeses compared to the less differentiated conditioned milk. Among bulk products, milk powder features an average markup of around one. The milk powder category encompasses whole milk powder - on which our methodology imposes a markup equal to one for a subsample of

firms - but also skimmed milk powder. Interestingly, markups are close to one on other bulk products, sold on similar global markets, on which our estimating procedure does not impose a constraint. This feature is supportive of our hypothesis of competitive products.

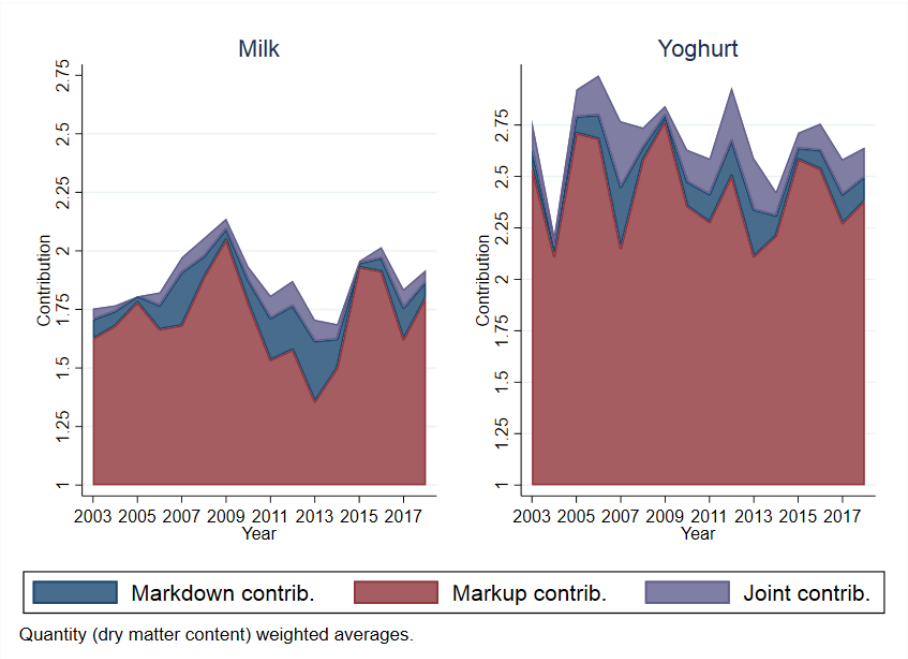
Figure 2.7: Markups - Estimated Weighted Product Averages



A caveat of our approach can explain that bulk products markups estimates slightly deviate from unity. Throughout our estimating approach, we considered that the appropriate measure of milk input is the *total* dry matter content, implicitly implying that fat and protein are perfect substitutes. However, this graph suggests a price for fat and another for proteins. The departure of the red line to one is indeed driven by skimmed milk powder price, which is rich in protein and poor in fat. When the line goes above (below) one, this means that the relative price of proteins increases (decreases). Cream and butter conversely are relatively richer in fat than in proteins. The average markups on these products thus vary oppositely to the skimmed milk powder average markup. Another fair concern already mentioned about our product-level markups is that we estimated marginal processing costs at the firm-level. However, the reader shall have in mind that the share of milk in total marginal costs is stable around 80% during the period. Thus, 80% of the estimated (total) marginal costs is constituted by milk purchases necessary to produce a given product, which are highly product-specific through e_j. This feature together with the stability of labor shares across mono-product firms specialized in different products lead us to think that the bias due to this approximation is relatively small.

Heterogeneity in Markdowns Contribution to the Margin, by Product

Figure 2.8: Average Markdowns and Markups Contributions, by Product



Total margins made on low markups (and margins) products rely more on buyer power exploitation. Figure 2.8 illustrates, for instance, how the markdown contributes relatively more to the total margin made on relatively homogeneous products such as conditioned milk compared to the one made on more differentiated products such as yoghurts. On average, buyer power on raw milk contributes to 19% of the dairy manufacturers' margins made on conditioned milk, peaking up to 50% in 2013, while markdowns more modestly contribute to overall margins on yoghurts, with an average contribution of 7% (14% in 2013).

6. Discussion

6.1. Comparison of Market Power Estimates with the Literature

This section discusses our estimates of markups and markdowns, comparing them to the existing literature.

Markdown literature

Table 2.7 displays markdowns levels estimated in the (most related to our work) literature. This literature gathers both very recent work in various industries and older work in the specific context of agri-markets, in which market power has long been a concern. Estimated markdowns vary a lot in the literature, for many reasons. First and

foremost, markdowns highly depend on the context, industry specificities or the input of interest. Importantly, estimated markdowns also depend on the estimation methodology and the underlying assumptions. While discussing assumptions made in the literature is beyond the scope of this paper, we want to emphasize here that our methodology has the advantage of remaining fully agnostic on the competition structures both upstream and downstream. Thanks to the existence of the competitive input/output (whole milk powder), we can disentangle markups and markdowns without having to specify demand or supply functions and estimate the corresponding elasticities. Our estimation methodology thus do not rely on estimating *reduced-form* elasticities, which may differ from *structural* elasticities, as pointed out by Berger et al. (2019).

Table 2.7: Markdowns in the Literature

Paper	Markdown	Industry	Input
Rubens (2021)	4.37	Cigarettes	Tobacco leaf
Morlacco (2019)	2.11	Food & Beverages	Materials
Zavala (2020)	2.04	Agri-Food	Various crops
Hershbein et al. (2021)	1.53	Various	Labor
Berger et al. (2019)	1.35	Various	Labor
This paper	**1.18**	**Dairy**	**Raw milk**
Azar et al. (2019)	1.17	Various	Labor
Crespi and Sexton (2005)	1.10	Agri-Food	Cattle. Potato & Rice
Various papers (90's-00's)[31]	1.00-1.03	Cattle ind.	Cattle

Sexton (2012) lists several factors explaining the mitigation of buyer-power exerted by dairy manufacturers. It is costly for a firm to change suppliers due to the existence of significant transportation and transaction costs. Manufacturers thus face a trade-off between exploiting short-term market power and preserving a long-term local supply. This generates a wedge between the current markdown and the one predicted by the classical approaches relying on short-term supply elasticities. Interestingly, our estimation methodology does not rely on these short-term elasticities. In our theory, marginal revenue and economic marginal cost could encompass any economic cost of lowering raw milk price or increasing output price fixed by the firm. The hypothesis of long-term considerations reducing markdown is consistent with the low level of buyer power found by an older literature which has tried to assess buyer power in various (U.S.) agricultural markets, exploiting other approaches, as summarized in Crespi et al. (2012). These studies often assumed constant market power across time, which our results show is a very (too) restrictive assumption. Thanks to our data and estimating framework, we find evidence of significant buyer power, very high during market booms, and still existing during market downturns, but drastically less exploited.

Markup litterature

Table 2.8: Markups in the Production Function Approach Literature

Paper	Markup	Industry	Output
De Loecker and Scott (2016)	1.92	Beer	Beers
De Loecker et al. (2016)	1.78	Food & Beverages	Food & Beverages
This paper (margin)	**1.62**	**Dairy**	**Dairy prod.**
De Loecker et al. (2020)	1.61	Manuf., Retail & Wholes.	Various
This paper (markup)	**1.45**	**Dairy**	**Dairy prod.**
De Ridder et al. (2021)	1.34	Manufacture	Various
De Loecker and Warzynski (2012)	1.28	Manufacture	Various
Hershbein et al. (2021)	1.2	Various	Various
Rubens (2021)	0.52	Cigarettes	Cigarettes

Table 2.8 locates our paper in the markups estimation literature using production function. To the exception of Rubens (2021) and Hershbein et al. (2021) who distinguish markups and markdowns[32], the relevant comparison to be made regards our *margin* estimates and their *markup* estimates. Indeed, most of these papers assume buyer power (on materials) away for estimation purposes. Using the margin decomposition, we have shown in our context that, *despite a relatively low average markdown level* (1.18), erroneously assuming that dairy firms do not impose markdowns on raw milk (*i.e.* $M = \mu$ and $\nu = 1$) would have led to overestimate markup rates by 38% on average. If the magnitude of the potential bias is of course highly context-specific, it seems to indicate that, at least in sectors where buyer power is a possibility, *markups* estimates may be more safely reinterpreted as *total margins*. Our estimates of the total margin align with De Loecker et al. (2016); De Loecker and Scott (2016); De Loecker et al. (2020), in contexts which are the closest to ours. Note that we included in Table 2.7 the weighted average levels of markups and margins on *all products* in the French dairy markets. This is typically the relevant point of comparison with other papers presented here, which most of the time do not distinguish between *final* and *intermediate* products. An exception is De Loecker and Scott (2016), who found - ignoring buyer power - an average markup of 1.92 on beers, thus comparable with our average margin of 1.87 on *final products*.

Our markup estimates align more with literature's markups in the broader manufacture sector (De Ridder et al., 2021; De Loecker and Warzynski, 2012), a possible interpretation being that these estimates may be overall less contaminated by buyer power in a context in which it is arguably less a concern[33]. On the contrary, in the beer industry as

[32] Rubens (2021) estimates a markup for Chinese cigarettes manufacturers which may appear very low but is explained by the present of a monopsonist buyer further downstream. Note that Hershbein et al. (2021) allow for and measure a markdown on labor, but not on materials, similarly to most papers here cited.

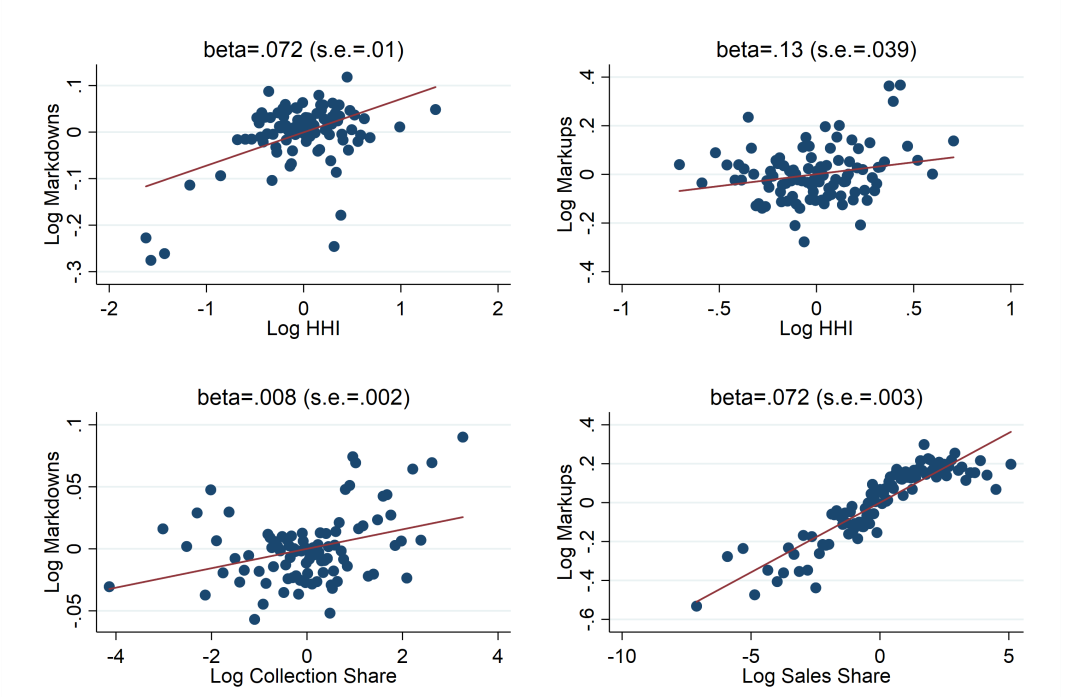
[33] At least at this stage of the value added chain.

in at least some sectors of the broader food and beverages industry, and even though disregarded by the authors for practical concerns, manufacturers may exploit buyer power, for reasons similar to some of the ones outlined in our specific context. This could be a reason why markups measured in these papers are higher than those measured in a broader manufacturing context.

6.2. Market Power and Competition Structures

Panel 2.9 plot our estimated measures of market power against usual variables, such as concentration measures (HHI) at the market-level or market shares at the firm-market-level. The graphs at the top show how average markups and markdowns are higher on more concentrated markets, consistently with many theories such as Cournot or monopolistic competition. At the bottom, we see how our measures of markdowns and markups positively correlate with dairy firms' collection and sales shares within the market. The relatively small coefficient governing the relation between markdowns and collection shares can be interpreted as a piece of evidence that upstream price is determined at the market-level. Downstream, the coefficient linking firms' individual market shares and markups is also significantly positive but an order of magnitude higher. These results are in any case reassuring we do measure market power and not other frictions, as alternative explanations would not generate such patterns.

Figure 2.9: Market Power and Competition



Obs. at the market-time (up) and group-market-time level (bottom), grouped into 100 equal-sized bins in terms of the X-axis var. Variables de-meaned by time on the up left-hand graph, by market and time on the up right-hand graph, and by market-time on the two bottom graphs.

7. Conclusion

In this paper, we show how total margins made by firms in imperfectly competitive markets rely on their exploitation of market power both when selling products but also when purchasing inputs. We quantify the respective contributions of buyer and seller power to manufacturers' margins in the French dairy market. To do so, we rely on a production function approach exploiting (i) the technical relationship between raw milk and dairy products and (ii) the existence of a competitive product - to estimate firm-market-level markdowns and firm-product-level markups. Our results indicate that dairy manufacturers exploit both buyer and seller power: on average, dairy firms purchase raw milk at a price 15% below its marginal contribution to their profits, while selling a dairy product at a price exceeding its economic marginal cost by 45%. Markups and markdowns aggregate to generate a global margin rate of 62%. These results imply that we would have overestimated markups rates by 38%, had we ignored buyer power, as is often done in the production function approach literature. Our paper also demonstrates the importance of implementing estimation methods which take firms, products and time heterogeneity into account, as markdowns and markups highly vary across these dimensions, even within a specific market such as the French dairy industry.

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Appendix

Appendix 2.A A Simple Model

In this section we display graphical representations of the equilibrium for a simplified framework assuming:

- a single-product and single-input dairy firm
- facing a linear product-demand $p(y) = 1 - y$ and input-supply $w(m) = m$
- no marginal processing cost ($\lambda = 0$)
- a transformation process $y = m$

We go from the equilibrium prevailing under perfect competition on both the output and input markets to the one prevailing in presence of market power on both sides, going through both the buyer and seller power case alone.

Figure 2.10: Perfect Competition

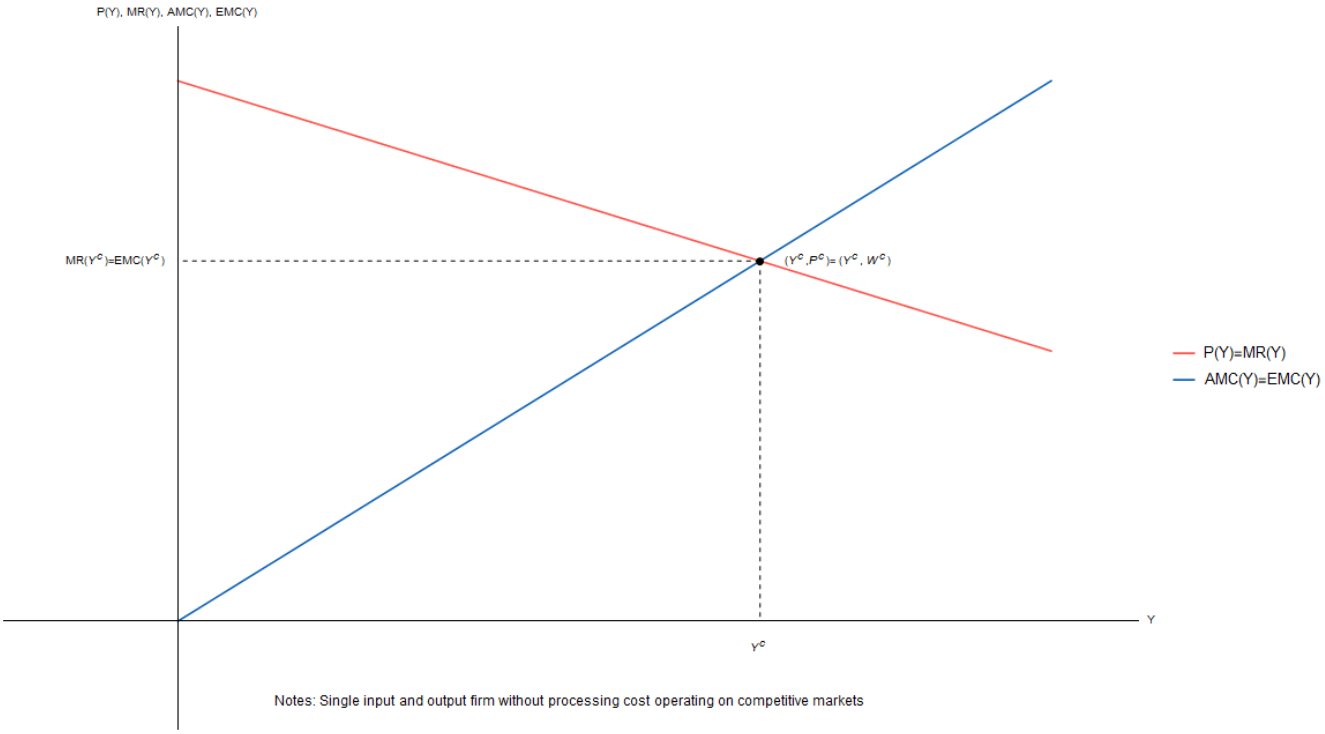


Figure 2.11: Seller Power Only

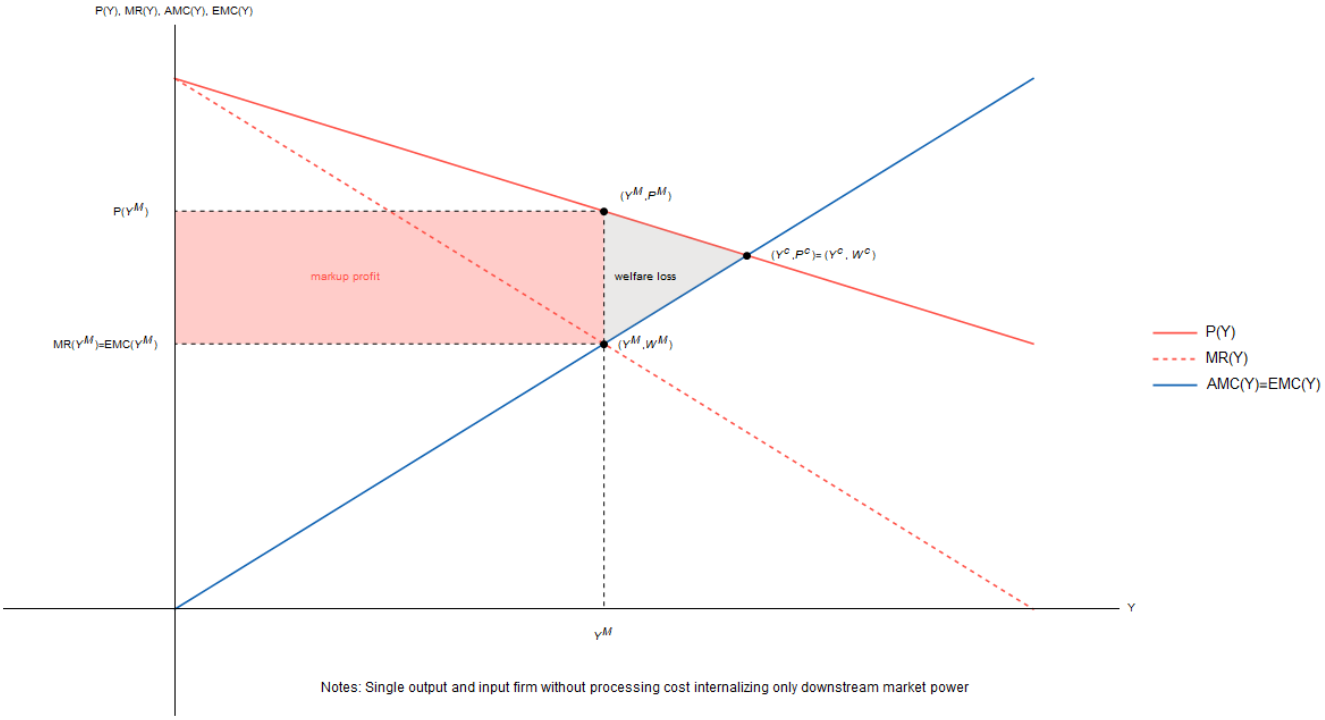


Figure 2.12: Buyer Power Only

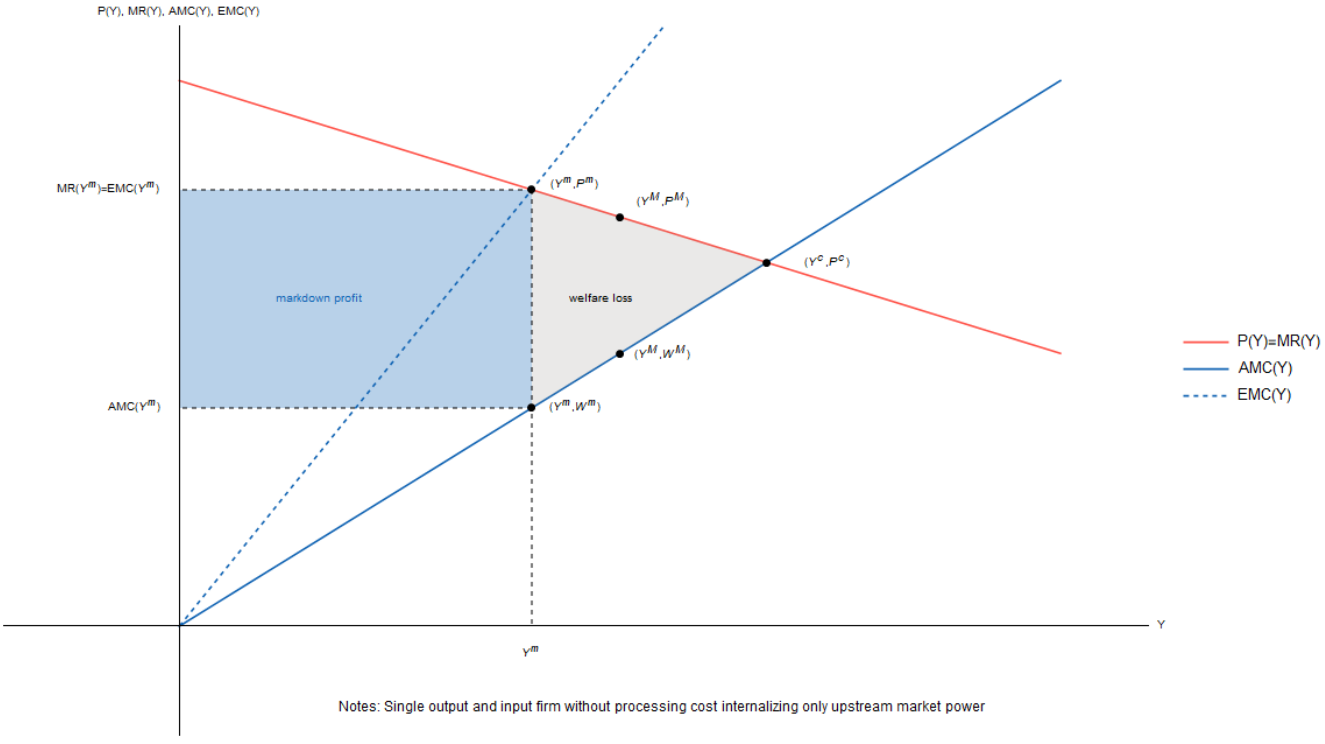
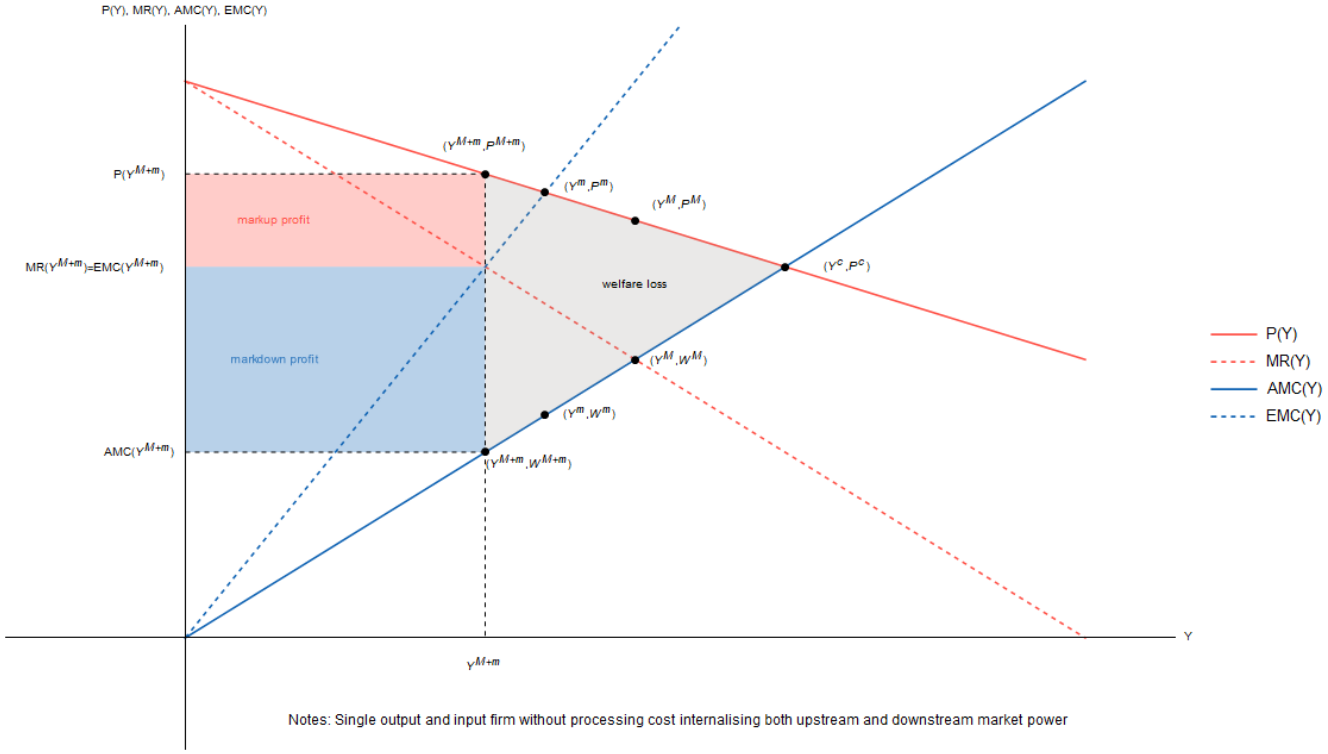


Figure 2.13: Buyer and Seller Power



Appendix 2.B Discussing the Main Assumptions

2.B1. Theoretical Assumptions

Static and Dynamic Inputs

Correlations shown in Table 2.9 are reassuring evidence that labor, milk and materials as a whole are arguably variable and statically chosen, while capital is more dynamic.

Table 2.9: Correlations between Yearly Growth Rates

	Labor (wage bill)	Capital	Milk Inputs
Output $\%\Delta_t$	0.20	0.09	0.68
Output $\%\Delta_{t+1}$	0.08	0.10	0.06

Competitive Labor

In the presence of oligopsony power on labor, we would have

$$\lambda_{fj} = \frac{\left(1+\Psi_f(l_f^*)\right) z_f}{\frac{\partial F_j(l_f, k_f, Y_{f-j}^*, \Omega_{fj})}{\partial l_f}} = \left(1+\Psi_f(l_f^*)\right) \frac{z_f l_f^*}{\beta_l^j y_{fj}^*}.$$

We assume away labor market power because dairy firms are:

- relatively smaller on labor market(s) than they are on milk markets. Labor market power is this industry is thus arguably not a first order concern.
- confronted to regulation, especially minimum wage. On workers at the minimum wage level, the labor supply is inelastic and there is no room for labor market power. The industry mainly employ low skilled workers, paid at the minimum wage.

Ignoring Materials other than Milk Inputs

We exclude non-milk intermediary inputs from our estimation of firms marginal costs. We argue that this restriction is unlikely to have a significant impact on our marginal costs estimates. We compute the ratio between the raw milk expenses declared in the production data (*i.e* EAL) over total intermediary expenses recorded in balance sheet data (*i.e* FICUS-FARE). The remaining gap between this ratio and 1 is at least partly explained by intermediary dairy inputs purchases (such as whole milk powder and other bulk products), which we do not observe but which are however taken into account in our theory. Any residual gap would result from any non-milk intermediary inputs purchases, which seems to be insignificant. The sample used for this ratio is restricted to firms and years for which we observe prices at the firm-department-year level.

Table 2.10: Milk to Materials Expenses Ratio

Average	Median	P25	P75	Obs.
0.78	0.88	0.65	0.95	980

2.B2. Identifying Assumptions

firm-level Production Function Estimation

The labor shares displayed in Table 2.11 are supportive of a firm-level production technology, as labor shares distribution of specialized firms are remarkably constant across product categories.

Table 2.11: Labor Shares by Product Category, Monoproduct Firms

	Butter	Cream	Cheese	Milk	Powder	Yoghurt
Average	0.79	0.77	0.80	0.83	0.78	0.84
Median	0.79	0.73	0.78	0.77	0.83	0.81
P5	0.62	0.65	0.57	0.57	0.60	0.64
P25	0.74	0.70	0.71	0.71	0.75	0.74
P75	0.86	0.81	0.88	0.84	0.93	0.89
P95	0.94	1.00	0.97	1.00	1.00	0.96
Obs.	91	54	1,878	188	110	383

Notes: Specialized firms here defined as firms for which at least 80% of milk purchases is transformed into that product. Labor shares computed assuming a constant depreciation rate of capital over 10 years.

Translog Estimates

Table 2.12 shows how all quantiles of the distribution of elasticities resulting from the translog specification relatively well align with their counterparts in the empirical distribution of respectively labor and capital shares in total processing costs (labor and capital costs).

Table 2.12: Translog Elasticities and Input Shares

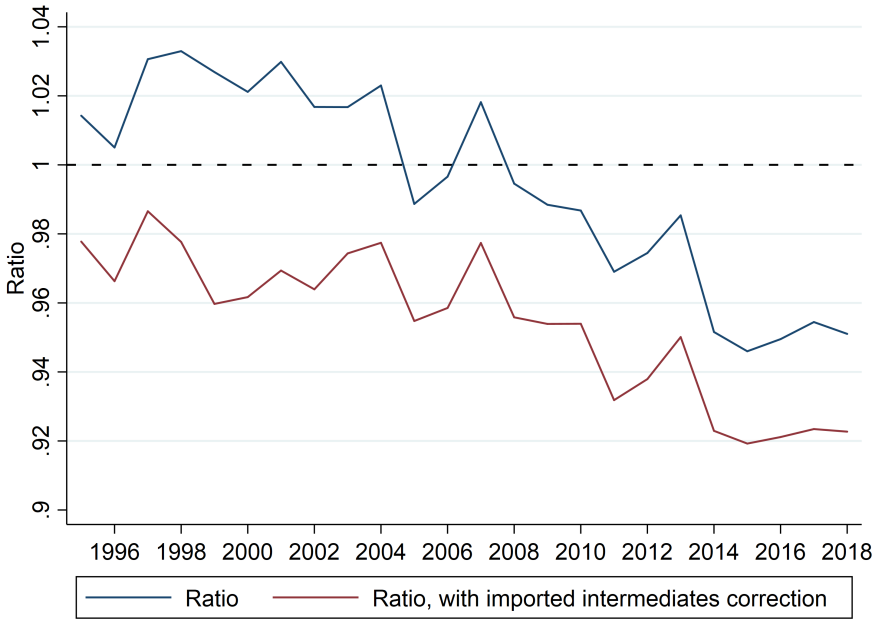
	Average	Median	P5	P25	P75	P95	Obs.
Labor Elasticity	0.79	0.79	0.65	0.73	0.86	0.95	2,736
Capital Elasticity	0.14	0.14	0.01	0.09	0.19	0.24	2,736
Labor Share in Processing Costs	0.73	0.73	0.57	0.66	0.80	0.90	2,736
Capital Share in Processing Costs	0.27	0.27	0.10	0.20	0.34	0.43	2,736

Notes: Distributions winsorized at 1% and 99%. Labor shares computed assuming a constant depreciation rate of capital over 10 years.

2.B3. Relevancy of Dry Matter Content Data

We plot here the ratio between the simulated manufacturers' needs in raw milk and the actual raw milk production. Over the period, the underestimation of the demand is contained between 2 and 8 percent which can be explained by a waste in the processing process which is assumed to be zero when dry matter content data are constructed.

Figure 2.14: Estimated needs in raw milk vs France and real production



Chapter 3

Production Quotas Reforms and the Cream-Skimming of the French Milk Market

Note: This chapter is co-authored with Etienne Guigue[1]

Abstract

This chapter analyzes the impact of production quotas and of their progressive removal on the French milk market. We show that production quotas generated two types of distortions. First, by mechanically fixing departmental production shares at their pre-quotas 1984 level, they stopped a natural spatial concentration for about 25 years, a process which restarted right after the beginning of the quotas removal process in 2008. Second, the implementation of quotas in France overall encouraged small farms' growth and conversely constrained expansion possibilities of bigger farms. We enhance that this redistributive scheme successfully refrained growing inequalities among farms, but it came at the cost of partially distorting the *cream-skimming* of farms. We finally document how the inherent catching-up process in farms selection intervened more or less early across regions, depending on the stringency implied by quotas constraints at the department level. We also show that most of these empirical observations can be rationalized by a simple model. Finally, the individual effect of the liberalization on farmers depends on two elements: the individual efficiency gains that the farm can achieve with the liberalization but also its localization, *i.e.* whether it is localized in a department protected by the quota or in a competitive department constrained in its production.

Keywords: Relocation, liberalization, quota.

[1]For this chapter we specifically thanks Marie-Laure Allain and Claire Chambolle.

1. Introduction

The remuneration of farmers has long been a concern in France, as numerous policy changes - ranging from the Common Agricultural Policy (CAP) creation in 1962 to the recent Egalim laws in France (2018 and 2021) - tend to show. This is also an important public debate in France, regularly fueled by media reports[1] but also cultural creations such as Edouard Bergeon's movie "Au Nom de la Terre" (2019) or Michel Houellebecq's novel "Sérotonine" (2019), essentially describing French farmers difficulties to earn a living.

This paper analyzes how French dairy farms have been affected by the introduction of milk production quotas in 1984 and their removal in 2015. This quota regime has shaped the European dairy industry for more than thirty years. Its implementation originally replaced a European price support policy which previously led to a huge overproduction in the early 1980's. Therefore, the objective of the quotas introduction was twofold: supporting farmers' incomes and controlling produced quantities.

Production quotas were first allocated to each European Union (EU) member state, imposing upper bounds on productions at the national level. Each state could then internally allocate production quotas among its milk producers. In France, the implementation of quotas also aimed at reaching two additional goals: (i) refraining a growing production dispersion across farms, and (ii) attenuating territorial inequalities. French authorities thus opted for an attribution of quotas by department, thus fixing their production level. Departmental authorities were then in charge of delivering quotas across farms, following a redistributive scheme favoring small farms to the detriment of larger farms. In 2003, a CAP reform aiming at reducing distortive effects of regulation within European agricultural markets acted the progressive removal of quotas starting in 2008 and completed in 2015, after seven years of progressive quotas increases[2].

Backed by a simple model, we distinguish the effects quotas had due to the constraints imposed on farms' sizes from those due to the implied constraints on the spatial allocation. This model allows us to make easily testable predictions on the market evolution after following the quotas removal.

In order to test these predictions, we exploit several datasets. The first one contains milk production and the number of farms at the department-year level for the 1995-2018 period. To complement these data, we also mobilize farm-year level quotas and production data, which we observe from 1995 to 2014 and from 2007 to 2018, respectively.

Using these data, we make observations which confirm the theoretical predictions. Through the fixed allocation at the department level, quotas have completely stopped a growing spatial concentration, freezing the distribution of milk production across space for

[1] See "L'ogre du lait" by France Culture, or "Produits laitiers : où va l'argent du beurre ?" by France 2 among many others.

[2] We carefully describe the specificities of the French allocation scheme and the details of the quotas removal in Section 2.1..

25 years. The concentration process restarted with the gradual quotas removal, resulting in an ongoing polarization of departments' market shares, as production grows in initially important departments and declines in initially smaller ones. Moreover, we show that the exit rates of farms in inefficient departments largely anticipated the quotas removal, farmers probably taking into account expected profits on the long run.

Due to the redistributive scheme French policymakers opted for, the growing inequalities in farms' productions and revenues were successfully restrained during the quota period. On the contrary, the quotas removal eventually authorized large farms to grow relatively faster than small, a phenomenon which was completely inverted by the quotas redistributive scheme. The containment of inequalities between farms and departments thus overall appears to have come a the cost of generating distortions which altered the natural *cream-skimming* of the least inefficient farms on the French milk market.

We additionally document the reallocation dynamics which progressively led the French milk market to its current (2018) structure. On the one hand, we show that the spatial relocation process started in 2008, following the first quotas increases, and quickly strengthened over the subsequent years. On the other hand, we exhibit evidence that the inter-farms reallocation processes initiated at various dates across territories, depending on the stringency of quotas constraints at the department level. We show that, consistently with our theoretical setting, individual farms evolutions under the quotas regime and the progressive liberalization ultimately depend on their geographical localization and position in the farms sizes distribution.

Our work is part of a literature studying the impact of the quota liberalization on the dairy market. Its expected impact on international dairy trade was largely studied *ex ante* (Bouamra-Mechemache et al., 2002b,a; Lips and Rieder, 2005; Witzke and Tonini, 2009). Bouamra-Mechemache et al. (2008) in particular compare the respective expected effects of a *soft landing* strategy, *i.e* the gradual increase of quotas before their complete removal, as ultimately adopted, and a *hard landing* one. The literature evaluating the effects of quotas and of their removal *ex post* is scarcer. Huettel and Jongeneel (2011); Zimmermann and Heckelei (2012); Samson et al. (2016) study the effects of quotas and their removal on dairy farms structures and growths in Europe, but none of them addressed the questions raised by quotas redistributive schemes such as the one implanted in France.

The rest of the paper is structured as follows. Section 2 presents the details of the quotas regulation, our data, and some facts motivating the theoretical elements introduced in Section 3. These facts also guide the subsequent empirical analyses of the spatial distribution of milk production presented in Section 4, as well as the description of the distortions generated across farms, shown in Section 5. Section 6 presents the dynamics of the liberalization across farms and space. Finally, Section 7 discusses possible further theoretical and empirical developments - and Section 8 concludes.

2. Context, Data and Motivating facts

2.1. The Quotas Regulation

Historical Context

The milk quotas regulation was implemented in 1984[3] in the European Union (EU)[4], as a part of the Common Agricultural Policy (CAP). The CAP has been created in 1962 with the primary goal of enhancing modernization and production of agriculture in Europe, and restrictions induced by the introduction of production rights thus mark an important shift. Before 1984, milk production was encouraged by numerous policies, such as guaranteed prices, public storage, protectionism and exports subsidies. As a consequence, the quantity of milk produced was growing fast, about +2.5% each year on average in the EU over the 1970-1983 period[5]. These production-supporting policies led to an important overproduction at the beginning of the 1980's. In 1983, the EU milk production exceeded its consumption needs by 20%, among which 13% were stored (the famous "mountains of butter") and 7% exported - at a loss - outside the EU. During the same year, the EU support price was 12% above the world average price of milk. The costs of production-supporting policies were evaluated to lie between 15% and 20% of the total production value. In such a context, the authorities opted for the creation of production quotas to protect farmers revenues and reduce the costs of the milk market regulation. Quotas were progressively introduced, at a level 3% below the 1984 European production, before being gradually decreased of 7% over the years until 1992, when they were eventually stabilized.

Milk Quotas Implementation

The production of each member state was decided at the European level. Then, each state could decide how to allocate production rights among its farmers. In France, quotas were initially allocated at the department level, based on the 1983 production levels. In turn, production rights were allocated across farmers within departments depending on the land owned by farmers. This implied that a farmer had to buy more land in order to acquire more production rights.

The modernization process of milk production over the years before the quotas implementation was very heterogeneous across farms and territories. The French quotas allocation scheme was thus designed according to a redistributive perspective of countering the rising concentration of milk production and revenues between territories (departments) and farmers. Further production divergences between departments were therefore mechan-

[3]See Council Regulation (European Economic Community) - No 856/84 of 31 March 1984 (in French).
[4]We here indifferently speak of the European Union and the European Economic Community.
[5]All the figures mentioned in this paragraph comes from the Rapport de la Commission d'Enquête du Sénat No 341 (1991-1992) (in French).

ically impeded by the quotas system, as the quotas were initially split by departments depending on their initial production shares. Importantly, no transfers of production rights between departments were authorized until 2012[6].

In order to limit growing inequalities across farms productions and revenues, a system of quotas taxes was also implemented. When land was transferred between two existing farms, quotas associated with the land were taxed in order to feed a departmental reserve, with a levy rate increasing with the buyer size. Available quotas in the departmental reserve were then attributed to farmers by a departmental comity, along a similarly redistributive scheme. The quotas were in priority allocated to relatively smaller farms and new young farmers, in order to facilitate their installation, before the potential leftovers could be split between relatively increasingly bigger demanding farms. This overall generated distortions, encouraging growth of relatively smaller farms and discouraging growth of relatively bigger ones for instance.

Quotas Removal: A *Soft Landing*

The 2003 CAP reform aimed to reduce distortive effects of regulations in European agricultural markets. In the dairy market, this policy will, associated to the growing world demand for dairy products, led the European authorities to planning the suppression of milk quotas. A *soft landing* strategy - meaning that quotas would be progressively increased between 2008 and 2015 - was decided. EU quotas were increased by 2% in 2008-2009 and by 1% each year until 2014-2015, before their total removal from 2015-2016 onward.

2.2. Data

Our analysis rests on the exploitation of several datasets, provided by the French Ministry of Agriculture[7]: the *Enquête Annuelle Laitière* (EAL, 1995-2018), the *Base Quotas* (Quotas Database, 1995-2014), and the *Enquête Livraisons* (EL, 2015-2018). From the EAL, we use the milk production and the number of farms at the department-year level[8]. To complement this data, we mobilize the Quotas Database and the EL, which contains farm level location, quotas and production data. More precisely, the former gives us the amount of quotas delivered to each farm for each year of the 1995-2014 period. For years 2007 to 2014, the database also contains the actual milk production/sales of each

[6]From 2012 to the complete removal of quotas in 2015, the repartition of quotas was delegated to "bassins laitiers" (instead of departments), which are agglomerations of several neighboring departments, thus authorizing such transfers to happen, but only within thesen narrowly defined regions.

[7]We are particularly thankful to Corinne Prost and FranceAgrimer for making this data available to us through the CASD.

[8]The EAL actually provides these measures at the buyer-department-year level, but we do not use the buyer dimension for now. We plan to extensively use this dimension in subsequent analyses, see 8.

farm, similarly to the EL for years 2015 to 2018[9].

Importantly, in what follows, we in priority use quantity data when available. For the study of farm-level behaviors before 2007, we have to use quotas data. Throughout the analysis of intensive growth rates by size of farms conducted in Sections 5. and 6., we interpret these quotas data *as if* they were productions data. In reality, the growth rates obtained may be lower bounds to the actual production growth rates. A check of respective trends for the overlapping years 2007 to 2014 for which we have individual quotas and produced quantities however confirms that quotas are a good proxy for quantities when considering farms' relative sizes and relative growth rates.

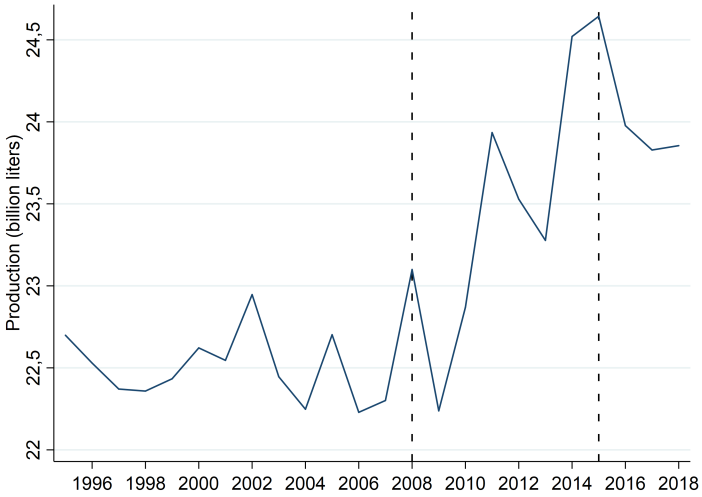
2.3. Motivating Facts

In this section, we present some aggregate trends which motivate the theoretical setup presented in Section 3. and highlight some questions raised by the progressive quotas removal, treated in the rest of the paper.

Milk Production and its Spatial Distribution

First, national milk production started to significantly rise in 2008, after having been basically stable since 1995. The progressive quotas increase was thus accompanied by a surge in raw milk production, and production quotas thus arguably seem to have impeded the growth of milk production at the national level, unsurprisingly reaching their primary goal to limit overproduction. Finally, the drop of the production in 2016 (before its stabilization) may be seen as the joint consequence of (i) the increased competition at the European level following the complete quotas removal, and (ii) of the introduction of incentives to farms to reduce quantities produced after a new overproduction crisis in 2015-2016.

Figure 3.1: Milk Production in France

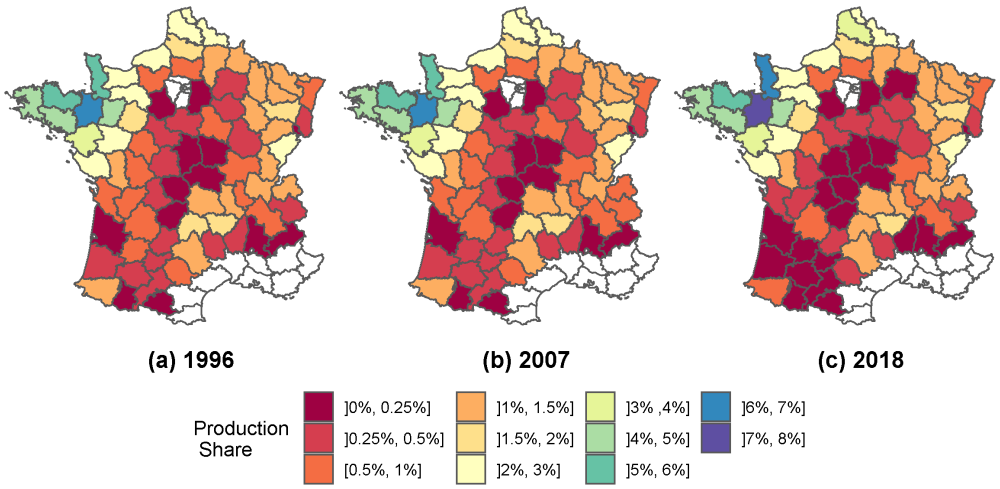


Trough their practical implementation by departments in France (described in Section 2.1.) quotas also froze the spatial repartition of milk production. Indeed, as shown by Figure 3.2, quotas mechanically stabilized production shares across departments between

[9] Again, this dataset actually contains this information at the buyer-farm-year level but we here also abstract from the buyer dimension for now.

1996 and 2007, thus stopping a trend of spatial concentration of the milk production at its 1996 level[10]. In 2018, at the end of the period of analysis and after the gradual quotas removal initiated in 2007, milk is more produced in initially important departments, and much less in initially small producing departments, from the South West of France for instance.

Figure 3.2: Departmental Production Shares



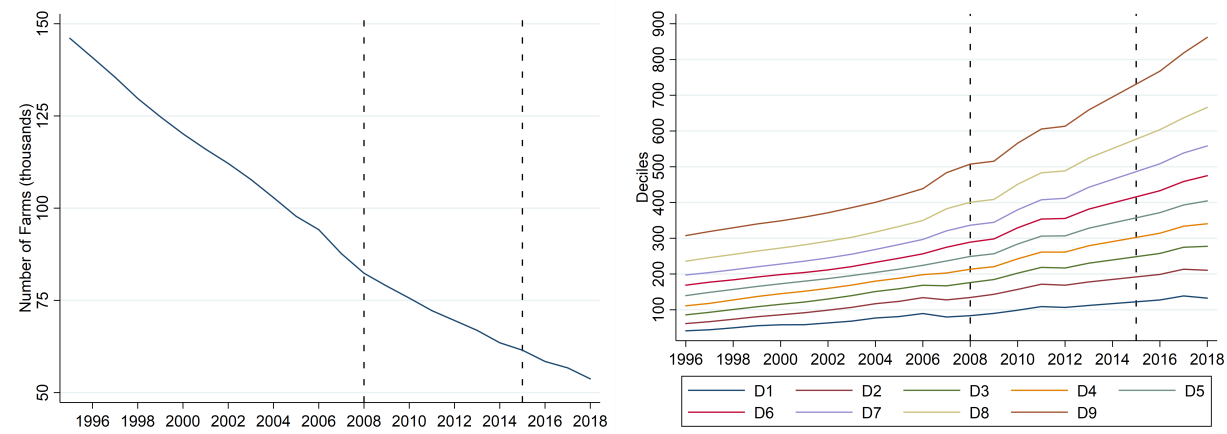
Departments in white have a null or negligible milk production.

In a first part of our analysis (Section 4.), we try to assess by how much and how quotas impeded the local growth or decline of milk production in the different territories, and thus slowed down its spatial concentration in France.

[10]Itself similar to its pre-quotas 1983 level.

Structure of Farms

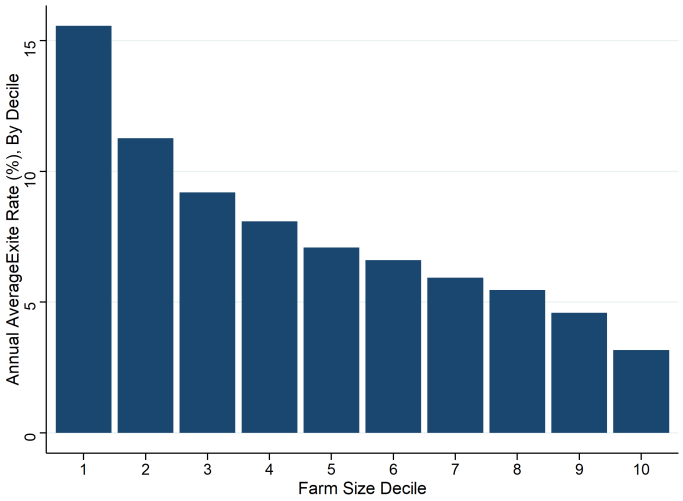
Figure 3.3: Number and Distribution of Farms



(a) Number of Farms (b) Deciles of Farms Sizes

(a) Number of raw milk producers in France. **(b)** Deciles of farms productions of raw milk, thousand liters.

Figure 3.4: Exit Rates by Farms' Sizes Deciles



Average annual exit rates by decile, 1996-2018.

Figure 3.3 (a) constitutes primary evidence that the introduction of quotas did not stop the long run trend towards greater concentration of milk production across a smaller number of farms. Indeed, the number of farms steadily decreased from 150,000 to around 55,000 between 1996 and 2018. As the production significantly increased after 2008, the yearly milk production of the average farm drastically increased, from 150,000 to 450,000 liters. This trend is common to many agricultural markets in developed countries and essentially the results of technical progress and increasing (or even increasingly increasing) returns to scale. If the quotas did not stop this *cream-skimming* process, it may however have altered it, due to the way they were implemented, aiming at favoring relatively smaller farms. Figure 3.3 (b) corroborates this intuition by showing how all deciles of the distribution of farms productions increased and widened from 1996 to 2018, but seemingly faster once the quotas started to rise.

Moreover, Figure 3.4 presents average exit rates of farms by size deciles over the whole period of analysis. Exit rates are markedly decreasing with the size of the farm[11]. We

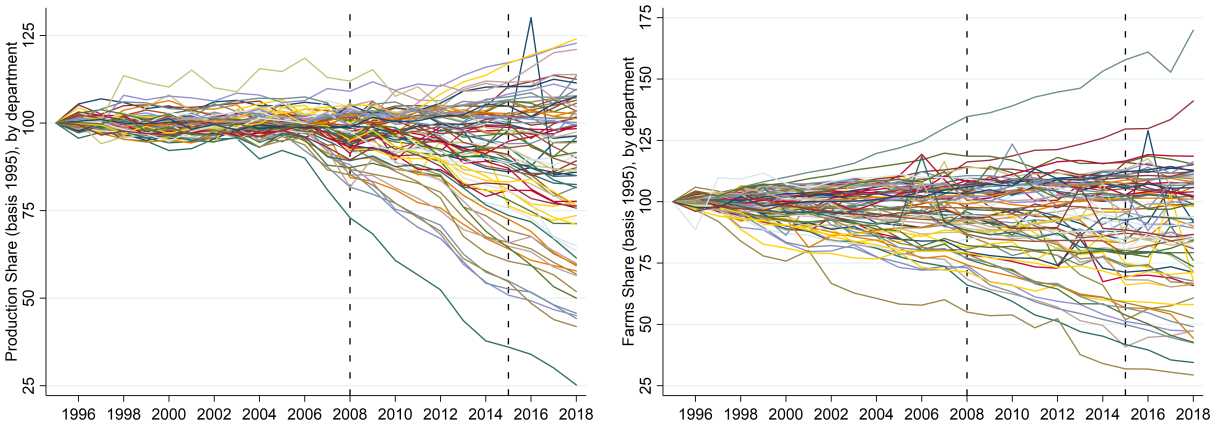
[11]This pattern is constant over the period as later shown in Figure 3.14 (b)

view this pattern as suggesting that more productive farms are generally larger, and use it as basis for our quick theoretical insights developed in Section 3..

In the second part of our analysis (Section 5.), we document how quotas constrained the distribution of milk production *across farms*, both *within* and *across* departments.

The Relocation Process

Figure 3.5: Relocation



(a) Production Shares (b) Farms Shares

(a) Average share of the national production by department, basis 100 in 1995. **(b)** Average share of the national number of farms by department, basis 100 in 1995.

Figures 3.5 (a) and (b) show the contrast between respective timings of the spatial relocation of production on one hand and of farms on the other hand. Whereas the spatial relocation of production essentially took place after the beginning of the quotas removal process (2008), the departmental farms shares kept diverging during the entire period. Efficiency gains associated to farms' sizes increases may thus have occurred at various times, depending on the territory. In the last section of our analysis (Section 6.), we try to identify these efficiency gains dynamics, as well as their timings and determinants.

3. Theoretical Insights on Milk Production and the Role of Quotas

This section quickly describes simple theoretical elements which guide us throughout our empirical analysis.

3.1. A Simple Setting

We view raw milk production as requiring an important fixed cost (land, material) associated with an increasing marginal cost such that each farm has an efficient size minimizing its average cost (denoted y^{eff}). We think about a more *productive* farm as a farm having lower production costs and a higher efficient size. This assumption is consistent with the decreasing relationship between exit probabilities and farms' sizes observed in Figure 3.4.

We consider that a farm's productivity depends on:

(1) its intrinsic quality, randomly drawn in a given distribution which shifts according to a department-specific parameter[12],

(2) a technical progress, increasing over the years.

(1) helps catching two empirical regularities: (i) high heterogeneity in farms sizes, as suggested by Figure 3.3 (b), and (ii) heterogeneity in production shares across departments, as shown on Figure 3.2. (2) is an empirically established fact on many developed agricultural markets, including the French milk market, and is consistent with the steady decrease in the number of farms observed in Figure 3.3 (a).

Farms are price-taking, and their profit maximization consists in choosing whether or not to be active in the market (extensive margin) and how much to produce (intensive margin). These decisions depend on their productivity and the market environment (milk equilibrium price, quotas). For simplicity we assume that demand is perfectly inelastic and constant over time so that price variations are fully determined by the supply.

In France, the quotas implementation has generated constraints on production at two different levels: at the farm level and at the department level. We hereafter analyze the theoretical effects of these two types of constraints, separately taken.

Constraints on Farms Sizes

As aforementioned, the implementation of quotas in France aimed to reduce farm size dispersion by making the marginal cost of acquiring production rights increasingly expen-

[12] We do not specify a particular law here, but any Normal or Fréchet laws with a department-specific position parameter for instance would do the job.

sive above determined thresholds. For simplicity, we here assume that individual quotas consist of a fixed quantity threshold that producers cannot exceed. This simplification is thus a particular case in which the marginal cost of growing above the quotas threshold is infinite. In what follows, we compare farms' production decisions in the absence and in the presence of an individual quota threshold.

Farm Production Without Size Constraints

Under a quota-free equilibrium, each farm chooses the quantity produced so as to equalize its marginal cost and the market price of raw milk. The least productive farm active on the market thus makes a null profit, producing the quantity y^{eff} which minimizes its average cost. All other active farms make a positive profit and produce a quantity higher than y^{eff}, and the more productive the farm is, the bigger its production and profit are. In this context, the price of milk determines the total supply through two margins: (1) the number of active farms (*extensive margin*) and (2) individual quantities produced by such farms (*intensive margin*).

Farm Production with Moving Size Constraints

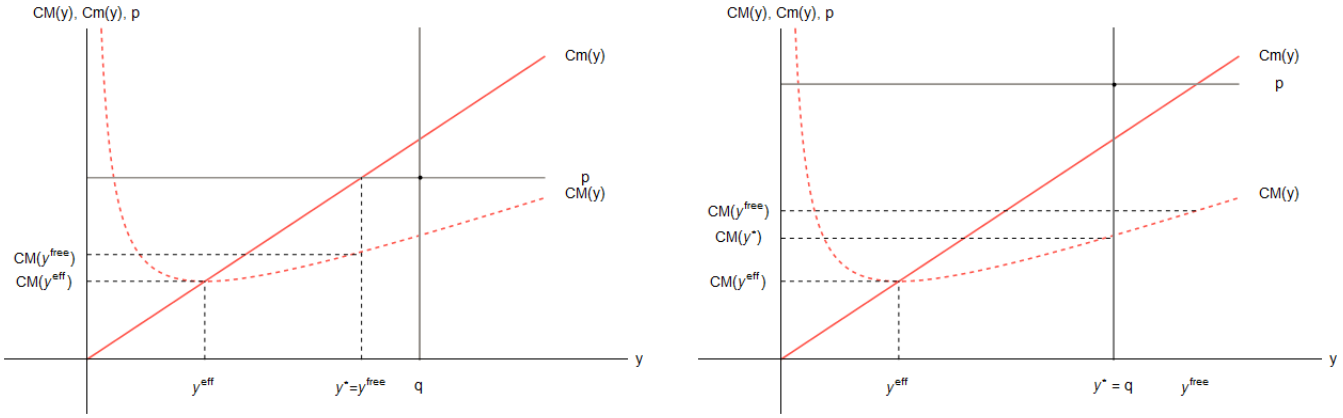
Under a quotas regime, the quantity produced by a given farm may be constrained or not, depending on the market price, the quota threshold and its individual productivity. Figure 3.6 and 3.7 distinguish two cases: when the quota threshold is above the farm efficient quantity y^{eff} and when it is below[13]. In Figure 3.6 (a) and (b), the quota q is above y^{eff} and the price p is above $CM(y^{eff})$. In both cases, the considered farm decides to produce a quantity $y^* > y^{eff}$ and makes a positive profit.

In Figure 3.6 (a), the quota is also greater than the farm's optimal quantity, *i.e* $q > y^{free}$, and the farm is unconstrained. In practice, we view this case as representing small farms, which are also relatively less productive according to our theoretical setting. These farms would thus not benefit from a quota increase as their production already is unconstrained. Actually, as the quota increase is associated with a market price decrease (due to more productive competitors' supply growth), such farms reduce their quantities produced and make less profit. These farms can exit the market if the price goes below the minimum of their average cost.

In Figure 3.6 (b), the quota is lower than the farm's optimal quantity, *i.e* $q < y^{free}$, and such a constrained farm thus produces $y^* = q$. This can describe farms of an intermediate size, with a similarly intermediate productivity. The effect of a quota increase on this type of farms is thus theoretically ambiguous. On the one hand, the

[13]The reader can read these scale-free graphs in two ways. First, and as we do here, one can consider p and q levels as fixed across the figures, and consider that marginal and average costs shift from a graph to the other. Alternatively, one can consider fixed marginal and average costs and shifts in p and q.

Figure 3.6: Farm's Equilibrium with a Quota Above the Efficient Quantity



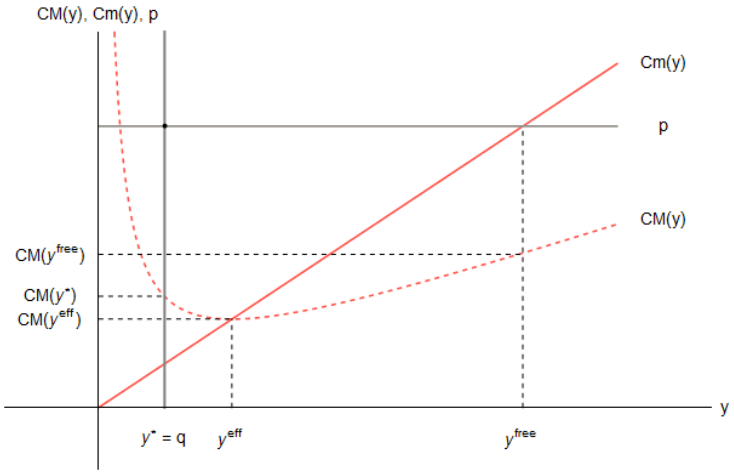
(a) Unconstrained Farm

(b) Constrained Farm

quota increase allows them to produce more and converge to the optimal quantity y^{free}. On the other hand, their supply is locally increasing with price. As a consequence, if the price drop induced by increases in competitors' productions is sufficiently important, these farms reduce their quantities and make lower profits.

In Figure 3.7, the quota is lower than the efficient quantity y^{eff}, and the farm equilibrium quantity is thus $y^* = q$. In this case, the farm cannot reach its efficient quantity, due to the quota. We thus view this case as describing relatively big and highly productive farms. A quota increase may thus allow such farms to converge to their efficient size y^{eff}. As a consequence, these farms always increase their quantity after a rise in their individual quota level, even if market price drops.

Figure 3.7: Farm's Equilibrium with a Quota Below the Efficient Quantity



Overall, under the quota regime, supply is constrained. Our theory thus predicts an equilibrium involving too many active farms and a sub-optimal allocation of production between them. Indeed, the more productive is a farm, the more downward distorted will be its quantity. As a consequence, the constraints on individual supplies of relatively more productive farms help relatively less productive farms to enter (or stay on) the market and to produce more. This supply distortion drives the milk market price upper than the one which would have prevailed without quotas. The following proposition summarizes the effects of loosening of farms sizes constraints (only), predicted by out theory.

Theoretical Prediction 1. *All else being equal, the loosening of constraints on farms sizes within a market leads:*

(i) a sufficiently small (resp. large) farm to decrease (increase) its quantity produced,

(ii) active farms under a certain size threshold to exit the market.

Spatial Distribution Constraints

A second constraint imposed by the quota implementation scheme is that the share of each department in national production is fixed.

Production Allocation Without Spatial Constraints

In a quota-free market, each farm's individual quantity is determined by the market price and its productivity. National competition across farms defines an equilibrium price for which the least productive farm active on the market produces its efficient quantity y^{eff} at its minimal average cost. As a result, production is efficiently split between departments. Differences in departmental market shares reveal heterogeneity in the natural department-specific part of farms' productivities, the department with the highest market share being the one with a farms' productivities distribution the most concentrated to the right. With technical progress over the years, farms' costs go down and the optimal quantity for a given price p goes up. As the demand is inelastic, the total quantity sold on the market is fixed, and the price thus goes down, the supply adjusting until turning back to the initial quantity. This adjustment implies that less efficient farms exit the market. Due to the heterogeneity in productivity distributions across departments, exits are concentrated in departments with the lowest market shares.

Production Allocation With Moving Spatial Constraints

Assume that spatial distribution of milk production was *ex ante* optimal, before the implementation of quotas. Once quotas introduced, production is fixed across departments, which become separated markets. This generates market-specific prices and the productivity cut-off levels of the least efficient active farm in each location are also department-specific. As a consequence, spatial production allocation becomes more and more inefficient, as long as technical progress increases. Indeed, the number of farms decreases at the same rhythm in each department, whereas the heterogeneous distributions of productivities across them would have generated divergences in a free market with unique price and cut-off level. When quotas are removed, convergence in prices implies that exit increases and (surviving) farms' production decreases in small departments, whereas opposite changes occur in large departments.

Theoretical Prediction 2. *All else being equal, the loosening of departments productions constraints:*

(i) leads a sufficiently small (resp. large) department to a decrease (increase) of its overall production,

(ii) generates similar sign variations of optimal productions for all active farms within a department.

Linking the Model to the Data

This section presents a very stylized theoretical framework which aims to extract the main mechanisms at stake under the quotas regime and during the liberalization process, delivering easily testable predictions. This model relies on two observables: the adjustment of market prices and equilibrium quantities changes. In the empirical part of this paper, we only focus on quantities which are sufficient to test theoretical predictions and reveal prices changes. Quantities have two main advantages compared to prices: (i) they allow to document the heterogeneous impact of the policy changes not only across markets but also across farms within a market, and (ii) nominal prices would not be informative. In fact, we would ideally use *real* prices of milk, which would require for our purpose deflating raw prices by time-varying production costs that are also highly depending on productions systems differing across territories. Moreover, it would also raise the question of the evolution of opportunity costs, notably the evolution of the cost of land due to the evolution of its economic yield.

Moreover, our theoretical predictions separately consider the effects of the removal of constraints induced by quotas on farms and departments sizes respectively. In practice, both types of constraints are gradually removed, and the observed resulting dynamics reflect joint effects. However, as shown in Section 6., divergences in production dynamics across departments along the entire period of analysis implied different effective liberalization timings, allowing us to partly disentangle both types of effects.

4. The Spatial Relocation Process

In this section, we show the dynamics of the relocation process across departments, and its interaction with both the quotas regime and its removal. We first focus on the relocation of production, before considering one of the extensive margins through which it took place: the repartition of farms across the French territory.

4.1. Production

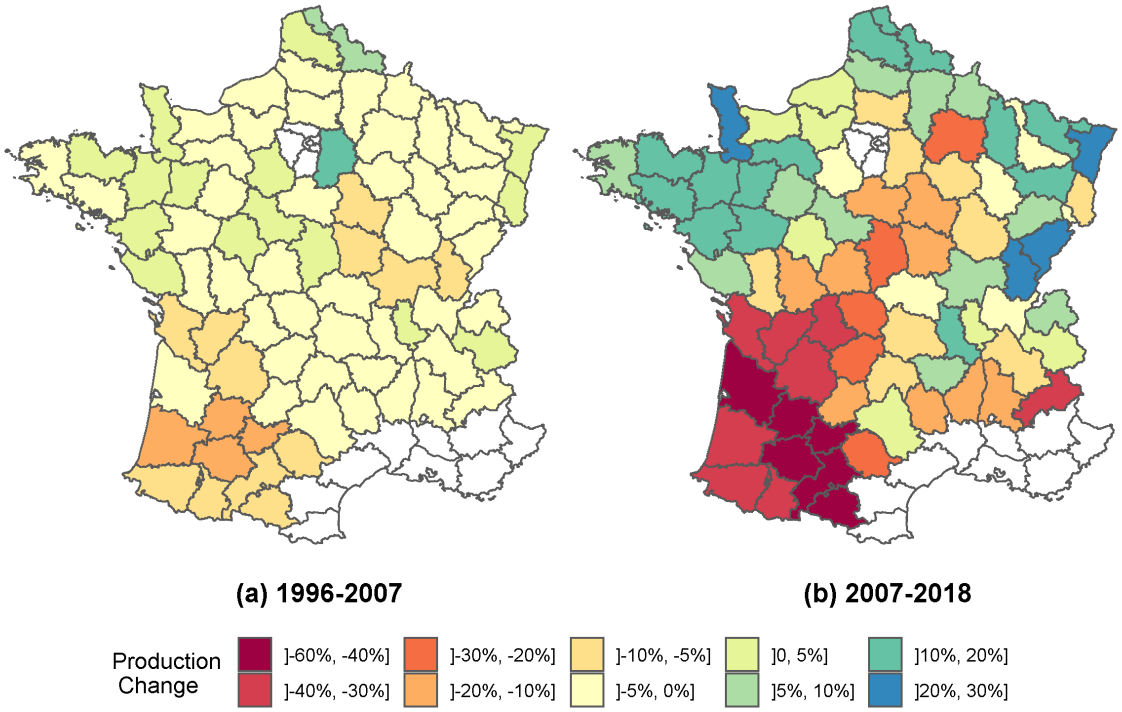
Heterogeneous Territorial Dynamics

Figures 3.8 (a) and (b) display production variations by department, between 1996 and 2007 on the left-hand side, and between 2007 and 2018 on the right-hand side. We can

thus compare the respective evolutions of production (a) over 11 years of stable quotas regime and (b) during the 11 subsequent years marked by the *soft landing* phase and the quotas removal.

Under the stable quotas regime, the production in each department is generally very stable, the variations of production in absolute values over the period being generally lower than 5%. The South-West region of France appears as an exception with a reduction of production greater than 10% in several departments. During the liberalization period, production changes are much starker. South-West departments bear the greatest production losses, with production decreases generally higher than 30%. Central departments also experiment declines in milk production. Conversely, milk production markedly increases in the North, North-West and, North-East departments. These divergences can essentially be explained by the restart in 2008 of a concentration process aborted by the introduction of quotas in 1984, held stable until 2007, as a comparison between Figures 3.2 and 3.8 suggests. We come to this in greater details in the following subsection.

Figure 3.8: Production



Departmental percentage production change between two years: (a) 2007 vs. 1996, (b) 2018 vs. 2007.

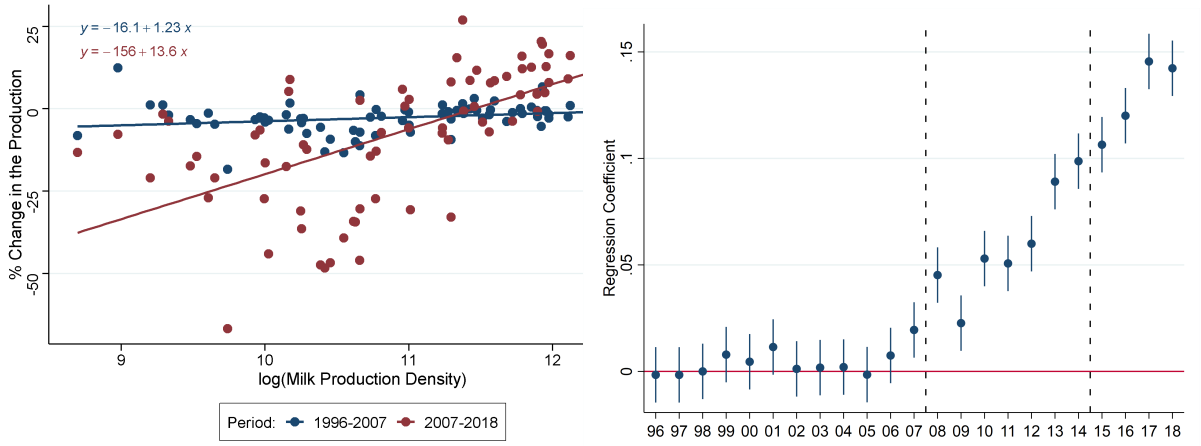
The Restart of an Aborted Concentration Process

Figures 3.9 (a) and (b) show more evidence on how the concentration process restarts in 2008, thanks to the production liberalization.

Figure 3.9 (a) plots production variations introduced in Figure 3.8 against departmental production densities at the beginning of the period of analysis (1996). Under the stable

quotas period, in blue, production levels are relatively stable for all departments, with a small positive correlation between production change and department density (regression coefficient of 1.23, significant at 5%, and $R^2 = 0.07$). Conversely, production variations are important between the beginning of the liberalization phase in 2008, and 2018. Interestingly, these changes significantly much more strongly positively correlate with the initial departmental milk production densities (regression coefficient of 13.5, significant at 1%, and $R^2 = 0.40$).

Figure 3.9: Concentration across Departments



(a) Production Changes (b) Production Shares

(a) Departmental percentage production change between two years (2007 vs. 1996 and 2018 vs. 2007) against the log of the initial departmental milk density. Initial density is defined as the milk production by km^2 of agricultural land in 1996. **(b)** Regression coefficient, details in the text.

These results are in line with Theoretical Prediction 2, the quotas removal having released high growth potentials which were so far limited in the initially more productive departments. This increase in competition on the contrary led relatively less productive departments to experiment milk production declines.

Figure 3.9 (b) delivers a similar assessment, with a greater focus on the timing of the liberalization. It displays the estimated coefficient $\hat{\beta}_1^t$ from the following regression:

$$s_{it} = \beta_0 + \sum_{t \geq 1996} \beta_1^t s_{i1995} \times D_t + \beta_2 \times s_{i1995} + \gamma_t + \gamma_i + \epsilon_{it} \tag{3.1}$$

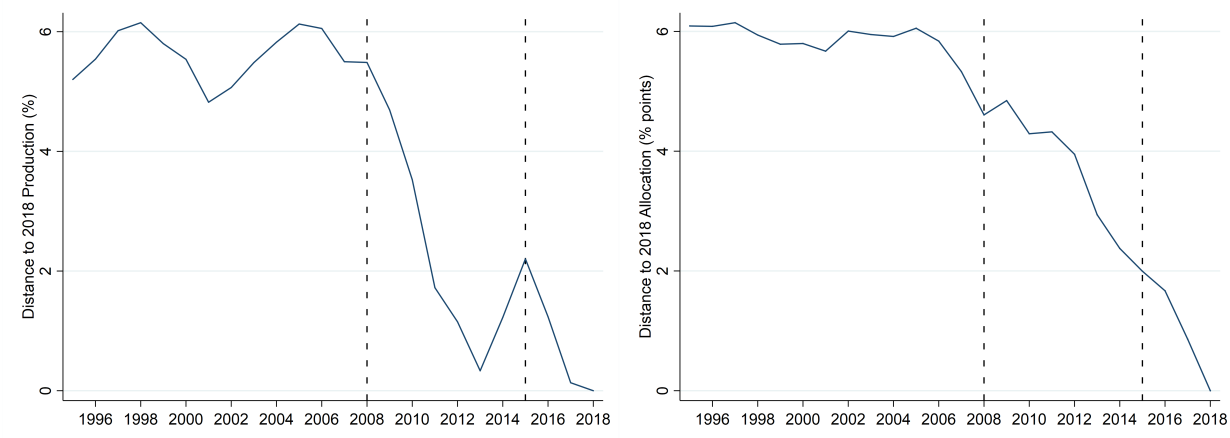
where $s_{it} = m_{it}/m_t$ is the production share of department i at time t[14], $s_{i1995} = m_{i1995}/m_{1995}$ is the initial production share of department i, D_t is a dummy for year t, and ϵ_{it} is the error term. Finally, we include time and department fixed effects, denoted by γ_t and γ_i, to control for time trends common to all departments and department-specific (and time-invariant) characteristics respectively. As we here consider production shares,

[14] m denoting milk quantities.

Figure 3.9 (b) thus confirms how the quotas regime impeded the spatial concentration of milk production in France, and how its gradual removal authorized this process to restart. Furthermore, it indicates how this specialization process immediately kicks in following the first wave of quotas increases in 2008 and keeps strengthening over time until the end of the period of analysis, suggesting an unachieved convergence towards a new steady state.

The Evolution of Spatial Production Distortions

Figure 3.10: Production Distortions



(a) Overall Production Level (b) Spatial Production Distribution

(a) % deviation of the production level in a given year compared to its 2018 level. **(b)** Distance between the production repartition across departments in a given year and its 2018 repartition. More details below.

The production increase and the divergences in the evolution of production levels and shares across departments observed after the liberalization were mechanically impossible under the quotas regime. Thus, quotas seem to have stemmed natural market forces both towards more production and more concentration. Based on the production and its repartition in 2018 (our last observed year), we can thus have an idea of the distortions quotas created with respect to these dimensions. Of course, one obvious limitation of such a reasoning is that the liberalization process is still going on, and the milk market did not yet reach its new natural *steady state*, as aforementioned. However, our measure still remains instructive for considering the timing of the convergence and reallocation processes.

Figure (a) plots the distance between the production of the considered year and the production in 2018, in percentage. This graphs essentially shows how the production converged towards its natural level relatively fast, between the first quotas increases of 2008 and 2015, before diverging again due to the introduction of the new production-decrease prone policies.

Perhaps more interestingly, Figure (b) plots a measure of spatial distortions, which we define as follows:

$$L_t = \frac{1}{2}\sum_i |s_{it} - s_{i2018}|$$

where remember $s_{it} = m_{it}/m_t$ is the production share of department i at time t. We thus compute the distance between the distribution of milk production across space over for each year with its distribution in 2018. To conserve the zero-sum game nature of production relocation, we take the half of the cumulative distance for each year, which prevents double-counting milk reallocation movements. Again, there is a convergence towards the 2018 equilibrium starting as soon as quotas started to increase, in 2008. Our measure thus grossly implies that 6% of the milk production was misallocated relatively to 2018, due to the presence of quotas. Such a conclusion may appear a bit premature, given other changes which occurred over the period. None of them however seem to have the potential to drive the heterogeneous dynamics observed across departments since 2008. Moreover, as the relocation process across space appears to be not finished yet, this measure can be interpreted as a lower bound compared to the true allocative distortions induced by quotas.

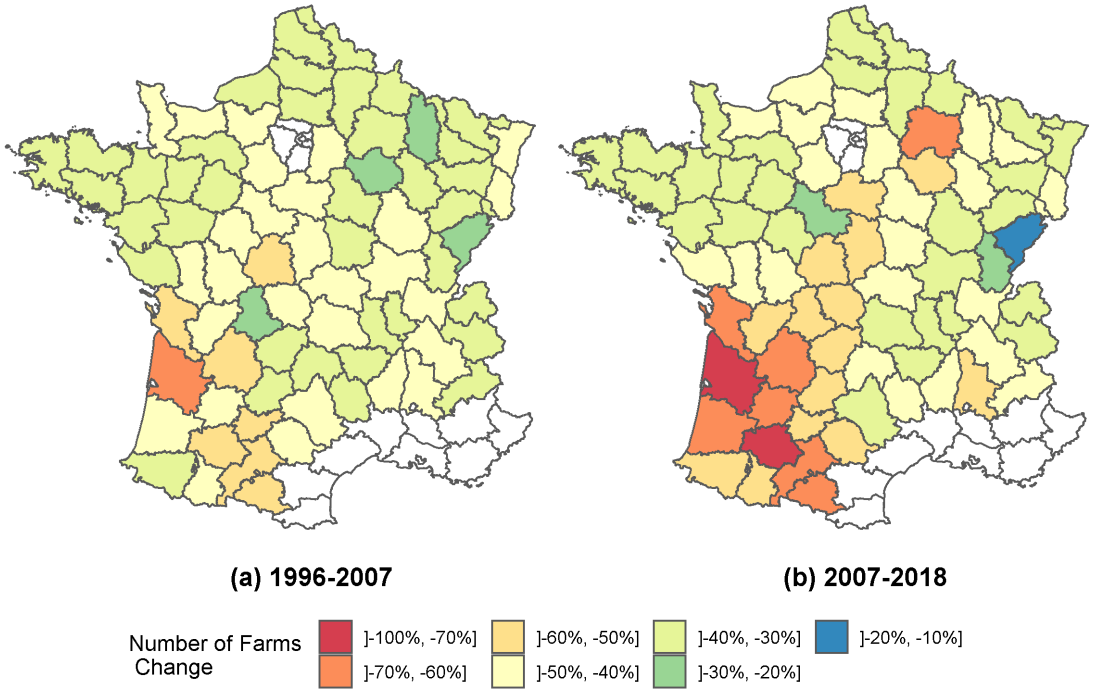
4.2. Farms

We have shown how the quotas aborted the production relocation, before its gradual removal allowed it to restart. We now more specifically turn to one particular margin of adjustment, the evolution of the repartition of the number of farms across the territory.

Heterogeneous Territorial Dynamics

Contrary to what we see for production, but in line with the steady decrease observed at the national level, the dynamics in terms of the repartition of farms appear to have been less clearly altered by the existence of quotas. Figure 3.11 thus contrasts with Figure 3.8, in that farms destruction rates seem to have remained relatively constant across time for most departments. An exception to this seems again to be some departments from the South West of France, where farms destruction rates drastically increased during the quotas removal process. More generally, the number of farms seems to decrease faster in relatively less specialized departments, consistently with the observed milk relocation, which results presented in the following subsection confirm.

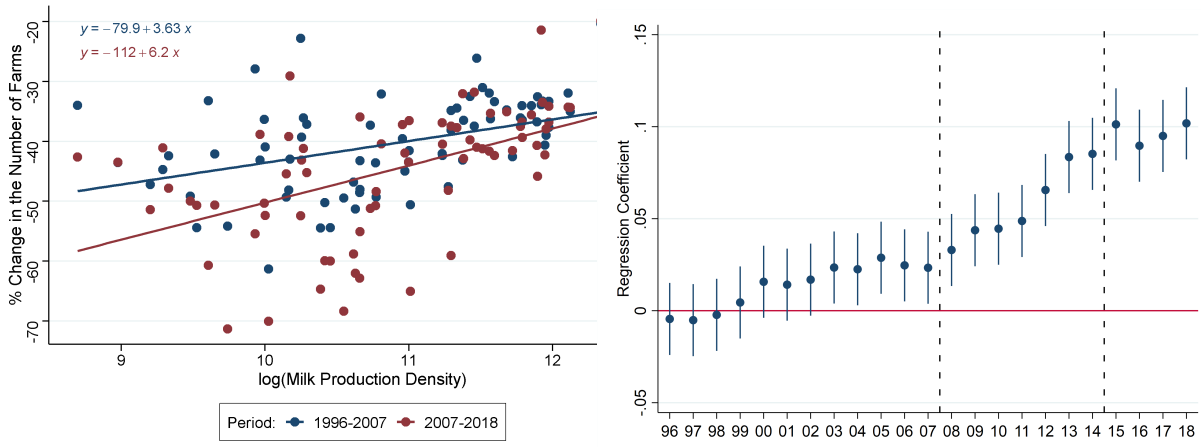
Figure 3.11: Number of Farms



Departmental percentage farms shares change between two years: (a) 2007 vs. 1996, (b) 2018 vs. 2007.

The Fostering of a Specialization Process

Figure 3.12: Specialization



(a) Number of Farms (b) Farm Share

(a) Departmental percentage changes in the number of farms between two years (2007 vs. 1996 and 2018 vs. 2007) against the log of the initial departmental milk density. Initial density is defined as the milk production by km^2 of agricultural land in 1996. **(b)** Regression coefficient, details in the text.

Applying a methodology similar to the one described in Section 4.1. to the evolution of the number of farms across departments and time[15] delivers a much more nuanced conclusion regarding the role of quotas onto the dynamics of the number of farms by department. The number of farms decreases faster in small territories even before the end of quotas (regression coefficient of 3.63, significant at 1%, and $R^2 = 0.20$), but the difference in decrease rates is accelerated after 2007 (regression coefficient of 6.20 significant at 1%, and $R^2 = 0.30$. Our theory delivers a plausible argument to explain differences in farms' destruction rate before the production liberalization. First, in less productive departments, the share of farmers unconstrained by quotas is relatively more important than in more productive departments. As a result, technical change allows more productivity gains in inefficient departments than in efficient departments, leading to a faster decrease in the number of farms. This argument is in line with the Theoretical Prediction 1 (ii)[16]. Overall, distortions induced by quotas on farms number and their repartition across the territory seem to be relatively more limited than the ones caused onto production and its location.

5. The Misallocation and Reallocation Across Farms

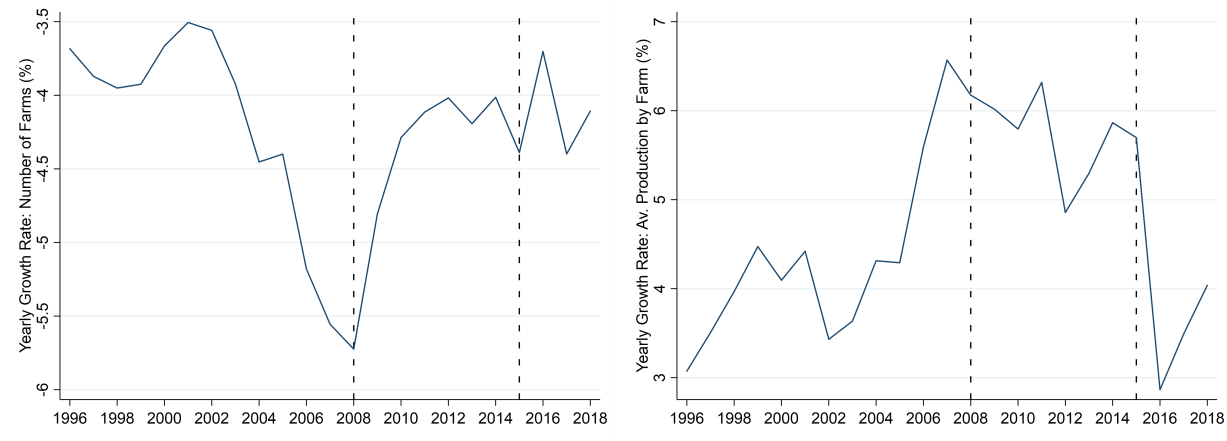
In this section, we document how quotas and their gradual removal have affected the farms selection process and the distribution of milk production *across farms*.

[15] We run a regression similar to (3.1) for constructing (b), where the only difference regards the outcome variable, which now is the departmental *farms* share on a given year.

[16] We show later in the paper (Section 6.) that the constraints implied by production quotas were actually loosening even before 2008 in the least efficient departments.

5.1. The Restructuring Rhythm

Figure 3.13: Growth Rates



(a) Number of Farms (b) Farms Average Production

Annual average growth rates, averaged over 3 years: **(a)** Number of farms,**(b)** Farms Average Production.

Figure 3.13 (a) shows the evolution of the yearly growth rate of the number of farms over the period of analysis. As the number of farms steadily decreases from 1996 to 2018, the growth rate is constantly negative[17]. From 1996 to 2002, this destruction rate is relatively stable, around 3.75%, before significantly increasing between 2003 and 2010, peaking at 5.6% in 2008. Interestingly, this peak follows the announcement in 2003 of the gradual quotas removal starting 2008. The acceleration of the decline in the number of farms between 2003 and 2008 can thus be seen as an anticipation by the least efficient farmers that the liberalized market equilibrium will be less favorable to them. This results from the fact that dairy production requires significant long-term investments, and farms therefore take into account future expected profits, anticipating long-term equilibria in their investment decisions. After this acceleration, the farms destruction rate stabilizes again at a level around 4%, slightly higher than the one prevailing under the quotas regime before the announcement of its end.

Figure 3.13 (b) shows how the growth rate of the average farm size changes over the entire period. The growth rate increases during the pre-liberalization period (1996-2008), going from 3% to about 6%, then stabilizes at relatively high levels (around 6% per year) during the transition phase (2007-2014) before dropping to 3-4% after total liberalization (2015-2018). The increase of farms growth rate during the pre-liberalization period is directly linked to the acceleration of the rate of decline in the number of farms. Exit has two positive mechanical effects on farm size: first, the exiting firms are generally small (see Figure 3.14 (b)), which pulls up the average size, and second, as production is constrained by quotas, maintaining the production level implies an increase in the size of each firm.

[17]For this reason, we refer to it as a destruction rate and describe it in absolute terms in what follows.

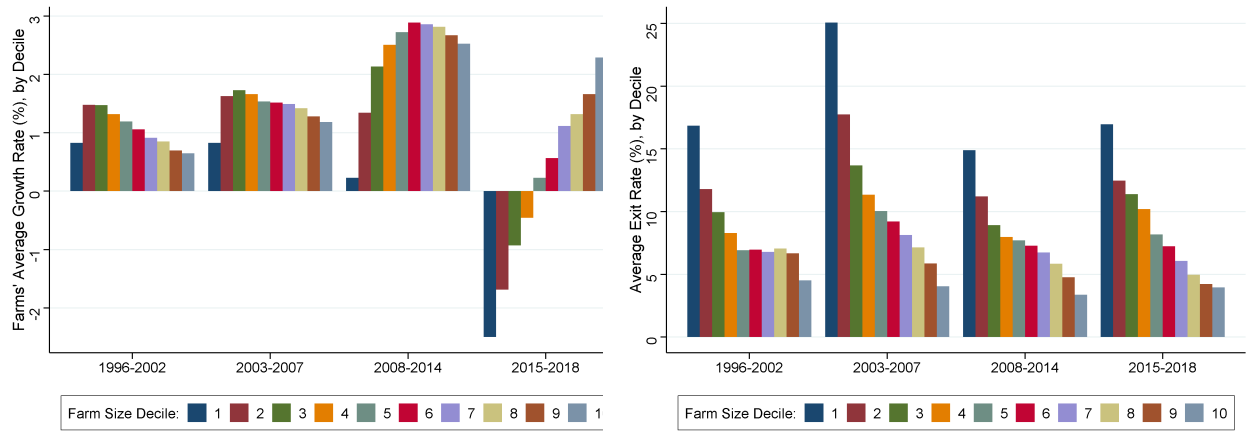
During the transition phase, maintaining this high growth rate is made possible by the production increase. At the very end of the period, total production decreases and the growth rate seems to tend towards its initial level, which may essentially result from the quantity-reducing effects of the introduction of incentives to reduce production in 2015.

These aggregate trends overall hide disparities of exits and growth rates of farms over time, which we now turn to.

5.2. The Levels and Margins of Restructuring

Figure 3.14 (a) displays the average yearly intensive growth rate of farms, across deciles of the size distribution, averaged over each period. The *intensive growth* here refers to the growth of farms from a given size decile, *conditional on surviving*. To avoid issues linked to incomplete years of production, we drop farms which are in their first or last years of activity. Under the stable quotas regime (1995-2007), the constraints implied by quotas are binding, and the intensive growth rates of farms in the lowest deciles of the distribution are driven up by the redistributive properties of the quotas repartition scheme, whereas the growth of large farms is largely discouraged (as described in section 2.1.). As a consequence, if we disregard the very first decile, intensive growth rates are under the quotas regime decreasing with farms' ranks in the size distribution. During the transition period (2008-2014) the picture starts to be different as quotas gradually increase, being less and less constraining. This results from the fact that the increase in milk supply is pulling prices down. Firms producing more than their efficient quantity reduce their supply while the most efficient firms can reduce their marginal costs through an increased production, consistently with theoretical prediction 1.

Figure 3.14: Margins



(a) Intensive Growth (b) Exit Rates

By size deciles, averaged over the given period: **(a)** Annual intensive growth rates, conditional on surviving, dropping entrants and exiters, based on individual quotas (1996-2006) and quantities (2007-2018); **(b)** Farms annual exit rates.

Finally, once the quotas completely removed (2005-2018), smaller farms are no longer protected by the redistributive scheme, and mechanisms at stake in the transition period are amplified. As a consequence, the smaller farms experiment important decreases of their production, while bigger and more efficient farms grow faster, consistently with our theory.

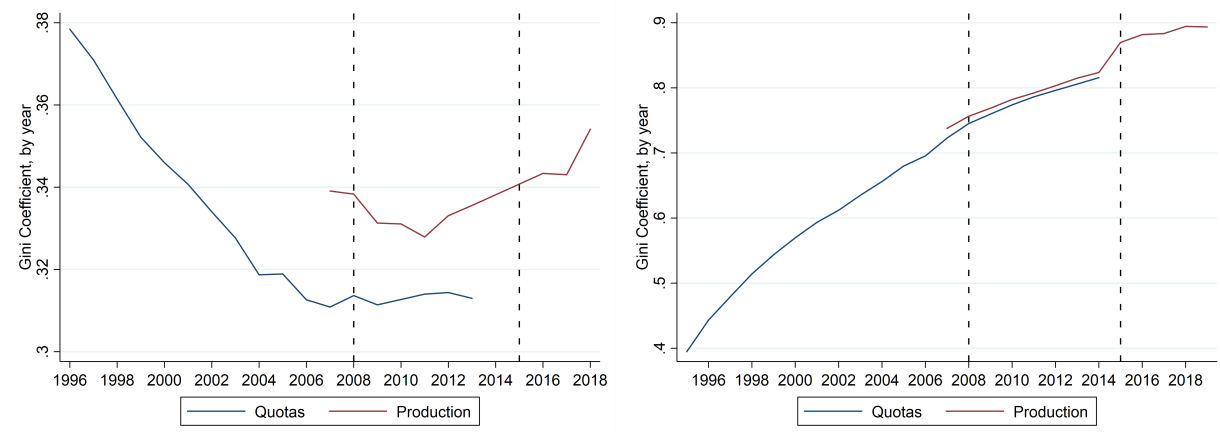
Figure 3.14 (b), displays exit rates of farms, across deciles of the size distribution, averaged over each period. The clear takeaway of this graph is that the exit probability is decreasing with the relative size of a farm over the entire period. The downward size distortion weighing on bigger farms under the quota regime does not seem to increase their probabilities of exiting, consistently with our departure assumption that larger farms are the most efficient. In line with trends already mentioned on the total number of farms, exit rates increase during the years before the quotas removal, especially for smaller farms, which tends to confirm they anticipated the negative effects of the quotas removal, right from its announcement in 2003.

Milk production quotas thus seem to have largely distorted the intensive growth margins in favor of smaller farms, and to a lesser extent also affected the extensive margin, at least in terms of exit rates. Overall, by favoring relatively smaller farms, the quotas regime thus seems to have slowed down the concentration natural dynamics of milk production in France.

5.3. The Impact of Quotas on Farms Inequalities and Inefficiency

Inequalities between Farms

Figure 3.15: Gini Coefficients



(a) Current Population (b) "Moving" Constant Population

Gini coefficients of the distribution of quotas and production levels across farms, based on individual quotas (1996-2014) and quantities (2007-2018). Samples: **(a)** Current population; **(b)** "Moving" Constant Population. More details below.

The management of milk production quotas in France aimed at two goals: containing inequalities between (i) farms revenues and (ii) between territories. In this Section, we focus on the first objective by considering dispersion in quantities produced[18]. Figure 3.15 displays the evolution of the Gini coefficient of farms' production levels. Figures (a) and (b) plot this measure across time for each year, with a current population (the standard measure) and a "moving" constant population of farms respectively. To build the second one, we affect a value infinitesimally close to zero[19] to exiting farms for all the subsequent years of analysis. Doing so, we take into account the importance of exits in computing inequalities. The "moving" term refers to the fact that new entrants are integrated in the sample across years. Finally, the Gini coefficients are computed based on individual farms quotas and quantities depending on their availability across time, and both measures reassuringly exhibit similar broad patterns during the overlapping years.

Both measures show how quotas limited inequalities between farms, especially when considering the current population panel, where quantities dispersion steadily decreased from 1996 to 2007, before stabilizing during the transition phase and eventually rising after the complete quotas removal. Figure 3.15 (b) naturally shows steadily growing inequalities across time under the quotas regime, due to the aforementioned importance of farms exits

[18] We do not observe farms revenues, but quantity dispersion measures are arguably sufficient statistics for studying revenues dispersion, given the relatively homogeneous milk pricing setting.

[19] Instead of zeros which are not supported by Gini coefficient computations.

across all years of analysis. However, this complementary dispersion measure starkly rises once the quotas completely removed, as a result of the heterogeneity in the intensive growth dynamics across farms of different sizes.

Quotas thus successfully refrained growing inequalities across surviving farms, by stemming a natural trend which reappeared once they got removed. Panel (b) also confirms that this redistributive motive did not completely impede productivity gains, as less efficient farms kept exiting over the entire period.

Inefficiency

In order to more precisely assess how much quotas have put a brake on an *a priori* efficient reallocation, we propose an *ad hoc* measure. For each year t, we rank farms in the distribution of quantities within each department i, which we denote r_i. We then build the following measure:

$$L_{it}^{k} = \frac{1}{2} \sum_{r} \left| s_{rit}^{k} - s_{r_i 2018} \right|.$$

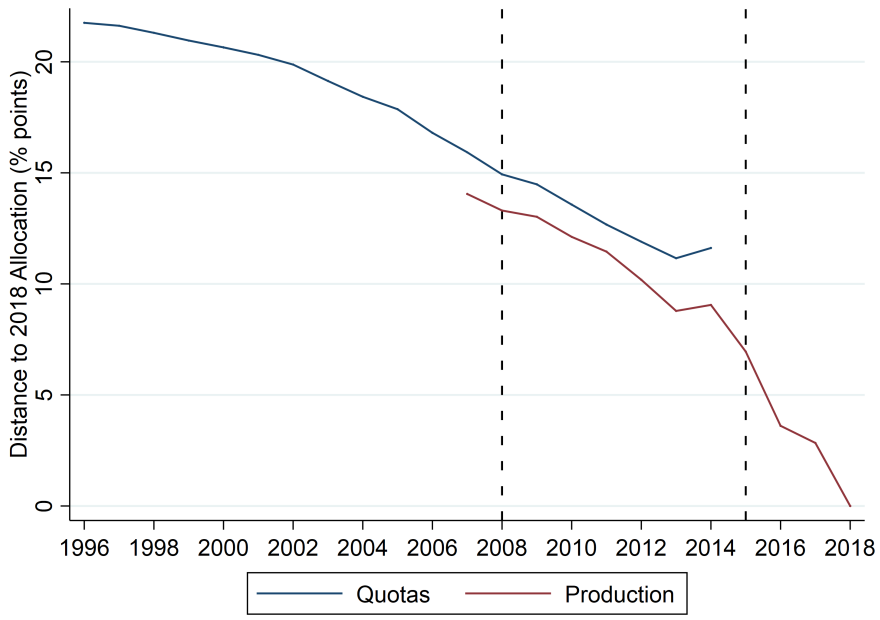
where $s_{rit}^{k} = k_{rit}/k_{it}$ is the market share of the farm occupying rank r in department i at time t, where k alternatively denotes milk quotas q or quantities m depending on the considered measure, and $s_{ri2018} = m_{ri2018}/m_{i2018}$. The L_{it} indicator thus measures the distance between the repartition of the production in department i at time t and its 2018 unconstrained repartition.

Through a weighted average, we can then aggregate these measures to get its national equivalent:

$$L_{t}^{k} = \sum_{i} L_{it}^{k} \times s_{it}^{k}.$$

where $s_{it}^{k} = k_{it}/k_{t}$ is the production or quotas share of department i at time t in national production. Figure 3.16 shows how the natural reallocation of production across farms seems to have occurred when quotas were totally removed, as the slope becomes steeper in 2015.

Figure 3.16: Reallocation across Farms



Distance between quotas and production repartition at the farms level in an given year and its 2018 repartition. More details above.

6. Disentangling the Effects of Farms Sizes and Spatial Constraints Loosening on the Restructuring

So far, we have analyzed the effects of the quotas regime and its removal on spatial distribution and inter-farms reallocation. However, we do not have explicitly considered heterogeneity in the timing of liberalization. In fact, in some departments, constraints implied by the existence of quotas determined at the department level were not binding, even before their increase in 2008. Consequently, in these low-productivity departments, constraints on farms sizes are also less important. This heterogeneity allows us to distinguish periods in which liberalization is incomplete, *i.e* only achieved in such departments, and to distinguish the heterogeneous effects of intra- and inter-department constraints.

6.1. Discretizing the Inter-Departmental Divergence

Departments are regrouped into six categories depending on their total milk production growth between 1996 and 2018. Table 3.1 presents some descriptive statistics.

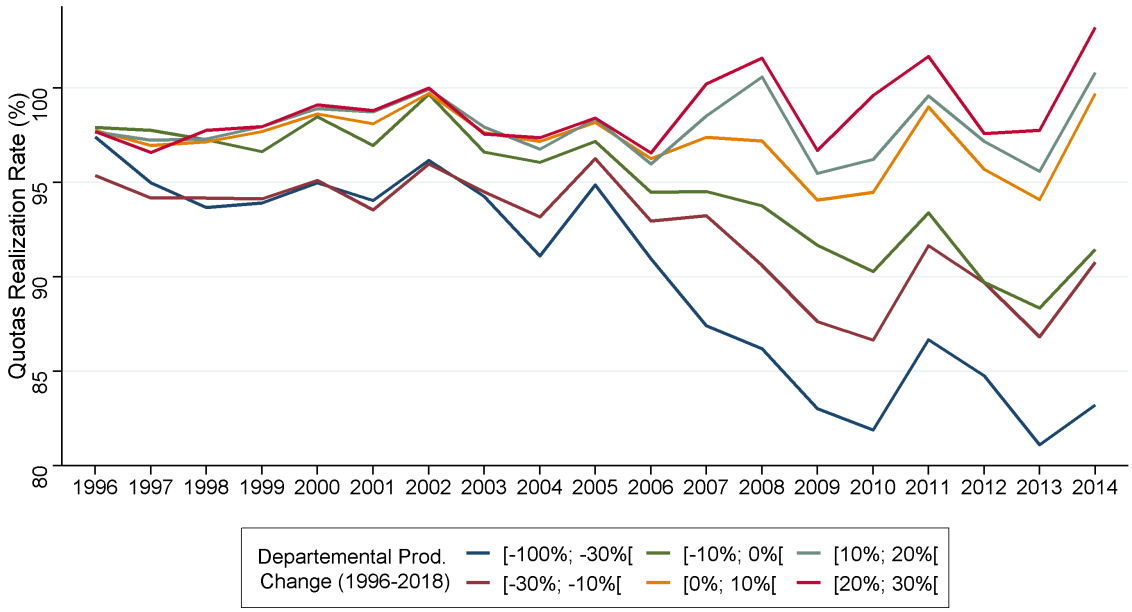
Table 3.1: Descriptive Statistics, by Departments Growths (1996-2018) Category

Dep. Prod. Change (1996-2018)	Number of dep.	Share of farms (%)		Share of production (%)		Farms av. size (liters)	
		1996	2018	1996	2018	1996	2018
[-110%; -30%[	25	8.8	5.2	7.4	4.0	126,351	348,255
[-30%; -10%[	15	6.2	5.0	5.1	4.1	124,132	366,788
[-10%; 0%[	14	13.2	13.2	12.1	10.8	138,329	374,815
[0%; 10%[	16	26.8	28.1	27.2	27.3	152,881	445,630
[10%; 20%[	13	28.1	30.1	30.7	33.4	164,776	494,759
[20% ; 30%[	7	16.8	16.9	17.3	20.5	155,275	554,394

An important number of departments (25 out of 90) experimented severe milk production declines, of more than 30%, leading them to represent only 4% of total milk production in 2018, against 7.4% in 1996. 29 departments experimented more moderates losses in milk activity, while production increased between 1996 and 2018 in 36 of them. The 20 departments who experimented the biggest growths (more than 10%) regroup about 54% of the national production in 2018, against 48% in 1996. In line with our theory, departments which grew the most are the ones where farms average sizes initially were the biggest, a pattern which is starkly more pronounced in 2018.

6.2. Spatial Heterogeneity in the Production Constraints Loosening

Figure 3.17: Quotas Realization Rates



Ratio between departmental effective production and quotas, averaged over the given category.

Under the quotas regime, in a department whose total production is constrained by quotas, the latter are in priority affected to small farms. This distorts farms' natural growth rates. Conversely, in departments for which this constraint is not binding, this distortive effect is loosen, and farms can relatively more freely choose which quantity of milk to produce. When quotas were first implemented in 1984, quotas constraints were mechanically binding in each department. In 1996 and over the subsequent years, the coercion degree of these constraints depends on the past dynamics of each department's production. Figure 3.17 shows that there is substantial cross-departments heterogeneity in the timing of these constraints loosening.

Figure 3.17 shows the average annual quotas realization rates of French departments - *i.e* the ratio between annual production in a given department and its total amount of quotas - regrouped along the previously defined categories. Starting as of 1996, average quotas realization rates already exhibit substantial heterogeneity, barely lying around 95% for the departments which later experienced the biggest falls (-10 to -100%) in milk activity. Putting it the other way round, it means that departments with the lowest realization rates in 1996 essentially are the departments which will lose the more over the entire period of analysis. For subsequent developments, this also imply that we can consider these departments as being "liberalized" from the very beginning of the period.[20].

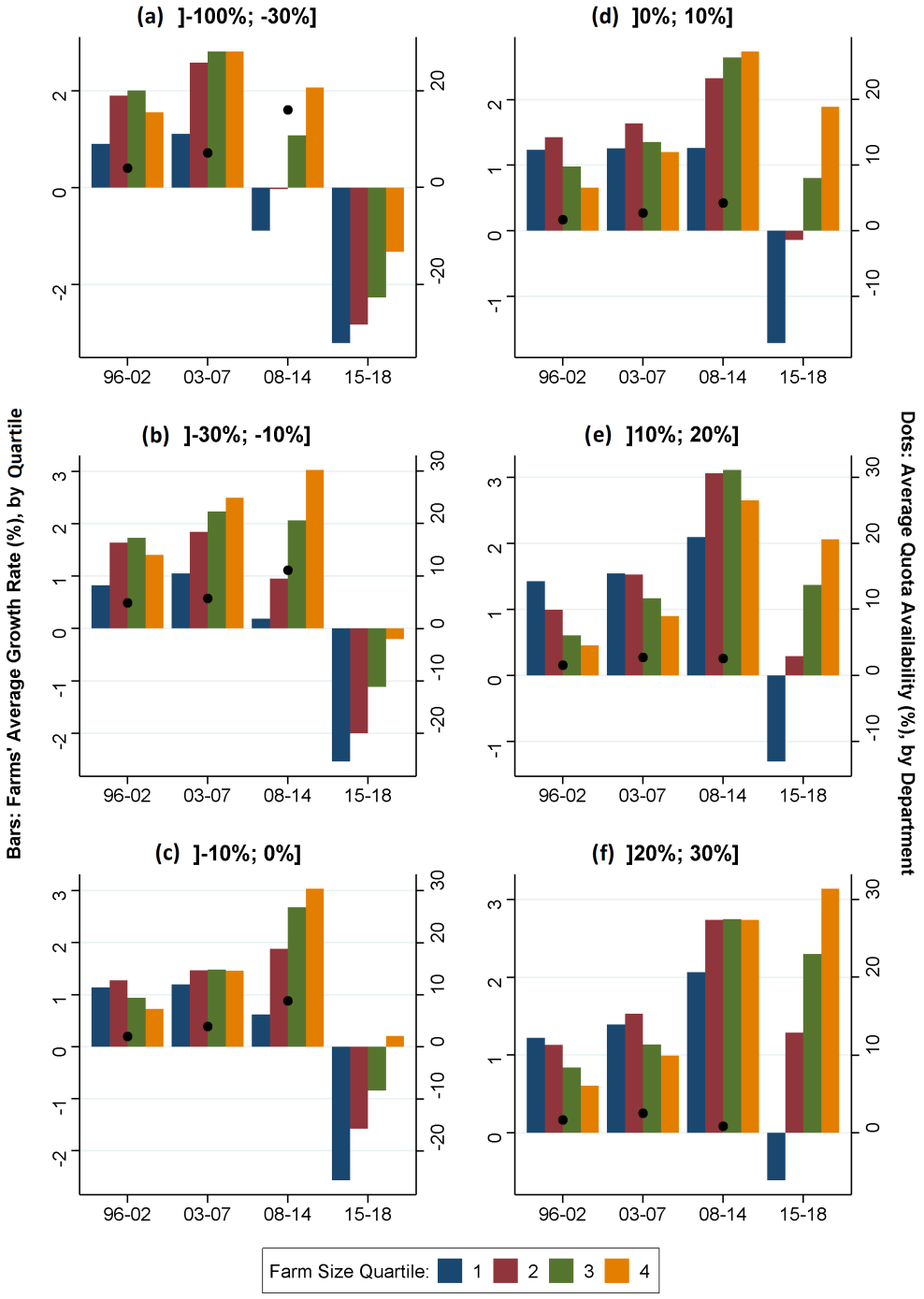
On the contrary, departments which suffered relatively less from the quotas removal on average fill 98% to 99% of their yearly quotas until 2006. From then, divergences appear and accentuate each year, between departments which ultimately experimented falls in milk production and those whose production grew. As a consequence, departments experimenting moderate declines $(]-10\%;0\%])$ or growth $(]0\%;+10\%])$ to a lesser extent see their quotas constraints significantly loosening. Dynamic departments which grew by more than 10% see this constraint disappearing only once the quotas completely removed, in 2015.

6.3. Departmental Liberalization and Inter-Farms Reallocation

Figure 3.18 allows us to analyze the heterogeneous relative farms' intensive growth rates by quartile, depending on the quotas realization rates. Indeed, we saw in Figure 3.17, the heterogeneity in the liberalization timings of the various categories of departments we built. We chronologically analyze Figure 3.18 in what follows.

[20]They may even have been "liberalized" before, which we cannot observe. The trends later described however seem to confirm that the liberalization took place during the period of analysis.

Figure 3.18: Intensive Farms Growth Rates by Quartile and Liberalization



Bars: Farms average growth rates, conditional on surviving, dropping entrants and exiters, by departmental 1996-2018 production growth and farm size quartile, over the given period. Based on individual quotas (1996-2006) and quantities (2007-2018). Dots: Average quantity of unfilled departmental quotas.

1996-2002 Over this stable quotas period, departments which ultimately experiment production declines greater than 10% ((a) and (b)) are already liberalized, as around 5% of their quotas are unfilled. In these departments, the quotas redistribution scheme is thus not as favorable to the smallest farms as it is in other - more constrained - departments. As

a consequence, farms' average growth rates of the first farms quartile are relatively much less upward distorted as they are in these other departments. For the most constrained departments, average intensive growth rates on the contrary starkly decrease with farms' relative sizes.

2003-2007 During the second period of analysis, which follows the quotas removal announcement, growth rates are clearly increasing with farms' relative sizes in the two categories of liberalized departments ((a) and (b)), while remaining distorted in favor of smaller farms in the others.

Overall, on these two first periods of analysis, departments exhibiting the lowest productivity levels are gradually liberalized. This liberalization is however not associated with an increased competition from more productive departments since the latter ones remain fully constrained by the quotas regime. Inter-department reallocation is thus still wiped out, but within these low productivity markets, intra-department production reallocation operates. Relatively more productive farms grow faster than smaller farms, generating the patterns described above. As inter-departments relocation is so far mechanically impossible, meaning that only the constraints on farms sizes within the aforementioned departments are loosening, these results are fully consistent with theoretical prediction 1.

2008-2014 During this *soft landing* phase, the quotas availability rates increase in the four first department categories ((a), (b), (c) and (d)), reaching at least 10% in the three first ones. As a result, market forces *withing these departments* are freed, and growth rates become increasingly rising with farms' relative sizes. Conversely, growth rates across quartiles are still distorted by the quotas redistributive scheme in the two categories gathering the most productive departments ((e) and (f)).

Moreover, quotas increases over these years strengthen the competition at the national level, as production is allowed to increase in every department. Growth rates are as expected more important in more productive departments in which production was so far constrained. Productivity gains are eventually allowed, which drives the raw milk market price down. As a result, divergence *between departments* takes place, farms in the least productive ones growing relatively less or even starting to decline for the smallest farms.

2015-2018 In 2015, quotas are completely removed and the French (and European) milk market liberalization is thus total. The increasing and natural relationship between growth rates and farms' relative sizes is now clear in every group of departments. Growth rates are now negative for relatively less productive farms in the *overall national distribution*. As relatively less productive farms increasingly concentrated in relatively less productive departments, the latter ones suffer the biggest drops in milk production. Con-

versely, growth potentials of biggest farms in the most productive departments - refrained during 30 years of production quotas - are finally occurring. These effects align with the joints efects described in theoretical predictions 1 and 2.

7. Research Avenues

In this section, we present further developments we consider for this project, and for which the work presented here would constitute an interesting basis.

7.1. Structural Model: Welfare Gains and Counterfactuals

The primary considered avenue to develop our research project is to develop our theoretical setting in order to build a comprehensive model of milk production in different regions, essentially inspired by trade models. Doing so, we could use the data we have in hand to (1) structurally estimate the model, and (2) run counterfactual analyses and compute welfare gains. This appears critical to a proper assessment of the effects of the production quotas introduction and removal onto the French milk market, and may thus be the very next step of the present analysis.

7.2. Causality and Difference-in-Difference Analyses

Moreover, we have long considered and still consider the possibility of conducting appropriate difference-in-difference (henceforth, DID) analyses to study the effects of the quotas regime and of its removal. This option is clearly appealing as it would help having more causal statements on the exact role of the quotas removal onto the *cream-skimming* of the French milk market. However, its practical implementation is relatively difficult as it seems very complicated to properly define controls groups in the present setting. First, the quotas removal was announced far in advance, and anticipated to a certain extent, as we have shown. Second, if we do exhibit evidence that the actual liberalization occurred at various dates across departments, *a priori* calling for a staggered event-study design or a stacked difference in difference approaches, they are made complicated by the importance of *spillovers effects*. Indeed, farmers are in competition within but also between departments, and the liberalization of a given department potentially affects equilibria in all others. These competition effects essentially depend on the degree of substitutability between departments. Throughout our theoretical and empirical analysis, we neglected this dimension, assuming homogeneous raw milk and hence, perfect substituability. In practice, the degree of substitutability is indeed high, as dairy manufacturers purchasing milk are often part of important groups implanted in various departments. Moreover, farmers on the upstream side of the dairy value added chain are also indirectly competing

through the competition prevailing on the dairy products markets further downstream.

An interesting case of reduced substitutability between milk across locations lies in the existence of Protected Designations of Origin (henceforth, PDO). PDOs imply that the labeled products are "produced, processed and prepared in a specific geographical area, using the recognized know-how of local producers and ingredients from the region concerned". The French dairy industry for instance counts about 40 cheese varieties protected by PDO labels. This implies that milk used to process such cheeses is necessarily produced by local farms, and is thus not substitutable with milk from other departments. By definition, farms producing such *protected* milk seem sheltered from the competition of farms located outside the given PDO zone, and may thus have been less affected by the increased *upstream* competition due to the quotas removal.

As such, they could at first sight constitute an interesting candidate for a control group in the type of analyses aforementioned. Indeed, the PDO neutralizes the direct channel through which quotas can affect a farm: increased spatial substitution between milk producers across departments. However, the quotas liberalization also have indirect effects due to products substitution on the downstream side of the market. Suppose we were willing to compare respective growths of two farms of a similar size, in the same department, before and after the quotas. The only difference between these farms in this hypothetical example would here reside in the fact that one is in a PDO zone, producing milk then processed into the given PDO-product, while the other is outside this PDO zone, and its milk is processed into yogurts. Performing a DID-analysis on such treatment and control groups would nevertheless thus not be informative on the effects of the increased risk of spatial substitution due to the quotas liberalization, for the following reason. As regions are to some extent specialized in terms of products processed with local milk, the two farms here are potentially confronted to differentiated demand dynamics once the quotas removed. These dynamics are governed by the relative efficiency gains in the production of substitutable dairy products permitted by the quotas removal. In our example, and taking into account that PDO cheeses are more cross-substitutable than PDO cheeses and yogurts are, it is likely that respective demand dynamics of the given PDO cheese and of yogurts diverged. This is due to the fact that territorial specialization is by definition extreme for PDO products, and much less pronounced for yogurts. As a consequence[21], relative efficiency gains permitted by the liberalization - and hence the associated demand dynamics - are likely to be more diverging across different PDO products than between the given PDO products and yogurts. For this reason, PDO farms cannot constitute proper control group candidates. A first look at the data for instance confirmed that some of the PDO cheeses performed very well while others seem to have under-performed after the quotas removal.

[21] And due to the heterogeneities across territories mentioned throughout our analysis.

Note that we ignored this territorial specialization in particular products throughout our analysis, because (i) it is much less pronounced for non-PDO products[22], and (ii) its effects on trends at the departments and farms levels seem to be of a second-order compared to the ones presented here.

8. Conclusion

In this paper, we analyze the impact of production quotas and of their progressive removal on the French milk market. We show that production quotas generated two types of distortions. First, by mechanically fixing departmental production shares at their pre-quotas 1984 level, they stopped a natural spatial concentration for about 25 years, a process which restarted right after the beginning of the quotas removal process in 2008. Second, the implementation of quotas in France overall encouraged small farms' growth and conversely constrained expansion possibilities of bigger farms. We enhance that this redistributive scheme successfully refrained growing inequalities among farms, but it came at the cost of partially distorting the *cream-skimming* of the least efficient farms. We finally document how the inherent catching-up process in farms selection intervened more or less early across regions, depending on the stringency implied by quotas constraints at the department level. We also show that most of these empirical observations can be rationalized by a simple model, which would require further developments in order to properly quantify the effects of production quotas on the French dairy market.

Finally, an interesting feature of the dairy market we eluded throughout this paper lies in its organization along a vertical supply chain, farmers selling milk to manufacturers which in turn process it into various dairy products. Given the high level of concentration at this stage of the chain, the importance of milk transportation costs, and the diverging dynamics in various dairy products demands, farms' trajectories may be dependent of a buyer they did not necessarily choose. We leave for future research the joint exploitation of *farm-to-firm* network and manufacturers' production data to study the role played by this (inter)dependence during the market liberalization.

[22]PDO milk being limite to 10% of milk produced in France.

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Conclusion

This dissertation aims to understand commercial relationships between suppliers and buyers within value chains. This applied research focuses on the agri-food sector using theoretical and empirical tools. The three chapters analyze value chain relations from downstream to upstream.

The first chapter is a theoretical model which analyzes the impact of purchasing alliances on the variety of products sold by supermarkets. The two waves of purchasing alliance creation in France in 2014 and 2018 have motivated the writing of this chapter. These purchasing alliances are set up by retailers to negotiate their supplies with their suppliers jointly. Alliances created in 2014 consist of purchasing cooperation limited to national brands generally offered by large companies. Alliances created in 2018 have an extended scope; they include private label products generally offered by small firms. This questions the regulatory authorities, who fear an increase of unbalanced commercial relations between producers and distributors. Under the model's assumptions, it may be profitable for retailers to commit to joint product listing decisions even if this reduces the industry profit. The most striking result is that reducing the scope of alliances does not protect small suppliers from being excluded or suffering profit losses. Moreover, it is not always profitable for retailers to expand their cooperation to all products.

The second chapter is a structural model that aims to quantify the market power of firms processing dairy products in France. This model allows distinguishing the two origins of market power. Upstream, the "markdown" is the ability to buy raw milk above the competitive price. Downstream, the "markup" is the ability to sell products above the competitive price. The exhaustive database covers the period 2003-2018. It provides quantities and prices of products sold and raw milk by origin. The analysis is cost-based and exploits the technical relationship between raw milk and dairy products to estimate manufacturers' margins. The two sources of market power of each firm are distinguished thanks to the existence of a competitive product. The markdown is estimated at the firm-origin level and the markup at the firm-product level. Results indicate that dairy firms purchase raw milk on average with a markdown of 15% and sell their product with a markup of 45%.

The third chapter is an empirical analysis of the restructuring of milk production in France between 1996 and 2019. Milk production has been liberalized in Europe with the end of the milk quotas introduced in 1984. Quotas, which aimed to avoid overproduction of milk in Europe, have been gradually increased from 2008 before being completely withdrawn in 2015. The database is exhaustive and provides each French dairy farm's production between 1996 and 2019. Between 1996 and 2007, the restructuring dynamics of milk production are homogeneous across all territories. From 2008, following the increase in production rights, the total quantity produced increased significantly. The dynamics became very heterogeneous between territories, with a concentration of production in the most productive territories. This chapter documents the heterogeneous impact of the end of quotas across territories and firms.

ECOLE DOCTORALE

Titre : Partage du profit et inefficacités au sein de marchés reliés verticalement

Mots clés : Économie Industrielle, Relations Verticales, Pouvoir de Marché, Pouvoir de Négociation

Résumé : Cette thèse vise à approfondir la compréhension des relations commerciales entre fournisseurs et acheteurs au sein des chaînes de valeurs. Ce travail se concentre sur le secteur agroalimentaire, il mobilise à la fois des outils théoriques et empiriques. La thèse se découpe en trois chapitres présentés d'aval en amont de la chaîne de valeur. Le premier chapitre est un modèle théorique qui analyse l'impact des centrales d'achat sur la variété des produits vendus par la grande distribution et sur l'équilibre des relations commerciales entre industriels et distributeurs. Le deuxième chapitre est un modèle structurel qui vise à quantifier le pouvoir de marché des industriels producteurs de produits laitiers en France. Il permet de quantifier les deux origines du pouvoir de marché qui sont : la capacité à se fournir en lait à bas coût et la capacité à vendre sa production à un prix élevé. Le troisième chapitre est une analyse empirique de la restructuration de la production laitière en France entre 1996 et 2019. Ce marché régulé par des quotas à partir de 1984 est libéralisé à partir de 2008 avec un accroissement des droits à produire avant d'être complétement libéralisé en 2015.

Title : Profit-Sharing and Inefficiencies in Vertically Related Markets

Keywords : Industrial Organization, Vertical Relationships, Market Power, Bargaining Power

Abstract : This thesis aims to understand commercial relationships between suppliers and buyers within value chains. This applied research focuses on the agri-food sector using theoretical and empirical tools. The three chapters analyze value chain relations from downstream to upstream. The first chapter is a theoretical model that analyzes the impact of purchasing alliances on product variety sold by retailers and the balance of commercial relations between manufacturers and retailers. The second chapter is a structural model that aims to quantify the market power of industrial producers of dairy products in France. It quantifies the two sources of market power : the ability to obtain milk at a low cost and sell its products at a high price. The third chapter is an empirical analysis of the restructuring of dairy production in France between 1996 and 2019. This market, regulated by quotas since 1984, was liberalized in 2008 with an increase in production rights before being completely liberalized in 2015.

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