SCUOLA DI DOTTORATO
UNIVERSITÀ DEGLI STUDI DI MILANO-BICOCCA

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Ciclo XXXI

ESSAYS ON ENTRY IN VERTICAL RELATIONSHIPS

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ANNO ACCADEMICO 2018/2019

Essays on Entry in Vertical Relationships

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September 2019

Abstract

Since the beginning of 90's, vertical contracting issues and their implications have been widely studied in the Industrial Organization literature. For instance, analysing the relationship between upstream and downstream markets is important not only to evaluate the impact that the different forms of vertical contracts have on total welfare and on consumer surplus, but also to better understand market structure. This thesis is organized in two chapters dealing with vertical contracting and market structure. Since, in this set-up there are many elements playing an interesting role, like contracting under asymmetric information, entry decisions and market choice by vertical related firm, throughout the work there is an analysis of how these elements interact between each others, and how different forms of contractual agreements between manufacturers and retailers, as two-part tariffs, resale price maintenance and quantity forcing, affect entry decisions and market choice. A novelty of this thesis is to consider market structure as endogenous and to study the consequences of this assumption, by adding new insights to the burgeoning existing literature on entry in vertical relationships.

CONTENTS

INTRODUCTION

Since the beginning of 90's, vertical contracting issues and their implications have been widely studied in the theoretical industrial organization literature. In fact, analyzing the relationship between upstream and downstream markets is important not only to evaluate the impact that the different forms of vertical contracts have on total welfare and on consumer surplus, but also to understand the characterization of market structure.

The present thesis is divided in two chapters. In the first one, I analyze the entry decision of N competing hierarchies (each composed by the manufacturer/retailer pair), with the aim to understand the welfare implications of two legal regime (i.e., quantitative forcing and retail price maintenance) with three scenarios of supply side's entry decision (downstream, upstream, or hierarchy). The results will provide a ready-to-use policy instrument for Antitrust authorities.

In the second chapter, instead, I study the endogenous market choice of M competing supply chain (i.e., each supply chain is made by an upstream firm U_i, the manufacturer, who produces a fundamental input that is sold to the downstream firm, the exclusive retailer R_i, who ultimately uses this input to produce the final good for consumers in the final market) between two markets that can have different characteristics. The findings show that there exist circumstances under which the economic agents, choose to locate in the more transparent or more competitive market, despite the usual behaviour that they should have in an asymmetric information environment.

The key motivation on which the present work relies on, is related to the fact that the study of how the market structures upstream and downstream evolve endogenously is fundamental to evaluate the effects that policy regulations on vertical restraints have on total welfare and consumer surplus. In fact, since vertical agreements can assume many forms (e.g. retail price maintenance, quantity forcing, linear pricing, two-part tariffs) and these are frequently object of policy regulations or de-regulations, it is necessary to develop theoretical models which consider the interactions between upstream and downstream markets, the economic agents who choose to locate in one market rather than in another, the type of contract that manufacturers offer to their retailers and, finally, how all the above mentioned factors reflect on overall welfare. This thesis proceeds towards this purpose. Indeed, in each chapter I consider not only that the market structure evolves endogenously, but also that, in reality, the entry decision is not always taken by the same economic player; both entry at the firm-level or at market-level can be considered and there are cases of coordinated entry, or restricted entry, where the role of who between the upstream or the downstream firm chooses, matters. In order to take this complex reality into account and to have a wider and complete picture, throughout the work different scenarios will be presented and discussed.

Below I expose a review of the most interesting and relevant contributions in the vertical contracting literature, focusing in particular on those who have studied and analyzed entry decisions in this framework. Moreover, there is an additional part which includes references to the "market failures" that usual characterize vertical relationships between manufacturers and retailers.

First of all, it is relevant to underline that vertical agreements usually take place in an asymmetric information environment, and are affected by an opportunism problem. Both these elements influence the nature and the types of contracts that manufacturers and retailers sign between each other.

The seminal papers of Hart and Tirole (1990) and McAfee and Schwartz (1994) were the first to write about the *opportunism problem* that characterize this type of contracts. In fact, as explained in Pagnozzi et al. (2018), "when secretely contracting with multiple retailers, the manufacturer has an incentive to lower the wholesale price in each bilateral negotiation, ultimately reducing the aggregate profits he can obtain. As a consequence, a manufacturer choosing the size of her retailer network prefers an exclusive retailer, which is to the detriment of final consumers".

The existence of the asymmetric information problem between manufacturers and retailers finds its origin from the fact that, usually, downstream firms are better informed than upstream firms about demand and/or costs characteristics. For example, retailers may hold private information on demand shocks and they exert nonverifiable efforts to boost demand, or they may also have superior information about their production technology, since their costs may depend on price shocks to local input that are not directly observable by manufacturers. Indeed, it is important to consider how these aspects (i.e., opportunistic problem and asymmetric information) interplay between each others, in a vertical contracting framework.

Given that, there is a growing theoretical and empirical literature dealing with vertical market structures and their implications in terms of entry decisions, consumer surplus and social welfare. At the beginning, the pioneer work of Hotelling (1929), by developing a model of spatial competition, has offered an attractive framework for studying oligopoly markets; then, Salop (1979) formulated a circular-city model that has become very popular in the Industrial Organization literature, and gradually, throughout the years, many authors have been studying vertical contracting and entry decisions. For example, a recent paper of Reisinger and Schnitzer (2012) studies what happens to the market structure and welfare where there is competition both in the upstream and in the downstream markets; in particular they develop a model of successive oligopolies with endogenous entry allowing for various degree of product differentiation and entry cost in both markets. They show that downstream conditions dominate the overall profitability of the two-tier structure, while the upstream conditions mainly affect the distribution of profits. Moreover, they also analyze the welfare effects and the shape of market structure, where there are two types of contracts that can regulate the relationship between manufacturer and retailer (i.e., two-part tariffs or RPM). Similar to the their work, also Ghosh and Morita (2007), Hendricks and McAfee (2010) and Inderst and Valletti (2011), allow for competition in both the upstream and downstream markets and determine the effect on entry distribution. In details, Ghosh and Morita (2007) consider a model of homogeneous goods and Cournot competition for manufacturers and retailers and free entry. They show that within this set up, insufficient entry can occur in both markets. Hendricks and

McAfee (2010), instead, suggest an alternative to the HHI index, for measuring industry concentration in a intermediate good market. They assume Cournot competition with homogeneous goods and they allow downstream firms to exert market power in the intermediate good market. Finally, Inderst and Valletti (2011) consider a model where upstream firms compete in prices and allow for different degrees of competition, their results show that foreclosure incentives of an integrated firm are lower than in models with upstream Cournot competition.

Another interesting work that is related with the topic of vertical contracting and market structure is the one by Esö, Nocke and White (2010), which study a downstream industry where firms compete for a scarce input good. Their results show that if the supply of such input good is large enough, the resulting industry structure is asymmetric, with one firm's being larger than the others.

Even though, in many works in the vertical contracting literature, market structure is assumed as exogenous (see Blair and Lewis (1994); Gal-Or (1991, 1999); Kastl et al. (2011); Martimort (1996)), there exists also a strand of literature, where entry is endogenized and indeed, the consequences of this assumption are studied. Raith (2003), for example, studies a model of an oligopolistic industry in which firms provide incentives to managers to reduce marginal costs. The central assumption is that the market structure is endogenously determined by free entry and exit, and the effects that this hypothesis generates on market structure are interesting; in fact prices and profits fall, inducing some firms to exit until the remaining firms' profits are zero again; each surviving firm by producing a larger output, has a greater incentive to reduce its costs.

Finally, a recent paper of Bassi, Pagnozzi and Piccolo (2016), offers compelling insights on the topic. The authors present a model where an endogenous number of competiting manufacturers, located around a circle, contract with exclusive retailers who are privately informed about their costs. They assume an asymmetric information environment, and they study the equilibrium solutions in terms of number of firms, joints profits of manufacturers and retailers, and the effects of endogenous entry on welfare, in two different cases: where the upstream firm offers to the downstream firms a linear contract or a two-part tariffs. Their results show that the number of brands is lower (*resp.* higher) with asymmetric information than with complete information when contracts are linear (*resp.* with two-part tariffs). They also found out that even though, the number of brands is always higher with linear contracts than with two part tariffs, joint profits of manufacturers and retailers are higher with linear prices.

Before concluding this introductory part, it is worth to present also the main results of the work by Etro (2010) who studied the role of unilateral strategic contracts for firms active in markets with price competition and endogenous entry. The author sustains that it is not on the mode of competition but on the impact of endogenous entry decisions that the nature of contracts depends on, and what is even more relevant for the present work is that, the "strategic purpose of any contract changes when entry in the market is endogenous".

CHAPTER I

RETAIL PRICE MAINTENANCE, QUANTITY FORCING AND ENTRY WITH ASYMMETRIC INFORMATION

I. INTRODUCTION

The present chapter investigates the welfare implications of two legal regimes (i.e., quantitative forcing and retail price maintenance) with three scenarios of supply side's entry decision (downstream, upstream, or hierarchy). Toward this purpose, I combine the agency problem that usually characterizes vertical agreements with additional features that are not always considered together: endogenous entry and the possibility of comparing two types of contracts that manufacturers can offer to regulate their relationship with retailers. The results will provide a ready-to-use policy instrument for Antitrust authorities.

The topic of vertical contracting has been widely addressed in the Industrial Organization literature, and several contributions have shown how the type of contract that regulates the relationship between manufacturers and retailers has effects on their behaviour, on the degree of competition in the market, and on the economic welfare as whole. It is worth to recall that within vertical contracting framework, there may exist asymmetric information. In fact, the relationship between upstream and downstream firms can be characterized by an agency problem originated by the fact that retailers are usually better informed than manufacturers about demand and/or costs characteristics; this generates a trade-off between efficiency and rent-extraction for manufacturers, who have to choose a (nonlinear) wholesale contract.

The motivation of this research relies on three main topics: first of all, RPM has always been considered a harmful contract, since it is commonly expected to reduce competition and to result in higher final prices. For this reason, it is illegal *per se* in almost all OECD countries, even though, some states (see Alan E. Bollard (1989)) have a procedure for authorizing this practice if the beneficial effects can be shown to outweight the detrimental ones. In the United States, instead, RPM was illegal until June 2007 when the Supreme Court established that the legality of RPM should be determined on a case-by-case basis under the "rule of reason": this decision essentially allowed the reestablishment of resale price maintenance in the United States in most (but not all) commercial agreements. Nevertheless, as argued further, there exist situations under which the establishement of an RPM agreement between upstream and dowmstream firms, generates a higher welfare for the whole economy, and others in which it also creates greater consumer surplus.

Secondly, the introduction of different types of entry choice in this model comes from the fact that, in practice, both entry at the firm-level or at market-level can be considered. More in general, there are cases of coordinated entry, or restricted entry, where the role of who between the upstream or the downstream firm chooses entry, matters. Actually, the reality of entry decision in vertical related firm is complex; for example we may have banks' decisions on the number of ATMs, or chains' decisions to open multiple hotels, or supermarket chains' decisions whether or not to open a stores across different markets (Ferrari, Verboven, 2010). Our scenarios take this heterogeneity into account.

Thirdly, since Mankiw and Whiston (1986) the topic of entry decision has been widely studied, especially with an exogenous market structure. They, indeed, were the first to clearly identify the " conditions under which the number of entrants in a free-entry equilibrium are excessive, insufficient or optimal", and they were also the pioneer in presenting the topic of excessive entry, arguing that in homogeneous product market the presence of imperfect competition and of "stealing business effect" generate a bias towards excessive entry such that entry restrictions may be socially desiderable, unless the fixed entry costs become sufficiently small. However, introducing endogenous entry gives the chance to study a model that is closer to reality and to insert this contribution in a more recent strand of literature that has not been widely explored yet. Endogenous market structure means considering a reality in which " strategies affect entry and entry affects strategies" (Etro, 2014) and, this is fundamental to clearly understand that at a certain point the size of the market is not anymore exogenous, but it changes because of firms' entry decisions, strategies, level of competition and policy shocks. Hence, it is this complexity that should be taken into account.

In this work I combine all the above mentioned features, by developing a linear model with N hierarchies, each composed by the manufacturer/retailer pair where every single manufacturer has an exclusive relationship with his retailer. Demand is uncertain, hence there exists a downstream demand shock θ distributed on the compact support $\Theta \equiv \left[0, \overline{\theta}\right]$, and only retailers privately know the realization of θ when contracts are signed (the latter assumption ensures to take into account the asymmetric information problem that characterize vertical agreements). Two types of vertical contracts are compared: the upstream firm can either commit to a simple *Quantity Forcing* (QF), which is a type of contract that specifies for any amount q_i produced by the retailer, a fixed fee $t_i(q_i)$ paid to the upstream firm; or to a more complete arrangement that is *Resale Price Maintenance* (RPM), which in addition to the fixed fee $t_i(q_i)$ paid with respect to the quantity, it also establishes a retail price $p_i(q_i)$ to be charged by the downstream firm as a fuction of retailer's output.

Within this framework our results show that the welfare implications of *Quantity Forcing* and *Retail Price Maintenance* are different depending on who between manufacturers, retailers or hierarchies takes the decision to enter in a specific market. In details, if the entry decision is taken by the entire hierarchy (i.e. the manufacturer/retailer pair) then a QF contract has to be preferred since it delivers a higher expected social welfare for whole the economy. The justification for this result relies on the fact that, when it is the hierarchy taking the decision to enter in the market, the expected welfare generated in the economy coincides with the expected consumer surplus, which is an increasing function of the number of firms N. Since the expected joint profits for the manufacture/retailer pair are higher when a QF contract is in force, then, more firms will enter if the legal regime is quantity forcing and consequently, more benefit will occurr for consumers who enjoy product variety, available on the market.

What happens, instead, if the entry decision is taken by the manufacturers and the sole welfare criterion pursued by an Antistrut authority is the consumer surplus? In this set-up, a RPM contract should be chosen. The intuition of this counterintuitive result, since RPM has always been considered harmful for consumers, is the following: manufacturers tend to prefer retail price restrictions, under an asymmetric information framework, as they can expand the means of controlling retailers (by establishing both retail price and output), so to limit their information rent, the consequence is that under RPM expected manufacturers' profits are higher with respect to QF regime, hence more firms will enter in the market, and of course, this increases consumer welfare. However, the findings show that when comparing the two contractual modes in term of total expected welfare generated in the economy, then in case of upstream entry's choice, QF is better.

Finally, the more interesting case is the one that considers downstream's entry choice, (i.e., it is the retailer to first positionate in the market). In this situation, a retail price maintenance agreeement ensures a greater expected social welfare for the entire economy, while if the Antitrust authority promotes only consumer surplus, then a QF arrangement has to be implemented.

The logic behid this result lies on the fact that, as discussed later in this work, expected retailers' rents are greater under a QF regime, hence when downstream firms take the decision to enter in a specific market, and the legal regime in force is quantity forcing then, more firms will enter, therefore this will benefit consumers. Nevertheless, considering the expected total welfare produced in the economy, since the expected manufacturers' profits are decreasing in N, upstream firms will benefit from the adoption of an RPM regime. Indeed the total welfare for the whole economy will be higher when the hierarchy adopts retail price restrictions, and it is the downstream firm to first positionate in the market.

It is worth to underline that, since this model drives all the comparisons between QF and RPM from the sole analysis of the expected welfare generated in the economy, depending on who between manufacturers, retailers or hierarchies takes the decision to enter in the market, the results are subject to a straightforward interpretation and they provide a *ready-to-use* instrument for Antitrust authorities. From a policy point of view, these predictions undermine the appeal of *per se* rule, especially for those markets where the entry decision is taken by downstream firms, and they suggests a wider prospective for the Antitrust authorities in evaluating the beneficial and the detrimental effects of retail price restrictions. Finally, results suggest also a novel interaction between asymmetric information and endogenous market structure.

II. LITERATURE REVIEW

The present work contributes to a large theoretical and empirical literature on vertical contracting started in mid-nineties with the seminal contributions of Spengler (1950) and Telser (1960).

First of all, there is a strand of literature analyzing vertical contracting under asymmetric information.

An earlier contribution is Gal-Or (1991a) who was the first arguing that nonlinear wholesale prices might not suffice to eliminate downstream rents and double marginalization; however vertical price control helps manufacturers to better extract retailer's rent and promote productive efficiency. The author sustains that in an asymmetric information environment a *laissez-faire* regime does not harm consumers, since being vertical pricing fixing an additional screening instrument for manufacturers, retail price comes closer to marginal costs. Many years later, Martimort and Piccolo (2007) expand the contributions on vertical contracting under asymmetric information, by studying contracts with and without RPM in a bilateral monopoly model where retailers have private information on demand, and their exert a non verifiable effort. Their results are in the spirit of the Chicago School, since they show that if the RPM is an optimal contract for the vertical structure, than it is also welfare enhancing for the consumers.

Another interesting work is represented by the paper of Kastl, Martimort, Piccolo (2011) who studied how the different contractual modes (Resale Price Maintenance and Quantity Forcing), have an impact on the information rent that has to be ensured by the manufacturers to their retailers, in order to induce truthful information revelation. The authors develop a model of competiting manufacturer/retailer pairs with both adverse selection and moral hazard characterizing the framework; moreover, retailers have the chance to conduce promotional externalities. They show that with competing brands a *"laissez-faire"* approach towards vertical price control may not always provide productive efficiency; and giving manufacturers freedom to control retail prices can harm consumers, especially if the externalities that the retailers can impose on each others are positive. This work extends their results in three directions. First of all, I operate under a more general framework of N competing supply chains, secondly the common shock θ negatively affects the downstream demand function and, finally, while Kastl, Martimort, Piccolo are mainly interested in comparing the *"laissez-faire"* and the "*ban on RPM*" regimes in terms of output produced, consumer's welfare and effects of cross-effort externalities between retailers, I focus the attention in studying the social welfare and the consumer surplus generated under the two legal regimes (i.e., QF and RPM) depending on which firm of the supply chain decides to enter in the market (i.e. downstream, upstream or hierarchy).

Other works like Blair and Lewis (1994) have considered a vertical contracting problem with asymmetric information for a general demand specification, but differently from this set-up they have focused only on RPM contract without comparing it with QF or other arrangements. Finally, there are other papers like Marvel and McCafferty (1985, 1986) who sustained the beneficial effects of a RPM contract with respect to other vertical agreements, however their argument relies on a free-riding explanation, while mine is wider, being based on the welfare generated in the whole economy with an endogenous market structure.

The present work is also related with the literature dealing with entry. The pioneer contribution of Mankiw and Whinston (1986) clearly exposes the conditions under which the number of entrants in a free-entry equilibrium is excessive, insufficient or optimal, and it was published subsequently to other articles which have shown that when firms incur in fixed set-up costs upon entry, the number of firms entering a market is not necessary equal to the socially desiderable number; like Spence (1976a), Dixit and Stiglitz (1977) who proved that in a monopolistically competitive market, free entry can result in too little entry relative to the social optimum, or Von Weizsacker (1980) and Perry (1984) who talk about excessive entry in a homogeneous product markets.

Even though, in many works that investigate the issues of vertical contracting, market structure is assumed as exogenous (see Blair and Lewis (1994); Gal-Or (1991, 1999); Kastl et al. (2011); Martimort (1996)), there exists also a strand of literature, where entry is endogenized and indeed, the consequences of this assumption are studied. It is important to understand that at a certain point the size of a specific market is not anymore exogenous because firms' strategies and firms' entry decisions jointly affect each others; this determines changes in the level of competition and ergo on the number of firms active in the market. Developing a linear model with an endogenous market structure allows to take this complexity into account.

To the best of my knowledge, and thanks to the work of Etro (2014), the strand of literature on endogenous market structure can be divided into two generations: the first one considers the key contributions of Von Weizsacker (1980) on U-shaped cost functions, Dasgupta and Stiglitz (1980) on endogenous sunk costs, Brander (1981) on trade implications, and Sutton (1991) on the empirical analysis of entry. While the second generation includes endogenous growth models with endogenous market structure and endogenous sunk costs as in Peretto (1999), the pioneer work of Melitz (2003) with his analysis of trade with heterogenous costs and endogenous entry and, Schumpeterian growth models with EMSs in the patent races as in Etro (2004). There are also other economic fields that have been studied within this framework, it is the case of international trade topics with Ghironi and Melitz, (2005) and Eckel and Neary, (2010) of which works have been focused on the analysis of the endogenous number and productivity of exporting firms, or Sutton (2007) who studied endogenous sunk costs in global markets. Still at an initial phase, there is also research in the fields of macroeconomics and the analysis of fiscal and monetary policy in a framework where the number of firm active is endogenous and evolving over time. It is especially in the area of contract theory and antitrust theory with endogenous market structure that there are growing and "promising avenues" for new reasearch and, the present contribution wishes to start fulfilling this gap.

The remainder of the paper is organized as follows. Section III sets up the model. Section IV presents the complete information benchmark. Section V derives the equilibrium quantities under the two regimes. Section VI characterizes manufacturers' expected profits, retailers' expected rents and compare the results between the two contractual modes. Section VII analyzes the consumer surplus and social welfare under the three scenarios of entry decision. Finally, Section VIII concludes and briefly discusses routes for future research.

Most of the proofs are relegated to an Appendix.

III. THE MODEL

Players and Environment. In this model there is a downstream industry where N retailers $R_1, ..., R_N$ compete by selling homogeneous goods. Denote q_i as the quantity supplied of this good by each retailer R_i on the final market. In order to produce the final good that has to be sold to consumers, each unit of output q_i requires one unit of an essential raw input that is supplied by upstream manufacturers M_i, each being in an exclusive relationship with his retailer R_i.

The inverse market demand for good i is $p_i(\theta, e_i, q_i, q_{i\neq j})$.

The common shock affecting downstream industry θ is uniformely distributed on the compact support $\Theta = [0, \overline{\theta}]$ with $\Delta\theta = \overline{\theta}$ denoting the spread of demand uncertainty.

Retailers privately know the realization of θ when contracts are signed. The variable e_i denotes a nonverifiable demand-enhancing activity performed by each retailer R_i; exerting effort is costly for retailers and $\Psi(e_i) = e_i^2/2$ is the quadratic disutility of effort incurred by retailer i.

The linear specification presented below characterizes the demand function:[1]

$$p_i(\theta, e_i, q_i, q_{i\neq j}) = a - \theta + e_i - q_i - \sum_{i\neq j}^{N} q_j \tag{1}$$

Finally, production technologies are linear for both upstream and downstream firms, and marginal costs are normalized to zero without loss of generality.

Contracts. Manufacturers can use two different types of vertical contracts: resale price maintenance (RPM) or quantity forcing (QF). Under QF, a contract is a nonlinear tariff $t_i(q_i)$ specifying for any amount q_i produced by R_i a fixed fee $t_i(q_i)$ paid to M_i. When, instead a RPM contract is offered by the manufacturer to his retailer, it is defined by a menu $\{t_i(q_i), p_i(q_i)\}$ which now specifies also a retail price $p_i(q_i)$ to be charged by the downstream firm as a function of R_i' s output.

Timing and Equilibrium Concept. The sequence of events is presented below:

- T=0 The social planner announces the legal regime: quantity forcing (QF) or retail price maintenace (RPM)
- T=1 The demand shock θ is realized and only the retailers observe this piece of information

[1] The demand system is generated by a representative consumer whose preferences are quasi-linear and represented by the utility function:

$$V(q_i, q_j I, \theta) = (a - \theta) \sum_{i=1}^{N} q_i + \sum_{i=1}^{N} e_i q_i - \frac{1}{2} \sum_{i=1}^{N} q_i^2 - \sum_{j\neq i} q_i q_j + I$$

The specification is standard in IO models

- T=2 Each manufacturer offers a menu of contracts to his retailer. Contracts can be accepted or rejected. If R_i decline M_i's offer, these two players get an outside option that, without loss of generality, is normalized to zero.
- T=3 R_i chooses his effort and how much to produce, pays the corresponding fixed fee and charges the retail price specified in an RPM contract, if any is in force.

Bilateral contracting is secret. Members of a given supply chain cannot observe the specific trading rules specified in the contract ruling the competing hierarchy.

The equilibrium concept we use is *Perfect Bayesian Equilibrium* with the added *"passive beliefs"* refinement. Hence, provided R_i receives any unexpected offer from M_i, he still believes that the rival retailers produce the same equilibrium quantity. We look for symmetric pure strategies equilibria.

IV. COMPLETE INFORMATION BENCHMARK

In this section I briefly present the retailer market equilibrium outcome when demand shock θ is common knowledge. Under complete information the choice of legal regime has no impact on the equilibrium outcomes since retail prices, quantities and downstream efforts are the same under both legal regimes.

The first order conditions are:

$$a - \theta + e^*(\theta) - q^*(\theta)(N+1) = 0$$
$$p^*(\theta) = q^*(\theta) = e^*(\theta) = \frac{a-\theta}{N}$$

With complete information the absence of any agency problem within the vertical hierarchy, induces the same level of effort for the retailer both if the manufacturer lets him choosing his downstream effort (like in the case of a QF agreement) or if it is controlled as when retail price restrictions are in force. This is no longer true in presence of asymmetric information, as it will be presented in the following sections.

V. EQUILIBRIUM QUANTITIES

This section characterizes the equilibrium quantity under QF and under RPM regimes.

V(i). *Quantity Forcing*

When a QF is in force between manufacturer and retailer, it is worth to underline that the upstream firm has as screening device only sales, since the retail price is set freely by the retailer, who can also decide his own effort.

The retailer R_i's information rent under QF regime can be written as:

$$u_i = (a - \theta + e_i(\theta) - q_i(\theta) - \sum_{i \neq j}^{N} q_j(\theta))q_i(\theta) - t_i - \Psi(e_i) \tag{2}$$

Observe that the retailer's chooses optimally his effort, that is

$$q_i(\theta) = e_i(\theta) \tag{3}$$

This condition shows that the agent fully internalizes the impact of his effort choice on the overall profit of the vertical chain. By substituting in (2) and simplifying we obtain:

$$\begin{aligned} u_i &= (a - \theta - \sum_{i \neq j}^{N} q_j(\theta))q_i(\theta) - t_i - \Psi(e_i) \\ u_i &= (a - \theta - (N-1)q^*)q_i(\theta) - t_i - \frac{q_i^2(\theta)}{2} \end{aligned} \tag{4}$$

Incentive compatibility yields immediately the following local and first order conditions:

$$\dot{u_i}(\theta) = (-1 - (N-1)\dot{q}(\theta))q_i(\theta) \tag{5}$$

We can now write the M_i's optimal contracting problem under a QF arrangement as:

$$\max_{q_i} \int_0^{\overline{\theta}} \{(a - \theta - (N-1)q^*)q_i(\theta) - \frac{q_i^2(\theta)}{2} - \frac{F(\theta)}{f(\theta)}(1 + (N-1)\dot{q}(\theta))q_i(\theta)\} df(\theta) \tag{6}$$

we derive the FOC wrt q_i , we define $\frac{F(\theta)}{f(\theta)} = h(\theta)$, hence the result is:

$$\dot{q}(\theta) = \frac{a - \theta - h(\theta) - q^* N}{(N-1)h(\theta)} \tag{7}$$

The above expression can be re-written as:

$$\begin{aligned} \dot{q} &= \frac{a - 2\theta - q^* N}{(N-1)\theta} \Rightarrow \\ q^{\cdot} + q^* \frac{N}{(N-1)\theta} &= \frac{a - 2\theta}{(N-1)\theta} \end{aligned} \tag{8}$$

where $h(\theta) = \theta$. I solve the differential equation as *"differential equation with boundary condition"* and the result is:

Lemma 1. When QF is chosen, the retailer's level of effort is set efficiently conditionally on the equilibrium output. The equilibrium quantity is:

$$q^{*QF}(\theta) = \frac{a}{N} - \frac{2\theta}{2N-1} \tag{9}$$

Proof. See Appendix. ■

V(ii). *Resale Price Maintenance*

The symmetric equilibria is characterized by means of optimality conditions that an RPM contract must satisfy at a best response. With an RPM contract the effort level is indirectly fixed as a function of θ, through the inverse demand, that is:

$$e_i = p_i + \theta - a + q_i + (N-1)q^* \tag{10}$$

Intuitively, RPM is less flexible than QF simply because, when retailer R_i faces a retail price target; indeed, he is indirectly forced to choose the effort level in a way that might be suboptimal from his point of view. Define R_i' s information rent as:

$$u_i = p_i(\theta)q_i(\theta) - \frac{1}{2}(p_i(\theta) + \theta - a + q_i(\theta) + (N-1)q^*)^2 - t_i \tag{11}$$

Those allocations satisfy the first and second order conditions for incentive compatibility:

$$\dot{u} = -(1 + (N-1)\dot{q}(\theta))(p_i + \theta - a + q_i + (N-1)q^*) \tag{12}$$

Equipped with this characterization, it is possible to turn to the optimal contracting problem.

The manufacturer M_i designs a menu of contracts to maximize the expected fee he receives from R_i subject to the participation and incentive compatibility constraints, together with the additional restriction in effort required by the retail price target:

$$\max_{p_i, q_i} \int_0^{\overline{\theta}} p_i q_i - \frac{1}{2}(p_i + \theta - a + q_i(\theta) + (N-1)q^*)^2 \tag{13}$$
$$-\frac{F(\theta)}{f(\theta)}((1 + (N-1)q^{\cdot}(\theta))(p_i + \theta - a + q_i(\theta) + (N-1)q^*))df(\theta)$$

At a best response to the schedule $q_{i\neq j}(\theta)$ and effort $e_{i\neq j}(\theta)$ implemented by the competing pairs $M_{i\neq j} - R_{i\neq j}$, the output and effort $e_i(\theta)$ in $M_i - R_i$ hierarchy are respectively given by the following first-order conditions obtained by pointwise maximization:

$$\begin{aligned} p^* &= (p^* + \theta - a + q^* + (N-1)q^*) + \frac{F(\theta)}{f(\theta)}(1 + (N-1)\dot{q}^*) \\ q^* &= (p^* + \theta - a + q^* + (N-1)q^*) + \frac{F(\theta)}{f(\theta)}(1 + (N-1)\dot{q}^*) \end{aligned} \tag{14}$$

In this set up, the only variable that is really useful to reduce R_i's information rent is his own effort.

In a symmetric equilibrium:

$$p^* = a - \theta + e^* - Nq^* \tag{15}$$

and

$$\begin{aligned} q^* &= a - \theta + e^* - Nq^* \Rightarrow \\ e^* &= (N+1)q^* - a + \theta \\ \dot{e}^* &= (N+1)\dot{q} + 1 \end{aligned} \tag{16}$$

Once computed the expressions for the effort $(\dot{e}^*, e^*)$ plug them into the expression for q^* obtained from the FOCs.

Define $\frac{F(\theta)}{f(\theta)} = h(\theta)$

$$q^* = [(N+1)q^* + \theta - a] + h(\theta)(1 + (N-1)\dot{q}^*) \tag{17}$$

Simplify with $h(\theta) = \theta$, and the above equation becomes:

$$q^* = [(N+1)q^* + \theta - a] + \theta(1 + (N-1)\dot{q}^*) \tag{18}$$

this can be re-written as:

$$\begin{aligned} \dot{q}^*(N-1)\theta + q^*((N+1) - 1) &= (a - 2\theta) \Rightarrow \\ \dot{q} + q^* \frac{N}{\theta(N-1)} &= \frac{a - 2\theta}{\theta(N-1)} \end{aligned} \tag{19}$$

I now solve the *"differential equation with boundary condition"* and I obtain:

Lemma 2. Under RPM the pricing rule is efficient. The output equilibrium quantity is:

$$q^{*RPM}(\theta) = \frac{a}{N} - \frac{2\theta}{2N-1} \tag{20}$$

Proof. Follows exactly Lemma 1 ■

From Lemma 1 and Lemma 2 we can deduce that without cross-effort externalities between retailers, the equilibrium quantities produced under RPM or QF are the same. However, as shown in the following section, the equilibrium price, the effort levels and consequently the expected upstream profits and the expected downstream rents will be different under the two regimes.

VI. ANALYSIS

The goal of this section is to compare the relevant quantites of the two legal regimes (i.e., expected manufacturers' profits, expected retailers'rents and expected joint profits).

It is worth to remember that if manufactures are able to expand the means of controlling their retailers, then they will be also able to limit information rent.

Lemma 3. Expected manufacturers' profits are higher under RPM contract, for a given N.

$$\mathbb{E}\left[\Pi^{RPM}(N)\right] > \mathbb{E}\left[\Pi^{QF}(N)\right]$$

The difference between the expected profits that the manufacturers obtain under RPM with those obtained under QF is positive; hence manufacturers prefer to sign a RPM contract. The economic intuition of this result hinges on the fact that any manufacturer wants to expand the control that he exerts on his retailer, in order to limit his information rent. As already explained at the beginning of this work, when an RPM contract is in force, the manufacturer establishes both the output supplied in the final market and also the price charged to final consumers, indeed he uses both controls (i.e., sales and prices) to track the retailer's effort, and this of course smothers his rent. It is precisely this improvement of the manufacturers' screening abilities that drives up their expected profits when a RPM agreement is settled. Moreover, even though under RPM the output is produced according to the efficient rule, the effort is downward distorted due to the asymmetric information, and it is also this aspect that contributes to decreasing the retailer's rent and indeed, to increment the expected upstream firms' profits.

Lemma 4. Expected retailers's rents are higher under QF contract, for a given N.

$$\mathbb{E}\left[U^{QF}(N)\right] > \mathbb{E}\left[U^{RPM}(N)\right]$$

The difference between the expected rents that retailers obtain under QF with those obtained under RPM is positive, hence retailers prefer to choose a QF contract. The explanation of this result is straightforward: in fact when a QF contract is in force, retailers gain flexibility by optimally choosing their level of effort, and this has consequences on the distribution of the information rent within each supply chain.

A quantity forcing contract is less complete with respect to RPM, since it specifies for any amount q_i produced by the retailer, only the fixed fee $t_i(q_i)$ paid to the upstream firm; hence it reduces the screening devices of the manufacturers only on sales. Given this limited control, the manufacturer is unable to clearly disentangle the impact of the common shock θ from his retailers' level of effort e_i on the residual demand that the downstream firm faces. Moreover, with a QF contract " the retailers fully internalize the impact of their effort in improving own demand and downstream profit: a demand-enhancing effect" (Kastl, Martimort, Piccolo (2011)). Summing up, a quantity forcing agreement gives the retailers enough freedom in choosing their effort in order to secure a greater share of return on improving his own demand and, consequently to enjoy a higher information rent.

Finally, compare the ex-ante joint profits generated under the two regimes.

Lemma 5. The ex-ante joint profits are higher with a QF contract, for a given N.

$$\mathbb{E}\left[\Pi^{T,QF}(N)\right] > \mathbb{E}\left[\Pi^{T,RPM}(N)\right]$$

The difference between the ex-ante joint profits that hierarchies obtain under QF with those obtained under RPM is positive.

Even if the ex-ante upstream profits are bigger when the manufacturers and the retailers agree on a RPM contract, the ex-ante joint profits generated by the hierarchy are greater with a QF regime. This result is mainly explained by two factors that interplay with each others. First of all, when QF is in force, retailers are free to choose optimally their level of effort, more clearly, the retailers do not internalize the impact of their own effort on the information rent given up by the upstream manufacturers, hence they obtain higher rents under QF. Secondly, under the QF regime, retailers undertake demand enhancing activities that boost their demand and profits and therefore enjoy higher information rent: these effects overcome the fact the expected upstream profits are greater under RPM compared to QF, and indeed the total ex-ante profits generated by the vertical hierarchy are bigger when a QF contract is implemented.

VII. CONSUMER SURPLUS AND WELFARE COMPARISON

In this section I characterize the consumer surplus and proceed to a welfare comparison under downstream, upstream and supply chain entry's decision.

As it will became clear throughout the section, the endogenous entry of the players, will represent a key element for the results.

Recalling that demands are those of a representative consumer whose preferences are:

$$V(q_i, I, \theta) = (a-\theta)\sum_{i=1}^{N} q_i + \sum_{i=1}^{N} e_i q_i - \frac{1}{2}\sum_{i=1}^{N} q_i^2 - \sum_{j\neq i} q_i q_j + I$$

It is immediate to derive the consumer suplus when the type is θ as

$$CS = (\frac{N}{2} + \sum_{i=1}^{N-1} i)q^2$$

The ex-ante consumer surplus is:

$$CS = \frac{1}{\Delta\theta}\int_0^{\overline{\theta}} ((\frac{N}{2} + \sum_{i=1}^{N-1} i)q^2)d\theta \tag{21}$$

The results of the welfare comparison under the three scenarios, are presented in the propositions below.

Proposition 1. When the entry decision is taken by the downstream firm, the expected social welfare generated in the economy is higher under a RPM regime, while the expected consumer surplus is greater with a QF contract.

To explain this result remember that the consumer surplus is increasing in N (i.e., the number of entrants), hence when the entry' choice is taken by the retailers, the difference between their expected rents and the fixed cost of entry K goes to zero in a free entry equilibrium. However, since expected retailers' rents are higher with QF that with RPM (as shown in Lemma 4) then there will be $N^{QF} > N^{RPM}$, indeed the $\mathbb{E}[CS^{QF}] > \mathbb{E}[CS^{RPM}]$. In fact, recall that a QF agreement leaves more possibilities to the downstream firms to enjoy an information rent, since they can appropriate a greater share of return on improving own demand.

Given this result, if the consumer surplus is the sole welfare criterion of Antitrust policies, as advocated by some scholars (Bork 1978, Chapter 2, pp.51), then a quantity forcing contract has to be preferred to retail price maintenance.

Nevertheless, if the social planner considers the total welfare generated in the economy, then the result is different. In fact, with downstream entry decision, the expected social welfare is the sum between the expected consumer surplus and the expected manufacturers' profits. The latter, are decreasing in N, meaning that the $\mathbb{E}\left[\Pi^{RPM}\left(N^{RPM}\right)\right] > \mathbb{E}\left[\Pi^{QF}\left(N^{QF}\right)\right]$ (as $N^{QF} > N^{RPM}$), this effect prevails on the previuos one (i.e. $\mathbb{E}[CS^{QF}] > \mathbb{E}[CS^{RPM}]$), hence we have that $\Delta\mathbb{E}\left[W\right] \equiv \mathbb{E}\left[W^{RPM}\right] - \mathbb{E}\left[W^{QF}\right] > 0$, meaning that a RPM contract delivers higher expected social welfare compare to QF.

The relevance of this result has to be view in the interaction between asymmetric information and entry decision. In fact, if the Antitust autorithy considers the total welfare generated in the economy, then with downstream entry decision, a RPM regime should be chosen. Even if the findings are coherent with the Chicago School arguing in favour of vertical price control, the reasoning on which his view hinges on, is different from mine. In details, the Chigago School sustains that with a RPM contract consumers cannot be hurt because upstream profit maximization requires avoiding double marginalization, indeed RPM agreement should be lawful per se if the unique welfare criterion is the consumer surplus. In my view, instead, *per se* rules should be taken carefully, since in this set-up a consumer surplus approach will lead to choose QF contract, because more firms will enter in the market, and this increases consumer benefits in terms of variety by expanding consumer's choice, while a total welfare criterion will lead to adopt an RPM agreement.

To sum up, the final outcome that with downstream entry decision a RPM regime should be implemeted is in line with the Chigago School but the justifications in support of this view are different.

Proposition 2. When the entry decision is taken by the upstream firm, the expected social welfare generated in the economy is higher under a QF regime, while the expected consumer surplus is greater with a RPM contract.

The upstream decision of entering the market has the following effects. First of all, the difference between the expected manufacturers' profits and the fixed cost of entry K goes to zero, moreover, since the expected upstream' profits are higher under RPM, we have that $N^{RPM} > N^{QF}$. Considering that the expected consumer surplus is increasing in the number of entrants, it holds that $\mathbb{E}\left[CS\left(N^{RPM}\right)\right] > \mathbb{E}\left[CS\left(N^{QF}\right)\right]$; this means that if the Antitrust authority compares the two regimes in terms of benefits for consumers, a RPM contract has to be preferred to a QF, when the entry decision is taken upstream.

The economic implication of this result is relevant in view of the fact that it offers some insights on retail price restrictions. Primarly, there exists a recent strand of literature showing that retail price restrictions improve manufacturers' profits under asymmetric information, since by expanding the means of controls that the upstream firm has on his retailer, manufacturers develop a better inference on the retailers' private information, and consequently manage better the retailers' rents extraction. When this aspect is framed in a entry decision's problem, as in this model, the higher expected profits for manufacturers traduce in a greater number of firms entering the market, and consequently in larger expected consumer surplus. This result, when the entry decision is taken by the upstream firm, is in line with Chigago School dogma of aligned preferences, over the choice of contractual modes between manufacturers and consumers, if the sole welfare criterion is consumer surplus.

Secondly, when I consider the expected social welfare as the sum of the expected retailers' rents and the expected consumer surplus, the outcome is different. In particular, since the expected rents for the downstream firms are decreasing in N, in this case $\mathbb{E}\left[U^{QF}\left(N^{QF}\right)\right] > \mathbb{E}\left[U^{RPM}\left(N^{RPM}\right)\right]$ given that $N^{RPM} > N^{QF}$, the impact of this aspect prevailes on the consumer surplus, hence the expected social welfare generated in the economy is higher provided that a QF regime is in force. This means that if the main welfare criterion of the Antitrust authority is the expected total welfare, a quantity forcing contract has to be chosen, when it is the upstream firm to first positionate in the market.

Proposition 3. When the entry decision is taken by the hierarchy, the expected social welfare generated in the economy is higher when a QF contract is in force.

The economic intutition of this result is straightforward. First of all, when the entry decision is taken at the hierachy's level, the difference between the expected joint profits and the fixed cost of entry K goes to zero in a free entry equilibrium, and as shown in *Lemma 5* the expected joint profits are higher with a QF regime; given that, it is $N^{QF} > N^{RPM}$. In this set-up the comparison between the total welfare generated in the economy under RPM and QF is simply reduced to the juxtaposition of the sole ex-ante consumer surplus generated under the two regimes. Recalling that the expected consumer surplus is an increasing function of the number of entrants, we have that $\mathbb{E}\left[CS\left(N^{QF}\right)\right] > \mathbb{E}\left[CS\left(N^{RPM}\right)\right]$, namely $\Delta\mathbb{E}\left[W\right] \equiv \mathbb{E}\left[W^{RPM}\right] - \mathbb{E}\left[W^{QF}\right] < 0$.

This last finding ensures that in the markets where the entry choice is established at the hierarchy's level, a QF regime has to be preferred as it generates higher expected consumer surplus.

VIII. CONCLUSIONS

In this first chapter I have developed a linear model with N competing supply chains with asymmetric information and endogenous market structure. I showed how depending on whom between manufacturers, retailers or hierarchies takes the decision to enter in the market, quantity fixing or retail price maintenance can deliver different results in terms of expected social welfare and consumer surplus.

From a policy point of view, the present work undermines the appeal of *per se* rule, since for example, in case of downstream entry it is a RPM contract that delivers higher expected social welfare for the economy, while if the sole welfare criterion for an Antitrust authority is the consumer surplus, then QF arrangement should be preferred.

Predictions show that the converse is true in case of upstream entry decision where, the expected social welfare is greater under QF regime, while the ex-ante consumer surplus is higher when RPM is in force. This last result is in line with the Chigago School arguing in favour of retail price restrictions which avoid double marginalization and align manufacturers' and consumers' preferences, even though the arguments on which mine results hinge on, are different.

The findings of this work may be used as a tool for Antitrust authorities in evaluating the competitiveness of vertical agreements. A wider approach to establish which contractual mode should be preferred in terms of welfare is necessary, as a market size that evolves over time is an aspect that should be taken into account. An interesting direction for future research is to allow for promotional and/or advertising externalities across retailers ($\sigma \neq 0$), and to relax the assumption on the effort ($\psi \neq 1$), which will offer a more complete picture. Nevertheless, incorporating these features could severely complicate the analysis, it seems plausible that the results will still remain valid.

APPENDIX

Proof of Lemma 1.

Equilibrium quantity under QF.

I solved this differential equation as *"differential equation with boundary condition"* :

$$\frac{a-2\theta}{(N-1)\theta} = q^{\cdot} + q^{*}\frac{N}{(N-1)\theta}$$

Let $\Gamma \equiv \frac{N}{(N-1)}$ the solution to the previous equation is:

$$q^{*QF}(\theta) = ke^{-\int_0^\theta \frac{\Gamma}{z_1}dz_1} + \int_0^\theta e^{-\int_{z_2}^\theta \frac{\Gamma}{z_1}dz_1}\frac{a-2z_2}{(N-1)z_2}dz_2$$

Notice that $e^{-\int_0^\theta \frac{\Gamma}{z_1}dz_1} = e^{-\Gamma \ln z_1|_0^\theta} = e^{-\infty} = 0$ due to the fact that $\Gamma > 0$ and $0 \leqslant \theta \leqslant \overline{\theta}$ $\quad q^{*QF}(\theta)$ is bounded it follows that $k = 0$ to fulfill the previous equation:

$$q^{*QF}(\theta) = \int_0^\theta e^{-\Gamma \ln z_1|_{z_2}^\theta}\frac{a-2z_2}{(N-1)z_2}dz_2$$

knowing that $e^{\Gamma \ln z_1|_{z_2}^\theta} = \frac{z_2^\Gamma}{\theta^\Gamma}$ and rearranging yields:

$$q^{*QF}(\theta) = \int_0^\theta \frac{z_2^\Gamma}{\theta^\Gamma}(\frac{a-2z_2}{(N-1)z_2})dz_2 =$$

$$\frac{1}{(N-1)\theta^\Gamma}\int_0^\theta z_2^\Gamma(\frac{a-2z_2}{z_2})dz_2 = \frac{1}{(N-1)\theta^\Gamma}\int_0^\theta (az_2^{\Gamma-1} - 2z_2^\Gamma)dz_2 =$$

$$\frac{1}{(N-1)\theta^\Gamma}(a\int_0^\theta z_2^{\Gamma-1}dz_2 - 2\int_0^\theta z_2^\Gamma dz_2) =$$

$$\frac{1}{(N-1)\theta^\Gamma}(a[\frac{z_2^\Gamma}{\Gamma}]_0^\theta - 2[\frac{z_2^{\Gamma+1}}{\Gamma+1}]_0^\theta) =$$

$$\frac{1}{(N-1)\theta^\Gamma}(a(\frac{\theta^\Gamma}{\Gamma}) - 2(\frac{\theta^{\Gamma+1}}{\Gamma+1})) = \frac{a}{(N-1)\Gamma} - \frac{2\theta}{(N-1)(\Gamma+1)} = \text{plug now } \Gamma$$

$$\frac{a}{N} - \frac{2\theta}{(2N-1)}$$

This concludes the proof. ■

Proof of Lemma 2.

Equilibrium quantity under RPM.

The proof proceeds exactly as the proof of Lemma 1.

Below there are the computations done in order to derive the expected manufacturers' profits, retailers' rents and joint profits generated in the economy.

A. Quantity Forcing

The retailer's information rent under QF regime is:

$$U_i(\theta) = \max_{\theta_i \in \Theta}\{-t_i(\theta) + \max_{e_i}\{(a - \theta - q_i(\theta) - \sum q_{i\neq j}(\theta))q_i(\theta) - \Psi(e_i)\}\} \tag{22}$$

In this set-up the retailer's chooses optimally his effort, that is:

$$q_i(\theta) = e_i(\theta) \tag{23}$$

The first order condition is:

$$\dot{u_i} = (-1 - (N-1)\dot{q})q_i(\theta) \tag{24}$$

That is used to maximize the transfer for the manufacturer:

$$t_i = p_i(\theta)q_i(\theta) - \Psi(e_i) - u_i \tag{25}$$

Given that, the expected profits for the manufacturer is:

$$\begin{gathered}\mathbb{E}[\Pi^{QF}(N)] = \mathbb{E}_\theta[p(\theta, e^{QF}(\theta), e^{QF}(\theta), q^{QF}(\theta), q^{QF}(\theta))q^{QF}(\theta) + \\ -\frac{1}{2}(e^{QF}(\theta))^2 - h(\theta)(-1 - (N-1)\dot{q}^{QF})q^{QF}(\theta)\end{gathered}$$

Then, using the first order conditions:

$$\begin{aligned} -\theta + e^{QF}(\theta) - (N+1)q^{QF}(\theta) &= h(\theta)(-1 - (N-1)\dot{q}^{QF}) \\ q^{QF}(\theta) &= e^{QF}(\theta) \end{aligned} \tag{26}$$

moreover:

$$p(\theta, e^{QF}(\theta), e^{QF}(\theta), q^{QF}(\theta), q^{QF}(\theta))q^{QF} - h(\theta)(-1-(N-1)\dot{q}^{QF}) = (q^{QF}(\theta))^2 \tag{27}$$

Indeed, under quantity forcing the profits for the manufacturer are:

$$\mathbb{E}[\Pi^{QF}(N)] = \frac{1}{\Delta\theta}\int_0^{\overline{\theta}} \{(q^{QF}(\theta))^2 - \frac{1}{2}(e^{QF}(\theta))^2\}d\theta \tag{28}$$

The expected retailer's rents are:

$$\mathbb{E}\left[U^{QF}(N)\right] = \frac{1}{\Delta\theta}\int_0^{\overline{\theta}}\int_{\theta}^{\overline{\theta}} -\dot{u}(x)dxd\theta = \frac{1}{\Delta\theta}\int_0^{\overline{\theta}}\int_{\theta}^{\overline{\theta}} -(-1-(N-1)\dot{q})q(\theta)dxd\theta \tag{29}$$

For the sake of completeness we also compute the expected joint profits under QF as the sum between the expected manufacturers' profits and expected retailers' rents.

$$\mathbb{E}\left[\Pi^{T,QF}(N)\right] = \mathbb{E}[\Pi^{QF}(N)] + \mathbb{E}\left[U^{QF}(N)\right] \tag{30}$$

B. Retail Price Maintenance

Following the same line of reasoning, I compute the expected manufacturers'profits, the expected retailers'rents and the expected joint profits when RPM contract is in force.

The retailer's information rent is:

$$U_i(\theta) = \max_{\theta_i \in \Theta}\{p_i(\theta)q_i(\theta) - \Psi(p_i(\theta) + \theta - a + q_i(\theta) + (N-1)q^*) - t_i(\theta) \tag{31}$$

From this the transfer for the manufacturer is

$$t_i = p_i(\theta)q_i(\theta) - \Psi(e_i) - u_i \tag{32}$$

Given that, the expected manufacturers' profits are:

$$\begin{aligned}\mathbb{E}[\Pi^{RPM}(N)] = \mathbb{E}_\theta[&p(\theta, e^{RPM}(\theta), e^{RPM}(\theta), q^{RPM}(\theta), p^{RPM}(\theta))q^{RPM}(\theta)\\ &-\frac{1}{2}(e^{RPM}(\theta))^2 - h(\theta)(-1-(N-1)\dot{q}^{RPM}(\theta))e^{RPM}(\theta)]\end{aligned}$$

Also in this case I use the first order conditions, obtained by point-wise maximization of retailer's information rent with respect to q_i and e_i :

$$q_i(\theta) = p_i(\theta) = a - \theta + e_i(\theta) - Nq_i(\theta) \tag{33}$$

$$q_i(\theta) = (e_i(\theta) - h(\theta)(-1-(N-1)\dot{q}^{RPM}(\theta)) \tag{34}$$

then I have:

$$\frac{1}{2}(e^{RPM}(\theta))^2 - h(\theta)(-1-(N-1)\dot{q}^{RPM}(\theta))e^{RPM}(\theta) = q^{RPM}(\theta)e^{RPM}(\theta) - \frac{1}{2}(e^{RPM}(\theta))^2 \qquad (35)$$

Because $q^{RPM}(\theta) = p^{RPM}(\theta)$ the general formula for manufacturers'expected profit under RPM is:

$$\mathbb{E}[\Pi^{RPM}(N)] = \frac{1}{\Delta\theta}\int_0^{\overline{\theta}} \{(q^P(\theta))^2 - q^P(\theta)e^P(\theta) + \frac{1}{2}(e^P(\theta))^2\}d\theta \qquad (36)$$

The expected retailer's rents are:

$$\mathbb{E}\left[U^{RPM}(N)\right] = \frac{1}{\Delta\theta}\int_0^{\overline{\theta}}\int_{\theta}^{\overline{\theta}} -\dot{u}(x)dxd\theta = \int_0^{\overline{\theta}}\int_{\theta}^{\overline{\theta}} -(-(1+(N-1)\dot{q})e(\theta))dxd\theta \qquad (37)$$

For the sake of completeness I also compute the expected joint profits under RPM. This quantity is, of course, equal to the sum of the expected manufacturers' profits and the expected retailers' rents:

$$\mathbb{E}\left[\Pi^{T,RPM}(N)\right] = \mathbb{E}[\Pi^{RPM}(N)] + \mathbb{E}\left[U^{RPM}(N)\right] \qquad (38)$$

At this stage,there are all the relevant quantities and it is possible to present the proofs of the *Lemmas*.

Proof of Lemma 3.

Expected manufacturers' profits are higher under RPM.

Below all the computations necessary to calculate the manufacturers' profits under RPM are outlined. The equilibrium quantities under RPM are:

$$q^{RPM} = \frac{a}{N} - \frac{2\theta}{2N-1} \qquad (39)$$

$$e^{RPM} = (N+1)q^{RPM} - a + \theta = \frac{1}{N-2N^2}(a + 3N\theta - 2Na) \qquad (40)$$

Using 39 and 40 in 36 and considering that $\theta \sim U(0,\overline{\theta})$:

$$\begin{aligned}\mathbb{E}[\Pi^{RPM}(N)] = \frac{1}{\overline{\theta}}\int_0^{\overline{\theta}}((\frac{1}{N(2N-1)}(-a-2Nx+2Na))^2+ \qquad (41)\\ -(\frac{1}{N(2N-1)}(-a-2Nx+2Na))(\frac{1}{N(2N-1)}(-a-3Nx+2Na))\\ +\frac{1}{2}(\frac{1}{N(2N-1)}(-a-3Nx+2Na))^2)dx =\\ \frac{12a^2N^2 - 12aN^2\overline{\theta} + 5N^2\overline{\theta}^2 - 12a^2N + 6aN\overline{\theta} + 3a^2}{6N^2(2N-1)^2}\end{aligned}$$

When QF is in force $q^{QF} = e^{QF}$, the equilibrium quantity is expressed in 9, hence:

$$q^{QF} = e^{QF} = \frac{a}{N} - \frac{2\theta}{(2N-1)} \tag{42}$$

Plug the expression 42 in 28, recall that $\theta \sim U(0, \overline{\theta})$ the result is the following:

$$\mathbb{E}[\Pi^{QF}(N)] = \frac{1}{\overline{\theta}} \int_0^{\overline{\theta}} ((\frac{1}{N(2N-1)}(-a - 2Nx + 2Na))^2 - \frac{1}{2}(\frac{1}{N(2N-1)}(-a - 2Nx + 2Na))^2)dx = \tag{43}$$
$$\frac{12a^2N^2 - 12aN^2\overline{\theta} + 4N^2\overline{\theta}^2 - 12a^2N + 6aN\overline{\theta} + 3a^2}{6N^2(2N-1)^2}$$

The difference between 41 and 43 is positive and it is equal to:

$$\mathbb{E}[\Pi^{RPM}(N)] - \mathbb{E}[\Pi^{QF}(N)] =$$
$$\frac{12a^2N^2 - 12aN^2\overline{\theta} + 5N^2\overline{\theta}^2 - 12a^2N + 6aN\overline{\theta} + 3a^2}{6N^2(2N-1)^2} - \frac{12a^2N^2 - 12aN^2\overline{\theta} + 4N^2\overline{\theta}^2 - 12a^2N + 6aN\overline{\theta} + 3a^2}{6N^2(2N-1)^2} =$$
$$\frac{1}{6}\frac{\overline{\theta}^2}{(2N-1)^2} > 0$$

This concludes the proof. ■

Proof of Lemma 4.

Expected retailers' rents are higher under QF.

In order to compare the retailers' rents under the two regimes, plug the equilibrium quantities presented above 39, 40, 42 in 37 and 29, the results are:

$$\mathbb{E}\left[U^{RPM}(N)\right] = \frac{1}{\Delta\theta}\int_0^{\overline{\theta}}\int_{\theta}^{\overline{\theta}} -\dot{u}(x)dxd\theta = -\frac{1}{6N}\frac{\overline{\theta}}{(2N-1)^2}\left(3a + 6N\overline{\theta} - 6Na\right) \tag{44}$$

$$\mathbb{E}\left[U^{QF}(N)\right] = \frac{1}{\Delta\theta}\int_0^{\overline{\theta}}\int_{\theta}^{\overline{\theta}} -\dot{u}(x)dxd\theta = -\frac{1}{6N}\frac{\overline{\theta}}{(2N-1)^2}\left(3a + 4N\overline{\theta} - 6Na\right) \tag{45}$$

The difference between 45 and 44 is positive:

$$\mathbb{E}\left[U^{QF}(N)\right] - \mathbb{E}\left[U^{RPM}(N)\right] =$$
$$-\frac{1}{6N}\frac{\overline{\theta}}{(2N-1)^2}\left(3a + 4N\overline{\theta} - 6Na\right) - (-\frac{1}{6N}\frac{\overline{\theta}}{(2N-1)^2}\left(3a + 6N\overline{\theta} - 6Na\right)) =$$
$$\frac{1}{3}\frac{\overline{\theta}^2}{(2N-1)^2} > 0$$

This concludes the proof. ■

Proof of Lemma 5.

Expected joint profits are higher under QF.

Finally, in order to show that the difference between the expected joint profits under QF and RPM is positive, I plug the quantities in 39, 40, 42 into 38 and 30. The results are the following:

$$\begin{gathered}\mathbb{E}\left[\Pi^{T,RPM}(N)\right]=\mathbb{E}[\Pi^{RPM}(N)]+\mathbb{E}\left[U^{RPM}(N)\right]= \\ -\frac{1}{6N^2(2N-1)^2}\left(-12N^2a^2+6N^2a\overline{\theta}+N^2\overline{\theta}^2+12Na^2-3Na\overline{\theta}-3a^2\right)\end{gathered} \tag{46}$$

$$\begin{gathered}\mathbb{E}\left[\Pi^{T,QF}(N)\right]=\mathbb{E}[\Pi^{QF}(N)]+\mathbb{E}\left[U^{QF}(N)\right] \\ \frac{a}{2N^2-4N^3}\left(a+N\overline{\theta}-2Na\right)\end{gathered} \tag{47}$$

The difference between 47 and 46 is positive:

$$\begin{gathered}\mathbb{E}\left[\Pi^{T,QF}(N)\right]-\mathbb{E}\left[\Pi^{T,RPM}(N)\right]= \\ \frac{a}{2N^2-4N^3}\left(a+N\overline{\theta}-2Na\right)-(-\frac{1}{6N^2(2N-1)^2}\left(-12N^2a^2+6N^2a\overline{\theta}+N^2\overline{\theta}^2+12Na^2-3Na\overline{\theta}-3a^2\right))= \\ \frac{1}{6}\frac{\overline{\theta}^2}{(2N-1)^2}>0\end{gathered}$$

This concludes the proof. ■

Proof of Proposition 1.

Welfare comparison between QF and RPM under downstream entry.

When the entry decision is taken downstream $\mathbb{E}\left[U^{QF}\left(N^{QF}\right)\right]-K=\mathbb{E}\left[U^{RPM}\left(N^{RPM}\right)\right]-K=0$ in the free entry equilibrium. Moreover, $N^{QF}>N^{RPM}$ since it is from (37) and (29) that $\mathbb{E}\left[U^{QF}(\cdot)\right]>\mathbb{E}\left[U^{RPM}(\cdot)\right]$ for any given N.

Expected social welfare under QF is

$$\mathbb{E}\left[W^{QF}\right]=\mathbb{E}\left[CS\left(N^{QF}\right)\right]+N^{QF}\mathbb{E}\left[\Pi^{QF}\left(N^{QF}\right)\right]$$

Expected social welfare under RPM is

$$\mathbb{E}\left[W^{RPM}\right]=\mathbb{E}\left[CS\left(N^{RPM}\right)\right]+N^{RPM}\mathbb{E}\left[\Pi^{RPM}\left(N^{RPM}\right)\right]$$

The difference in the expected social welfare between RPM and QF is:

$$\Delta\mathbb{E}\left[W\right] \equiv \mathbb{E}\left[W^{RPM}\right] - \mathbb{E}\left[W^{QF}\right] = \mathbb{E}\left[CS\left(N^{RPM}\right)\right] - \mathbb{E}\left[CS\left(N^{QF}\right)\right]$$
$$+N^{RPM}\mathbb{E}\left[\Pi^{RPM}\left(N^{RPM}\right)\right] - N^{QF}\mathbb{E}\left[\Pi^{QF}\left(N^{QF}\right)\right] =$$
$$\frac{1}{6N^{QF}N^{RPM}\left(2N^{QF}-1\right)^2\left(2N^{RPM}-1\right)^2}$$
$$[-(N^{QF}N^{RPM}\left(4N^{QF} - 5N^{RPM} + 32N^{QF}(N^{RPM})^2 - 36(N^{QF})^2N^{RPM} + 4N^{QF}N^{RPM} + 4(N^{QF})^2 - 4(N^{RPM})^2\right))\overline{\theta}^2 +$$
$$(-18N^{QF}N^{RPM}a\left(2N^{RPM}-1\right)\left(2N^{QF}-1\right)\left(N^{QF}-N^{RPM}\right))\overline{\theta} +$$
$$(3a^2\left(2N^{RPM}-1\right)^2\left(2N^{QF}-1\right)^2\left(N^{QF}-N^{RPM}\right))]$$

which is positive due to the assumptions on the parameters of the model that is $a > \overline{\theta} > 0$ and $N^{QF} > N^{RPM} > 2$.

Hence $\Delta\mathbb{E}\left[W\right] > 0$, namely, expected social welfare is larger under RPM.

This concludes the proof. ■

Proof of Proposition 2.

Welfare comparison between QF and RPM under upstream entry.

When the entry decision is taken upstream $\mathbb{E}\left[\Pi^{QF}\left(N^{QF}\right)\right] - K = \mathbb{E}\left[\Pi^{RPM}\left(N^{RPM}\right)\right] - K = 0$ in the free entry equilibrium. Moreover, $N^{RPM} > N^{QF}$ since it is from (36) and (28) that $\mathbb{E}\left[\Pi^{RPM}\left(\cdot\right)\right] > \mathbb{E}\left[\Pi^{QF}\left(\cdot\right)\right]$ for any given N.

Expected social welfare under QF is

$$\mathbb{E}\left[W^{QF}\right] = \mathbb{E}\left[CS\left(N^{QF}\right)\right] + N^{QF}\mathbb{E}\left[U^{QF}\left(N^{QF}\right)\right]$$

Expected social welfare under RPM is

$$\mathbb{E}\left[W^{RPM}\right] = \mathbb{E}\left[CS\left(N^{RPM}\right)\right] + N^{RPM}\mathbb{E}\left[U^{RPM}\left(N^{RPM}\right)\right]$$

The difference in the expected social welfare between RPM and QF is

$$\Delta\mathbb{E}\left[W\right] \equiv \mathbb{E}\left[W^{RPM}\right] - \mathbb{E}\left[W^{QF}\right] = \mathbb{E}\left[CS\left(N^{RPM}\right)\right] - \mathbb{E}\left[CS\left(N^{QF}\right)\right]$$
$$+N^{RPM}\mathbb{E}\left[U^{RPM}\left(N^{RPM}\right)\right] - N^{QF}\mathbb{E}\left[U^{QF}\left(N^{QF}\right)\right] =$$
$$-\frac{1}{3}\frac{\overline{\theta}^2}{\left(2N^{QF}-1\right)^2\left(2N^{RPM}-1\right)^2}\left(4(N^{QF})^2N^{RPM} + 2(N^{QF})^2 - 4N^{QF}N^{RPM} - 2N^{QF} - 2(N^{RPM})^2 + 3N^{RPM}\right)$$

which is negative due to the assumptions on the parameters of the model that is $a > \overline{\theta} > 0$ and $N^{RPM} > N^{QF} > 2$.

Hence $\Delta\mathbb{E}[W] < 0$, namely, expected social welfare is larger under QF.

This concludes the proof. ■

Proof of Proposition 3.

Welfare comparison between QF and RPM under hierarchy's entry.

When the entry decision is taken at the hierarchy's level $\mathbb{E}\left[\Pi^{QF}\left(N^{QF}\right) + U^{QF}\left(N^{QF}\right)\right] - K = \mathbb{E}\left[\Pi^{RPM}\left(N^{RPM}\right) + U^{RPM}\left(N^{RPM}\right)\right] - K = 0$ in the free entry equilibrium. Moreover, $N^{QF} > N^{RPM}$ since it is from (36), (37), (28) and (29) that $\mathbb{E}\left[\Pi^{QF}(\cdot) + U^{QF}(\cdot)\right] > \mathbb{E}\left[\Pi^{RPM}(\cdot) + U^{RPM}(\cdot)\right]$ for any given N.

Expected social welfare under QF is

$$\mathbb{E}\left[W^{QF}\right] = \mathbb{E}\left[CS\left(N^{QF}\right)\right]$$

Expected social welfare under RPM is

$$\mathbb{E}\left[W^{RPM}\right] = \mathbb{E}\left[CS\left(N^{RPM}\right)\right]$$

The difference in the expected social welfare between RPM and QF is

$$\Delta\mathbb{E}[W] \equiv \mathbb{E}\left[W^{RPM}\right] - \mathbb{E}\left[W^{QF}\right] = \mathbb{E}\left[CS\left(N^{RPM}\right)\right] - \mathbb{E}\left[CS\left(N^{QF}\right)\right] =$$
$$-\frac{1}{3}\frac{\overline{\theta}}{\left(2N^{QF}-1\right)^2\left(2N^{RPM}-1\right)^2}\left(N^{QF} - N^{RPM}\right)$$
$$\left(3a + 2N^{QF}\overline{\theta} + 2N^{RPM}\overline{\theta} - 6N^{QF}a - 6aN^{RPM} - 8N^{QF}N^{RPM}\overline{\theta} + 12N^{QF}N^{RPM}a\right)$$

which is negative due to the assumptions on the parameters of the model that is $a > \overline{\theta} > 0$ and $N^{QF} > N^{RPM} > 2$.

Moreover, since the CS is an increasing function of N, ($\frac{\partial\mathbb{E}[CS]}{\partial N} = \frac{a(6N-3)-4N\overline{\theta}}{3(2N-1)^3}\overline{\theta} > 0$) and $N^{QF} > N^{RPM}$ it is that $\Delta\mathbb{E}[W] < 0$, namely, expected social welfare is larger under QF.

This concludes the proof. ■

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CHAPTER II

VERTICAL CONTRACTING AND ENDOGENOUS MARKET CHOICE

I. INTRODUCTION

Competitive environment, toughness of adverse selection problem and contractual structures are all determinants for players' market choice; therefore, optimal market allocation and the elements affecting the decision's outcome have attracted a lot of attention in the theoretical Industrial Organization literature. This paper investigates the market choice of vertical related firms, between two different competitive environments. Towards this purpose, I consider the endogenous market location decision between two different markets (A, B) of M supply chains, by developing a simple model with competing vertical related firms, each composed by a manufacturer who supplies to his retailer a fundamental input necessary to produce a final good, and an exclusive retailer who is privately informed about his marginal cost of production. The results show how the equilibrium market choice and consequently, the number of firms entering in the markets, depends on the environment in which firms operate in terms of costs, level of uncertainty and, of course, on the presence of asymmetric information.

Studying the interaction between upstream and downstream market is important since vertical agreements are frequently object of policy issues and, failing to consider the side-effects that a measure in the upstream market may produce in the downstream market or viceversa, can undermine the effectiveness of a regulation. Similarly, as I have shown in the previous chapter, the consequences of different forms of vertical agreement (e.g. retail price maintenance, two-part tariffs, quantity forcing, linear pricing) on total welfare and consumer surplus can be correctly evaluated if the market structure is assumed endogenous, indeed it is allowed to change over time.

With the aim to take the above factors into account, the idea of the theoretical approach is to use a model of circular competition a' la Salop (1979), where the supply chains entering a market locate equidistantly on a circle where consumers are uniformly distributed. Each consumer has a valuation for a single unit of the good; the supply chain's location represents the variety it produces while the consumer's location represents its most preferred type, so consumers pay a transportation cost to reach a retailer and purchase its product; these costs can be intepreted as the loss of utility for purchasing a variety of the good that is different from the preferred one. In this way, the model captures the idea that different consumers prefer different varieties of a product, and the number of competing supply chains that enter the market affects the degree of differentiation among their products. Moreover, since each supply chain produces a different variety, their entry implies that consumers are able to acquire a variety that is closer to their preferred one. The novelty of this work is taking into account that upstream and downstream market structures evolve endogenously.

How does the differences among the two markets in terms of degree of competition and severity of asymmetric information affect market choice? How the market choice depend on who among the economic players take the decision to locate?

To address these issues, I analyze retailers, manufacturers and hierarchies market choice with alternatives set-up. First if the two markets A, B have different transportation costs, indeed assume that one market will be more competitive with lower transportation costs, while the other market less competitive (i.e. higher transportation costs).

The second case is studying economic players market choice when the two markets have different degree of transparency. In order to understand what this variable describes, it is fundamental to recall that this is a set-up characterized by asymmetric information, since retailers are privately informed about their marginal costs of production. This assumption is consistent with the adverse selection literature and it relies on the idea that downstream firms are better informed than their upstream firms on costs of inputs like labour, energy and other fixed costs that are not related to the essential input that the manufacturer provides to his retailer, to realize the good sold in the final market. Hence, I conjecture that changes in the level of uncertainty in the market, as for instance implied by better monitoring technologies, can affect the equilibrium market choice and sequentially the equilibrium number of firms entering in the more/less transparent market[2].

Throughout the paper I assume that the vertical relationship between manufacturers and retailers is regulated by a *two-part-tariffs* contract (i.e. a fixed-fee and a linear wholesale price); this type of contract is standard in the vertical contracting literature and as explained in Motta (2004, Ch.6) it avoids double-marginalization and guatarees higher social welfare.

It is worth to underline that, also in this chapter, in order to consider the complexity of the reality in terms of which economic agent makes the market's choice, I characterize manufacturer, retailer or hierachy's decision with asymmetric information within the two different scenarios (i.e. the two markets have different transportation costs, or different level of uncertainty) since, also in this framework, the role of who between either the upstream or the downstream firm or the whole supply chain chooses entry, matters.

The results are the followings.

In the first case in which the two markets have different transportation costs and the market choice is made by the retailers, as expected, these tend to locate in the less competitive market (i.e. the one characterized by higher transportation costs). This happens because the information rent that should be granted to retailers, in order to induce truthful information revelation, is increasing in the transportation costs. However, this is a only a first order effect since, I establish the existence of a negative second

[2] Troughout the chapter I will equivalently talk about level of uncertainty or level of transparency in the market; meaning that if the level of uncertainty increases in one market than it becomes less transparent.

I will refer also to the growing level of uncertainty as a worsening of the asymmetric information problem.

order effect which prevails when there is a large asymmetry between markets A and B in terms of transportation costs. This is because starting from a situation of large asymmetry between the markets, if the transportation costs become too high the retailer's price has to increase as well. However, since market demand is negative related with transportation costs, if the demand shrinks too much, the positive first order effect on the information rent is over compensated by the negative second order effect, and retailers prefer to stay in the market which is characterized by lower transportation costs and, indeed, higher competition.

What happens when the market allocation is determined by the upstream firm? Also in this case the first order effect is greater than zero, suggesting a positive relationship between manufacturers' profits and trasportation costs, so that an increase in these transportation costs generates more entry in the market where the increase arises. In fact, if there is a large asymmetry bewteen the two markets, for manufacturers it is convenient to choose the market which is characterized by higher transportation costs because the increases in sales revenues will be higher than the increase in the information rent that has to be insured to retailers. Nevertheless, if the asymmetry between the two markets in terms of transportation costs is small enough, then manufacturers prefer to stay in the one that has lower transportation costs, since the raise in their profit will be determined by the lower information rent that they have to pay to the lower number of retailers located in that market (the second order effect prevails).

Moreover, the threshold that establishes how large the asymmetry between the two markets should be in order to appeciate the second order effect, is increasing in the level of uncertainty in the market. This means that when the asymmetric information becomes more severe in both markets, retailers mimicking opportunities increase and manufacturers have to ensure higher rents to retailers in order to make them provide truthful information about marginal costs of production. This will reduce the tendency for manufacturers to go in the less competitive market (i.e. the one that is characterized by higher transportation costs) because locating in that market will result in paying higher information rent due to the increase of both transportation costs and uncertainty. These two factors combined together may overcome the positive effect that an increase in the transportation costs has on upstream' sales revenues.

In the second scenario in which different level of uncertainty is allowed between the two markets, the results are equally interesting.

In fact, when the market choice is done by retailers it is unexpected to see that they not always prefer the less transparent market. The findings show that if the asymmetry between the two markets in terms of level of uncertainty is small enough, then retailers choose to locate in the less transparent market. This is because bad monitoring technologies make retailers mimicking opportunities more profitable and truthful information revelation more costly, so downstream firms' information rent will increase. This result is coherent with strategic delegation literature: higher uncertainty increases retailer's price and the same happens for the profitability of the market which, ultimately, induces more entry. However, if the two markets differ a lot for degree of transparency, then retailers prefer to locate in the more transparent market, since a sufficiently high increase in the level of uncertainty, makes wholesale price raise even more than the information rent's increment.

To sum up if the asymmetric information problem becomes slightly more severe in one market with respect to the other, wholesale price increases, retailer's price increases but the " positive " first order effect that bad monitoring technologies have on retailer's information rent is larger, so that downstream firms prefer to select the less transparent market. Still, if the difference between the two markets in terms of asymmetric information is significant, then retailers prefer to go in the more transparent market as, choosing the less transparent market will not be anymore convenient since, the higher wholesale price that retailers have to correspond to their manufacturers overcomes the increases in the information rent (negative second order effect). Nevertheless, by evaluating also the impact of an increase in the transportation costs in both markets, it can be seen that it makes easier for retailers choosing the less transparent market. In fact, the eventual increase in the transportation costs combined with the worsening of market's uncertainty, reduces the chances that downstream firms choose the more transparent market.

As far as it concern the manufacturers' market choice in this framework, the results are straightforward: both the first and second order effect have a positive sign, meaning that the equilibrium number of upstream is increasing in the level of uncertainty; said in another way, manufacturers always choose the less transparent market, no matter how large is the asymmetry between the two. Within this framework, upstream firms face a trade off when the adverse selection problem becomes more severe: from one side, uncertainty makes retailers mimicking opportunities more profitable and, consequently, manufacturers have to ensure a higher rent to retailers so to induce truthful information revelation, this reduces their profits; however, on the other side, an increase in level of uncertainty in the market makes sales revenues increase as well; the latter effect prevails on the former and upstream firms choose to locate in the less transparent market. Even if this result echoes the literature on strategic delegation, it does not hinge on the observability of the contract but on the presence of asymmetric information and adverse selection. Bad monitoring technologies exacerbate the asymmetric information between manufacturers and retailers, so that upstream firms can extract more surplus from the fixed fee; this ultimately leads to more entry and more product variety in what I defined as the less transparent market.

Finally, about hierarchy location decision, the results show that the supply chains prefers to enter in the less competitive and less transparent market if the asymmetry between the two is sufficiently small; however if, instead, it is large enough supply chains choose the more competitive and the more transparent market. In both scenarios, the raise in either the transportation costs or the worsening of the asymmetric information problem, may generate an indirect effect on the demand side. This could prevail on the positive effect that increase produce on the supply chains' sales revenues.

On the normative side, I also study the social planner choice.

When the two markets are characterized by a different level of uncertainty, the welfare is maximized when the majority of firms choose to enter in the more transparent market. This happens when the market choice is made by the retailers or the supply chains and there is a large asymmetry between the two circles. Despite that, in case of manufacturers' choice, their allocation will always be different from the one pursued by the social planner and welfare will be never maximized. Surprisingly though, a social planner prefers players to locate in the market which has higher transportation costs.

II. LITERATURE REVIEW

The analysis on endogenous market choice of competing supply chains, under asymmetric information, contributes to three strands of literature: industrial organization, vertical contracting and vertical contracting and welfare. Certainly, an innovative feature of the present paper is introducing the endogenous market choice for vertical related firms which comes from a wider topic of endogenous entry decision. One of the first relevant work in the area of contract theory is the paper of Pagnozzi and Piccolo (2016), where privately informed agent(s) first chooses whether to access the market and then, to contract with a principal. This suggest that the characteristics of agents who contract in a market may not be exogenous but may be determined by entry decisions.

This feature of endogenous entry has been introduced quite recently in the economic literature and there exist some works underlining how the combined effect of asymmetric information and endogenous entry affects the equilibrium outcomes. For instance, Etro (2010) sustains that endogenous entry influences the strategic purpose of any contracts and furthermore, it is not on the mode of competition but on the impact of endogenous entry decisions that the nature of contracts depends on. In Creane (2012) instead, asymmetric information takes the form of each seller knowing the quality of its own product (i.e. quality is a private information) and if there is endogenous entry, the results show that markets may be characterized by above normal profits, even with low measures of concentration and entry in the market.

The present paper, by combining together elements of vertical contracting and asymmetric information with an endogenous market structure departs from previous literature, where instead market structure was assumed as exogenous—see, e.g., Blair and Lewis (1994), Gal-Or (1991, 1999), Kastl *et al.* (2011), and Martimort (1996).

A relevant work that proposes insights on the link between entry incentives and the selling conditions offered by the manufacturers to retailers with market structure that evolves endogenously, is the one by Reisinger and Schnitzer (2012). They consider non-exclusive vertical relationships with endogenous entry both in the upstream and in the downstream market. The authors delevop a model of successive oligopolies with endogenous entry allowing for various degrees of product differentation and entry costs in both markets. They show that total profits are determined by the competitive conditions in the downstream market, while competitive conditions in the upstream market mainly affect the distribution of profits. Moreover, they also analyze both two part-tariffs and linear contracts and, show that welfare is larger with linear prices because they induce more downstream firms to enter, although two-part tariffs avoid double marginalization. Similar to this work, in the present chapter I consider two markets that differs for some parameters, but I operate in a framework of asymmetric information, while they assume perfect information.

The main structure for the theoretical model has been derived starting from the paper of Bassi, Pagnozzi and Piccolo (2016) who analyze a set-up where an endogenous number of competing manufacturers, located around a circle, contract with exclusive retailers who are privately informed about their costs. They show that the number of brands in the market depends on the presence of asymmetric information, and on the types of contracts between manufacturers and retailers. Their results demonstrate that with two-part tariffs wholesale prices fully reflect retailers' costs, while with linear contracts, wholesale price are constant and independent of retailers'costs. Finally, they show that the number of brand is lower (*resp.* higher) with asymmetric information than with complete information when the contracts are linear (*resp.* with two-part tariffs). However, joints profits of manufacturers and retailers are higher with linear prices. On the normative side, they also evaluate the effects of endogenous entry on welfare.

I take as benchmark this structure, but the present work differ by assuming that the endogeneity is on the market choice of retailers and manufacturers, between two markets that may differ in either the transportation costs or the degree of transparency.

With respect to the contractual structure, I conjecture that manufacturers offer to their retailers a two-part tariffs contract. This is standard in the vertical contracting literature and consistent with U.S. data on yogurt consumption (Berto Villas-Boas, 2007) and French data on bottled water consumption (Bonnet and Dubois, 2010).

Finally, for the last strand of literature, vertical contracting and welfare, there are several papers dealing with these issues. As already presented in Reisinger and Schnitzer (2012), Hart and Tirole (1990), McAfee and Schwartz (1994) and White (2007) assume a monopolistic supplier and study whether it is able to extract monopoly rents from competiting downstream firms, while others like Bernheim and Whinston (1998) analyze a different framework with multiple competitive upstream firms and only one downstream firm and explore under which conditions the downstream firm accepts an exclusive dealing contract.

To the best of my knowledge and thanks to the work of Etro (2014), we know that research in the fields of contract theory and industrial economics with endogenous market choice it is still at an initial phase and, I wish to start fulfilling this gap.

The rest of the paper is organized as follows. Section III and Section IV presents the model and the analysis. In Section V, I analyze the welfare within this contractual environment. Finally, Section VI concludes. Most of the proofs are relegated to an Appendix.

III. THE MODEL

Players and Environment. In the thereoretical part of this work there are two markets (A, B) described by the "circular city" model of Salop (1979).

Goods are distributed by an exogenous number of M supply chains (firms) located equidistantly around the circle (see, e.g., Raith, 2003); each hierarchy is composed by one upstream supplier (or manufacturer) U_i and one exclusive downstream buyer (or retailer) R_i. I assume that there are not fixed entry cost, and the market choice is determined by the no-arbitrage condition. The key aspect of the present work is the endogenous allocation's choice made by the economic agents of the model, and how this choice is affected by the characteristics of the markets. The hypothesis that the supply chains are located equidistantly around the circle, is a standard assumption that can be interpreted as the result of a model in which a large number of manufacturers sequentially decide whether to enter the market, and then locate equidistantly, once all firms willing to enter have done so.

There are two main elements that will play a strategic role: transportation costs and asymmetric information.

For the first one, there is a mass of consumers uniformly distributed with density 1 around a circle of perimeter 1; each consumer has a valuation v for a single unit of the good[3] and she pays a linear transportation cost to reach firms; this cost that can be interpreted as the loss of utility for purchasing a variety of the good that is different from the preferred one.

Specifically, as presented in the paper of Bassi et al. (2016), consumer located at $x \in [0, \frac{1}{N}]$ between firm i and firm j pays a transportation cost equal to tx to buy from firm i and to $t\left(\frac{1}{N} - x\right)$ to buy from firm j. Hence, letting p_i be the retail price of firm i, the consumer is indifferent between the two firms if and only if

$$p_i + tx = p_j + t\left(\frac{1}{N} - x\right) \quad \Leftrightarrow \quad x\left(p_i, p_j\right) \equiv \frac{p_j - p_i + \frac{t}{N}}{2t}.$$

Letting p_{i-1} and p_{i+1} be the prices charged by the firms located to the left and to the right of firm i respectively, the total demand of firm i (in an interior solution)[4] is

$$D_i\left(p_i, p_{i-1}, p_{i+1}\right) = x\left(p_i, p_{i-1}\right) + x\left(p_i, p_{i+1}\right) = \frac{p_{i-1} + p_{i+1} - 2p_i}{2t} + \frac{1}{N}. \tag{48}$$

If all his rivals charge the same price p, firm i's demand is

$$D_i\left(p_i, p\right) = \frac{p - p_i}{t} + \frac{1}{N}. \tag{49}$$

Throughout our work I conjecture that the two markets (A, B) may differ on the size of transportation costs. Hence, I assume that these are τ for market A, and t for market B, where $\tau \geqslant t$. Then, N firms enter in market A while $M - N$ firms enter in market B.

The second relevant feature of this model is the presence of asymmetric information that characterizes the relationship between manufactures and retailers in any vertical contracting problem.

[3] For simplicity v is large enough so that each consumer always buys one unit regardless of the price.

[4] We are going to assume that all firms have positive demand (see below). This implies that each consumer buys from one of the two firms between which he is located, and that the demand of a firm only depends on the prices charged by its closest competitors.

In order to have a positive demand it should always be that $t > \frac{M}{2}\sigma$

Retailers are privately informed about their costs of production, or the costs of other inputs that are provided by alternative suppliers. In this set-up, downstream firms are privately informed about their marginal cost of production θ_i which is distributed on the compact support $\Theta \equiv [\mu - \sigma, \mu + \sigma]$, with $\mu > \sigma$ so that the marginal costs are always positive and σ represents the degree of uncertainty that characterizes each market, due precisely to the adverse selection problem. For simplicity, manufacturers' marginal costs of production are normalized to zero.[5]

In the second part of the paper, I consider that the markets A, B may have different degree of transparency (i.e. σ); let assume that σ indicates the level of uncertainty for market A, while in market B it is s, and $\sigma \geqslant s$, so that N firms enter in market A while $M - N$ firms enter in market B.

For each of the two cases presented (i.e., markets differ because of transportation costs, or level of asymmetric information), I will consider three scenarios of market's allocation: if the market choice is made by the upstream firm, by the downstream firm or by the entire hierarchy.

*Contracts***.** Manufacturers can offer their retailers a *two-part tariffs* contract: the upstream firm proposes a contract $\{w_i(m_i), T_i(m_i)\}$ that specifies a linear wholesale price $w_i(m_i)$ and a fixed franchise fee $T_i(m_i)$ both contingent on retailer's report m_i about his cost $\theta_{i.}$ I use the *Revelation Principle* to characterize the equilibrium of the model[6].

*Timing and Equilibrium Concepts***.** The sequence of events unfolds as follows:

- T=0 Manufacturers/Retailers decide to enter.
- T=1 Manufacturers/Retailers choose in which market to locate equidinstantly around each circle.
- T=2 Retailers privately observe their costs.
- T=3 Manufacturers simultaneously offer contracts to retailers, who choose whether to accept them.
- T=4 If a retailer accepts the contract offered by his manufacturer, he makes a report about his cost. Otherwise, manufacturers and retailers obtain their reservation utility (which is normalized to zero for simplicity).
- T=5 Retailers choose prices, the market clears and contracts are executed.

Bilateral contracting is secret. Members of a given supply chain cannot observe the specific trading rules specified in the contract ruling the competing hierarchy.

The equilibrium concept used is *Perfect Bayesian Equilibrium* with the added *"passive beliefs"* refinement. Hence, regardless of the contract offered by his own manufacturer, a retailer always believe that

[5] The assumption that only retailers are privately informed about their production costs is consistent with the adverse selection literature, that focuses on the effects of the information rents obtained by a privately informed agent who contracts with a principal with full bargaining power. Introducing private information on manufacturers' marginal costs would not affect any of our qualitative results (Maskin and Tirole, 1990).

[6] see e.g., Myerson [1982] and Martimort [1996]

rival manufacturers offer the equilibrum contract, and each retailer expectes that rival retailers truthfully report their types to upstream firms, in a separating equilibrium. The solution of the model looks for symmetric pure strategies equilibria.

IV. EQUILIBRIUM ANALYSIS

Before proceeding towards the analysis in which I study the economic player's market choice and, how the equilibrium number of firms change with respect to the transportation costs and the degree of uncertainty in the market, I present the main results for retailers' rents and manufacturers' profits, that will be used to determine the market choice and that comes from the reference paper of Bassi et al. (2016).

Recall that the theoretical model has been developed in an incomplete information framework and that the market structure evolves endogenously.

In this set-up, as retailers are privately informed about their marginal cost of production, they have an incentive to report a higher marginal cost in order to pay a lower fixed fee, yet producing at a lower cost. Therefore, manufacturers have to provide an information rent to retailers aiming at inducing truthful information revelation.

Consider a separating equilibrium in which retailers choose the retail price $p^e_{T,j}(\theta_i)$.[7] Given a wholesale price $w_{i,j}(u_i)$, R_i chooses p_i to solve

$$\max_{p_i \geq 0} D_{i,j}(p_{i,j}, \overline{p}^e_{T,j})(p_{i,j} - w_{i,j}(u_i) - \theta_i),$$

where $\overline{p}^e_T = \frac{1}{2\sigma}\int_{\mu-\sigma}^{\mu+\sigma} p^e_T(\theta_i)\, d\theta_i$ denotes the average equilibrium price. The price that maximizes R_i's expected profits is

$$p^e_{i,j}(w_{i,j}(m_i), \theta_i) = \frac{\theta_i + w_{i,j}(m_i) + \overline{p}^e_{T,j} + \frac{t_j}{N}}{2}. \tag{50}$$

Following a standard convention in the screening literature, R_i's expected utility when his cost is θ_i and he reports u_i is

$$u_i(m_i, \theta_i) \equiv D_{i,j}(p^e_{i,j}(w_{i,j}(m_i), \theta_i), \overline{p}^e_{T,j})(p^e_{i,j}(w_{i,j}(m_i), \theta_i) - w_{i,j}(m_i) - \theta_i) - T_{i,j}(m_i).$$

For a contract to be incentive compatible, truthfully reporting $u_i = \theta_i$ must maximize R_i's utility — i.e., the following local first- and second-order incentive constraints must hold[8]

$$\left.\frac{\partial u_i(m_i, \theta_i)}{\partial m_i}\right|_{u_i=\theta_i} = 0 \quad \Leftrightarrow \quad \dot{T}_{i,j}(\theta_i) = -D_{i,j}(p^e_{i,j}(w_{i,j}(\theta_i), \theta_i), \overline{p}^e_{T,j})\dot{w}_{i,j}(\theta_i) \quad \forall \theta_i. \tag{51}$$

$$\left.\frac{\partial^2 u_i(m_i, \theta_i)}{\partial m_i^2}\right|_{u_i=\theta_i} \leq 0 \quad \Leftrightarrow \quad \dot{w}_{i,j}(\theta_i) \geq 0. \tag{52}$$

[7] The subscript T indicates the type of contratc, that is two-part tariff in this environment.

[8] In the Appendix, it is shown that these conditions are also sufficient for global incentive compatibility — i.e., $u_i(\theta_i, \theta_i) \geq u_i(m_i, \theta_i)\ \forall (m_i, \theta_i) \in \Theta^2$.

Moreover, letting $u_i(\theta_i) \equiv u_i(\theta_i, \theta_i)$ denote R_i's utility when he reports his true type (i.e., his information rent), the participation constraint is

$$u_i(\theta_i) \geq 0, \quad \forall \theta_i. \tag{53}$$

Therefore, U_i solves the following maximization program

$$\max_{w_{i,j}(\cdot), T_i(\cdot)} \int_{\mu-\sigma}^{\mu+\sigma} \left[D_{i,j}(p^e_{i,j}(w_{i,j}(\theta_i), \theta_i), \overline{p}^e_{T,j}) w_{i,j}(\theta_i) + T_{i,j}(\theta_i) \right] d\theta_i, \tag{54}$$

subject to conditions (51), (52) and (53).

Following Laffont and Martimort (2000, Ch. 3), first ignore the constraint $\dot{w}_{i,j}(\theta_i) \geq 0$, and then check that it is actually satisfied in the equilibrium characterized. In the Appendix, it is shown that $u_i(\theta_i)$ is decreasing and the participation constraint is binding when $\theta_i = \mu + \sigma$ — i.e., $u_i(\mu + \sigma) = 0$. Hence, R_i's rent is

$$u_{i,j}(\theta_i) = \int_{\theta_i}^{\mu+\sigma} D_{i,j}(p^e_{i,j}(w_{i,j}(x), x), \overline{p}^e_{T,j}) dx. \tag{55}$$

This rent is increasing in consumers' demand because a retailer obtains a higher utility by reporting a higher marginal costs when this allows him to sell a higher quantity on average. Notice also that, since the demand for the good sold by R_i is decreasing in $p_{i,j}$, this provides an incentive for a manufacturer to increase the wholesale price to limit the retailer's rent (recall that retail prices are increasing in wholesale prices). Indeed, just to underline the relationship between wholesale price, retail price and demand that will be used also in explaining the results of economic player's market choice, an increase in wholesale price induces an increase in retailer's price, and this ultimately lower the demand for the final good produced by the retailers, and indirectly limits the retailers' information rent.

With a standard change of variables, the fixed fee is

$$T_{i,j}(\theta_i) = D_{i,j}(p^e_{i,j}(w_{i,j}(\theta_i), \theta_i), \overline{p}^e_{T,j})(p^e_{i,j}(w_{i,j}(\theta_i), \theta_i) - w_{i,j}(\theta_i) - \theta_i) - u_{i,j}(\theta_i).$$

Substituting this into (54) and integrating by parts, U_i's (relaxed) maximization problem is

$$\max_{w_{i,j}(\cdot)} \int_{\mu-\sigma}^{\mu+\sigma} D_{i,j}\left(p^e_{i,j}(w_{i,j}(\theta_i), \theta_i), \overline{p}^e_{T,j}\right) \left[p^e_{i,j}(w_{i,j}(\theta_i), \theta_i) - \theta_i - \frac{G(\theta_i)}{g(\theta_i)} \right] d\theta_i.$$

which led the upstream firm, U_i to set a wholesale price

$$w^e_{T,j}(\theta_i) = \theta_i - \mu + \sigma_j > 0 \quad \forall \theta_i \tag{56}$$

while the downstream firm, R_i sets a retail price

$$p^e_{T,j}(\theta_i) \equiv p^e_{i,j}(w^e_{T,j}(\theta_i), \theta_i) = \theta_i + \sigma_j + \frac{t_j}{N} \quad \forall \theta_i. \tag{57}$$

In order to trade-off efficiency and rents, in an asymmetric information environment, manufacturers increase wholesale prices and this distortion is increasing in σ_j. As a result, retail prices are higher too.

Using the equilibrium retail price (57) and letting $u^e(\theta_i)$ denote the equilibrium rent of the retailer, the expected profits of a manufacturer who enters the market are:

$$\tfrac{1}{2\sigma}\int_{\mu-\sigma}^{\mu+\sigma}\left\{D_{i,j}(p^e_{T,j}(\theta_i),\overline{p}^e_{T,j})(p^e_{T,j}(\theta_i)-\theta_i)-u^e(\theta_i)\right\}d\theta_i = \underbrace{\frac{1}{N}\left[\frac{t_j}{N}+\sigma_j\right]}_{\text{sale revenues}}-\underbrace{\sigma_j\left[\frac{1}{N}-\frac{\sigma_j}{3t_j}\right]}_{\text{information rent}}.$$

The profits are made of two elements: sales revenues and information rent. It is immediate to identify the presence of a trade-off since more uncertainty (reflected by a larger σ) makes retailers' mimicking opportunities more profitable and, consequently, it makes truthful information revelation more costly for manufacturers. However, a larger σ also increases both wholesale and retail price, thereby raising sales revenues and profit margins.

From this point onward I present the two scenarios in which I analyze the market choice. Moreover, it is worth to underline that when the due markets are equal, firms equally distribute among them.

IV(i). *Different Transportation Costs*

- RETAILER'S ENTRY

The first scenario consists in the analysis of what happens if it is the downstream firm to decide in which market to locate. Recall that market A is characterized by τ as transportation costs, and in market B those are t, and $\tau \geqslant t$. Consider that N firms enter in market A and $M-N$ firms enter in market B.

The equilibrium market choice is taken according to the no-arbitrage condition (i.e. the retailers' rents ensured in the two markets should be equal):

$$\begin{aligned}\Gamma_\tau(N) &= \Gamma_t(M-N) \\ \sigma\left(\frac{1}{N}-\frac{\sigma}{3\tau}\right) &= s\left(\frac{1}{M-N}-\frac{s}{3t}\right)\end{aligned} \qquad (58)$$

The aim is to understand in which market the retailers choose to locate; if they select the one that is characterized by higher transportation costs or the other which has lower transportation costs and it is, indeed, more competitive. First of all, it is relevant to point out that retailers' rent are increasing in t, this means that an increase in the transportation costs increases rents. This result is standard in the economic literature, in fact an increase in the transportation costs makes retailer's rent higher, hence entry in that market becomes more profitable. In another way, an increase in the transportation costs, expand the profit margin and therefore increases the number of firms (Tirole, " Theory of Industrial Organization", p. 283).

Troughout the analysis I start from the benchmark case where the two markets are equal and firms equally distribute among them, so that $N = \frac{M}{2}$. Secondly, I study the behaviour of the function that describes how many retailers enter in market A, following slightly variations in the transportation costs from the benchmark case. The aim is to indentify whether there exists a threshold for $d\tau$, defined as the difference between the transportation costs in the two markets (i.e. $\tau - t$), such that the majority of retailers prefer to choose the more competitive market, the one that is characterized by lower transportation costs.

In order to do so, I have initially applied the Implicit Function Theorem, and secondly I have outlined the second order Taylor expansion for the function N. In this way it is possibile to distinguish the impact of the first and second order effect on the number of firm who chooses to enter in market A (i.e. the one that has higher transportation costs).

The second order Taylor expasion for N is:

$$N \simeq \frac{M}{2} + \left.\frac{\partial N}{\partial \tau}\right|_{\substack{\tau=t \\ \sigma=s}} d\tau + \frac{1}{2} \left.\frac{\partial^2 N}{\partial^2 \tau}\right|_{\substack{\tau=t \\ \sigma=s}} (d\tau)^2 \tag{59}$$

The first order effect in the Taylor expansion is positive, while the second order effect is negative: if there exist cases such that $N < \frac{M}{2}$ it means that the second order effect prevails and, the majority of retailers prefer to locate in the market B, which is more competitive having lower transportation costs.

Proposition 1. When the market choice is taken by the downstream firm and the two markets have different transportation costs, there exists a $d\widetilde{\tau}$ such that if $d\tau > d\widetilde{\tau}$, the majority of downstream firms chooses the market with lower transportation costs.

The proposition above states that if there is a large asymmetry between the two markets in terms of transportation costs, there are circumstances under which the majority of retailers prefer to locate in the more competitive market. In this set up, an increase in the transportation costs makes retailers' prices increase as well; it is the so called the first order effect which makes retailers' rents raise too. However, there is a negative second order effect due to the fact that the demand is inversely related with transportation costs. Since, these costs can be interpreted as a loss of the utility for purchasing a good that is different from the preferred one, a boost in the transportation costs generates a shrink in consumer's demand and if this reduction is significant, the positive first order effect on prices is over compensated by the second order effect, and retailers prefer to stay in the market which is characterized by lower transportation costs and, indeed, higher competition.

- MANUFACTURER' S ENTRY

In this second scenario I consider upstream firm's market choice.

Manufacturers' profits are:

$$\pi = (\frac{1}{N}\left(\frac{\tau}{N}+\sigma\right)-\sigma\left(\frac{1}{N}-\frac{\sigma}{3\tau}\right))$$

The first term of this expression represents sales revenues, while the second is the rent that has to be ensured to the retailer in order to induce truthful information revelation.

As in the previous case, I have considered what happens to the function describing how many firms choose to enter in market A, when there are variations around the benchmark case. First of all, there exists a positive relationship between transportation costs and upstream firm's profit.

The indifference condition that manufacturers should satisfy in order to choose their location is presented below, after I apply the Implicit fucntion therorem and I derive the second order Taylor expasion for N.

$$\pi_\tau(N) = \pi_t(M-N) \tag{60}$$

$$(\frac{1}{N}\left(\frac{\tau}{N}+\sigma\right)-\sigma\left(\frac{1}{N}-\frac{\sigma}{3\tau}\right)) = \left(\frac{1}{M-N}\left(\frac{t}{M-N}+s\right)-s\left(\frac{1}{M-N}-\frac{s}{3t}\right)\right)$$

The Taylor expansion is the following:

$$N \simeq \frac{M}{2} + \left.\frac{\partial N}{\partial \tau}\right|_{\substack{\tau=t\\ \sigma=s}} d\tau + \frac{1}{2}\left.\frac{\partial^2 N}{\partial^2 \tau}\right|_{\substack{\tau=t\\ \sigma=s}} (d\tau)^2 \tag{61}$$

Also in this case the first and second order effect have an opposite sign and I have been able to identify a threshold $d\widetilde{\tau}$ below which the negative effect prevails so that $N < \frac{M}{2}$, meaning that the majority of manufacturers choose to locate in the more competitive market, the one that is characterized by lower transportation costs.

Proposition 2. When the market choice is taken by the upstream firm and the two markets have different transportation costs, there exists a $d\widetilde{\tau}$ such that if $d\tau < d\widetilde{\tau}$, the majority of upstream firms chooses the market with lower transportation costs.

When manufacturers choose in which market to locate, if $d\tau < d\widetilde{\tau}$ (i.e. the asymmetry between the market is sufficiently small), the majority of upstream firms prefers to choose the market which has lower transportation costs. In order to explain the economic intution behind this result, it is necessary to take into account also the behaviour of the retailers, since their decision affects the manufacturers' profits due to the size of the information rent. This point is consistent with previous literature (see Reisinger et al. (2012)) who have extensively argued how there are feedback effects between upstream and downstream behaviours. When the asymmetry between the two markets in terms of transportation costs is small enough, manufacturers prefer to stay in the market which has lower transportation costs, so that the decrease in their profit due to minor transportation costs is compesated by the fact that they will have to pay lower information rent. On the other hand, if there is a large asymmetry bewteen the two market, for the upstream firms it is convenient to choose the market which is characterized by higher transportation costs, since the increases in sales revenues will be higher than the increase in the information rent that has to be insured to their retailers.

- HIERARCHY'S ENTRY

The final case that we consider, is the one in which the market choice is made by the joint decision of manufacturer and retailer (i.e. the hierarchy).

The joint profits of the hierarchy are:

$$\Pi = (\frac{1}{N}\left(\frac{t}{N} + \sigma\right) - \sigma\left(\frac{1}{N} - \frac{\sigma}{3t}\right)) + \sigma\left(\frac{1}{N} - \frac{\sigma}{3t}\right) = \frac{1}{N}\left(\frac{t}{N} + \sigma\right)$$

It is immediate to notice that what matters in the profit of the supply chain are the sales revenues, which are increasing in the transportation costs. Also in this case, I have been able to identify a threshold above which the hierachies prefer to locate in the more competitive market.

The indifference condition for determining market choice is the following:

$$\begin{aligned} \Pi_\tau(N) &= \Pi_t(M-N) \qquad (62) \\ (\frac{1}{N}\left(\frac{\tau}{N} + \sigma\right)) &= (\frac{1}{M-N}\left(\frac{t}{M-N} + s\right)) \end{aligned}$$

I apply the Implicit Function Theorem and present the second order Taylor expansion for N.

$$N \simeq \frac{M}{2} + \left.\frac{\partial N}{\partial \tau}\right|_{\substack{\tau=t\\ \sigma=s}} d\tau + \frac{1}{2}\left.\frac{\partial^2 N}{\partial^2 \tau}\right|_{\substack{\tau=t\\ \sigma=s}} (d\tau)^2 \qquad (63)$$

There are a positive first order effect and a negative second order effect, and there exists a threshold above which, the latter prevails on the former.

The results are summarized in the proposition below:

Proposition 3. When the supply chains choose in which market to locate and the two markets have different transportation costs, there exist a $d\widetilde{\tau}$ such that if $d\tau > d\widetilde{\tau}$, then the majority of hierarchies chooses the market with lower transportation costs.

This proposition states that when the asymmetry between the two markets is sufficiently large in terms of transportation costs, the hierachy prefers to choose the market which is highly competitive. This result is mainly due to the effect that the transportation costs have on the demand size. In fact, as we already know there is a negative relationship between transportation costs and demand; hence, if they grow too much, the deman shrinks and the negative second order effect prevails on the first order positive one, which instead represents the expansion that an increase in the transportation costs produces on the hierachy's sales revenues. In another way, if $d\tau$ is bigger than the threshold (i.e the asymmetry between the two markets is sufficiently high), the hierarchies prefer to stay in the more competitive market, because the greater increase in the transportation costs shrinks the demand too much, so that the raise in sales revenues because of the higher t is negatively compensated by the lower demand.

The opposite happens when, instead, the asymmetry between the two markets is small (i.e. $d\tau < d\widetilde{\tau}$), in this case a tiny increase in the transportation costs in market A, generates a positive effect on the sales revenues, and hierarchies prefer to go in the less competitive market (the first order effect prevails).

IV(ii). *Different Degree of Transparency*

In this second part of the analysis, I assume that markets A and B are characterized by a different degree of transparency (σ), which indicates how much is severe the asymmetric information problem that affects a specific market. As already mentioned, the presence of asymmetric information is standard in vertical contracting literature, and it is originated from the fact that retailers are better informed about the costs of inputs such as labor, energy and rental costs that are provided by other suppliers and, which are not directly related to the provision's of the manufacturers essential input that is used to produce the final good. Retailers can use this asymmetry as an advantage to report higher marginal cost and, consequently, paying a lower fixed fee to their manufacturers. From previous literature, we know that an additional source of asymmetric information may come from the fact that retailers are privately informed on their production efficiency.

I repeat the analysis as in the previuos scenario by considering the three cases of market choice: whether either the upstream or the downstream or the entire hierarchy choose first in which market to locate. For the sake of completeness, recall that: N firms enter in market A whose parameter for degree of transparency is σ, while $M - N$ firms enter in market B with s indicates the level of transparency with $\sigma \geqslant s$ and $d\sigma = \sigma - s$.

- RETAILER'S ENTRY

The first case within this new set-up is the retailer's market choice.

The retailer's rent is presented below, and as expected it is increasing in the parameter σ. In fact, more uncertainty in the market makes retailers' mimicking opportunities more profitable and consequently, rents have to increase if manufacturers want successfully induce truthful information revelation.

$$\Gamma = \sigma \left(\frac{1}{N} - \frac{\sigma}{3t} \right)$$

When deciding in which of the two markets to locate, retailers' choice should satisfy the indifference condition:

$$
\begin{aligned}
\Gamma_\sigma(N) &= \Gamma_s(M-N) \\
\sigma\left(\frac{1}{N}-\frac{\sigma}{3\tau}\right) &= s\left(\frac{1}{M-N}-\frac{s}{3t}\right)
\end{aligned} \tag{64}
$$

I apply the Implicit Function Theorem and outline the second order Taylor expasion for N (i.e. the function describing the number of firms who choose to locate in market A, the one that is characterized by a lower degree of transparency/more uncertainty).

$$
N \simeq \frac{M}{2} + \left.\frac{\partial N}{\partial \sigma}\right|_{\substack{\tau=t \\ \sigma=s}} d\sigma + \frac{1}{2}\left.\frac{\partial^2 N}{\partial^2 \sigma}\right|_{\substack{\tau=t \\ \sigma=s}} (d\sigma)^2 \tag{65}
$$

The presence of a positive first order effect and a negative second order effect, ensures the posibility to identify a treshold $d\widetilde{\sigma}$ above which retailers prefer to locate in the more transparent market. In fact if the asymmetry between the two markets is sufficiently large then $N < \frac{M}{2}$, meaning that the number of those who enter in market B (i.e. the one that is characterized by a lower σ, indeed the more transparent) is higher than the one of those who enter in the less transparent market. It can be said, that retailers not always prefer the less transparent market. The result is summarized in the proposition below:

Proposition 4. When retailers choose in which market to locate and the two markets are characterized by a different level of uncertainty, there exists a $d\widetilde{\sigma}$ such that if $d\sigma > d\widetilde{\sigma}$, the majority of downstream firms chooses the more transparent market.

We have shown that if the asymmetry between the two markets in terms of σ is small enough, then retailers go in the less transparent market. This is because a slightly large σ makes the retailers mimicking opportunities more profitable making truthful information revelation more costly for the upstream firms and consequently, retailers' information rents will increase. This result is coherent with strategic delegation literature: a higher σ increases retailer's price and the same happens for the profitability of the market which induces more entry. However, if the two markets differ a lot for degree of transparency, then retailers prefer to locate in the more transparent market. The economic intution relies on the fact that a very high σ, makes wholesale price increase. In fact, in order to trade off efficiency and rents manufacturers boost wholesale prices above the complete information benchmark and this distortion is increasing in σ, this means that if the level of uncertainty is too high, the first order positive effect (i.e. increase in information rent), is overcompesated by the second order negative effect (i.e. increase in the wholesale price that retailers should correspond to their manufacturers), hence the downstream firms prefer to locate in the more transparent market, which still ensure a significant rent.

To sum up if there is a small increase in σ and a modest asymmetry between markets A and B, wholesale price increases, retailer's price increases but the effect on the information rent is larger so that downstream firms prefer to go in the less transparent market. However, if the difference between the two markets in terms of toughness of asymmetric information is above the threshold, then retailers prefer to locate in the more transparent market; this happens because choosing otherwise will led retailers to pay a high wholesale price to manufacturers which overcomes the raise in the information rent due to the expansion of σ.

- MANUFACTURER' S ENTRY

Now let us study the upstream market choice.

The manufacturer's profits are:

$$\pi = (\frac{1}{N}\left(\frac{t}{N}+\sigma\right) - \sigma\left(\frac{1}{N}-\frac{\sigma}{3t}\right))$$

In this case the effect of an enlargement of σ on the manufacturers' profits is not straightforward. In fact, as explained by Bassi et al. (2016), there exists a trade off because upstream firms have to pay higher rents to retailers, but profits margin increases as well because retail prices increases.

In order to study upstream market choice, I identify the indifference condition:

$$\pi_\sigma(N) = \pi_s(M-N) \tag{66}$$
$$(\frac{1}{N}\left(\frac{\tau}{N}+\sigma\right) - \sigma\left(\frac{1}{N}-\frac{\sigma}{3\tau}\right)) = (\frac{1}{M-N}\left(\frac{t}{M-N}+s\right) - s\left(\frac{1}{M-N}-\frac{s}{3t}\right))$$

After having applied the Implicit Function Theorem, it is possible to present the second order Taylor expasion below:

$$N \simeq \frac{M}{2} + \left.\frac{\partial N}{\partial \sigma}\right|_{\substack{\tau=t\\ \sigma=s}} d\sigma + \frac{1}{2}\left.\frac{\partial^2 N}{\partial^2 \sigma}\right|_{\substack{\tau=t\\ \sigma=s}} (d\sigma)^2 \tag{67}$$

In this case, the first and second order effect have the same positive sign, meaning that manufacturers always choose to positionate in the less transparent market. The result is summarized in the following *Lemma:*

Lemma 1. When the two markets have different level of uncertainty, the majority of upstream firms chooses to locate in the less transparent market.

This result indicates that upstream firm always prefers to locate in the market which is less transparent and it is characterized by higher uncertainty. The explanation relies on the fact that a raise in σ have a significant positive effect on the sales reveneus that is larger than the increase in the size of the information rent that manufacturers should correspond to their retailers. An implication of this result, as suggested by the previous literature, is that an exarcebation of the adverse selection between manufacturers and retailers caused, for example by bad monitoring technologies, induces more entry and hence, product variety for final consumers.

- HIERARCHY' S ENTRY

The final case that I present in this paper, is the one that considers what happens when the market choice is made by the joint decision of manufacturer and retailer (i.e. the hierarchy).

The joint profits of the hierarchy are:

$$\Pi = (\frac{1}{N}\left(\frac{t}{N}+\sigma\right) - \sigma\left(\frac{1}{N}-\frac{\sigma}{3t}\right)) + \sigma\left(\frac{1}{N}-\frac{\sigma}{3t}\right) = \frac{1}{N}\left(\frac{t}{N}+\sigma\right)$$

As already pointed out, what matters for the profit of the supply chain are the sales revenues, which are increasing in σ. Proceeding towards the usual analysis, I was able to identify a threshold for $d\widetilde{\sigma}$ such that if the asymmetry between the market is sufficiently high and it falls above the sill, then the supply chain prefers to choose the more transparent market.

I outline below the no-arbitrage condition for determining hierarchy's market choice. Successively, I apply the Implicit Function Theorem and discuss the second order Taylor expansion for the function N (i.e. the number of firm who choose to locate in the less transparent market A).

$$\Pi_\sigma(N) = \Pi_s(M-N) \tag{68}$$
$$(\frac{1}{N}\left(\frac{\tau}{N}+\sigma\right)) = (\frac{1}{M-N}\left(\frac{t}{M-N}+s\right))$$

The Taylor expansion is:

$$N \simeq \frac{M}{2} + \left.\frac{\partial N}{\partial \sigma}\right|_{\substack{\tau=t\\ \sigma=s}} d\sigma + \frac{1}{2}\left.\frac{\partial^2 N}{\partial^2 \sigma}\right|_{\substack{\tau=t\\ \sigma=s}} (d\sigma)^2 \tag{69}$$

In this case there is a positive first order effect and a second negative order effect. The former is related to the fact that an increase in the uncertainy in the market, or said in another way when the market becomes less transparent, sales revenues grow. The latter instead, represents an indirect effect on the demand side due to the raise in the retailer's price which reduce consumers' demand of the final good. The result show that if the difference is very high, so that $d\sigma$ is bigger than the threshold, the hierarchies prefer to stay in the more transparent market hence, the second order effect prevails. If instead, the asymmetry between the two markets is small, then hierarchies choose to locate in the less transparent market and in this case, it is the first order effect which predominates.

The result is summarized in the propostion below:

Proposition 5. When the supply chains choose in which market to locate, and the two markets have different level of uncertainty, there exists a $d\widetilde{\sigma}$ such that if $d\sigma > d\widetilde{\sigma}$, the majority of hierarchies chooses the more transparent market.

Said in another way, this proposition claims that when the asymmetry between the two markets in terms of level of uncertainty is sufficiently high, then hierarchies prefer to locate in the more transparent market, the one in which the asymmetric information problem is less severe. The economic intuition is the following: a worsening of the asymmetric information problem within the market has a positive effect on the supply chains' sales revenues, however, if σ grows too much in one of the two circles, then the final price at which the good is sold in the market may become so high to reduce the consumers' demand, and consequently cut down hierachies' profits. The threshold that has been identified for $d\sigma$ allows to set a cut-off, above which the indirect effect that bad monitoring technologies have on the demand side prevails on the positive effect that an increase in the level of uncertainty has on the sales revenues.

V. COMPARATIVE STATICS AND WELFARE

In section IV I have shown that there exist circumstances under which the economic agents who first choose in which market to locate, prefer the more competitive and the more transparent market. In particular, for mostly of the cases presented in this work it has been possible to identify a threshold above or below which the level of asymmetry between the markets in terms of either transportation costs or degree of transparency affects the market choice.

At the beginning of this section, I present a comparative statics on the thresholds that have been identified above, with the aim to understand how these relax or tighten the condition that determines economic players' market choice.

The first case that I analyze is the one that involves manufacturer's decision, when the two markets A and B have different transportation costs. It has been shown that if the asymmetry between the market is sufficiently large (i.e. $d\tau > d\widetilde{\tau}$) then the majority of upstream firms prefer to locate in the less competitive market, the one that is characterized by higher transportation costs (i.e. $N > \frac{M}{2}$), while if $d\tau < d\widetilde{\tau}$ manufacturers choose the more competitive market. Considering what happens to the threshold $d\widetilde{\tau}$ by changing the parameter σ, it is possible to show that the cut-off increases, meaning that the condition ensuring $N > \frac{M}{2}$ becomes more stringent. The result is summarized in the *Lemma* below:

Lemma 2. If there is a worsening in the level of uncertainty in both markets following the increase in the transportation costs in one of the two circles, it is more likely that upstream firms decide to locate in the more competitive market.

The explanation of this result is based on two elements: first of all, there exists a threshold $d\widetilde{\tau}$ above which upstream firms prefer to enter in the market which has lower transportation costs (i.e. the more competitive market), secondly retailers information rent is increasing in both σ and τ. Given that, if σ increases (in both markets) after the raise in the transportation costs in market A, there will be a reduction in the tendency for manufacturers to go in the less competitive market. This happens because the joint increase in transportation costs and in the degree of asymmetric information generates higher information rents and those may overcome the positive effect that an increase in t has on manufacturers' sales revenues

The second case that I am going to consider is the retailer's market choice when the two circles have different degree of transparency. As shown in section IV, if $d\sigma < d\widetilde{\sigma}$, so that the asymmetry between the markets is small enough, retailers decide to enter in the less transparent market. At this point, assume that in both markets there is an increase in the transportation costs and consequently the sill $d\widetilde{\sigma}$ increases, this means that the above cited condition relaxes; thus it becomes easier for retailers to locate in the less transparent market, if this experiences also a boost in the transportation costs.

Lemma 3. An increase in the transportation costs in the market which has already experienced a raise in the level of uncertainty induces more entry by the downstream firms in the less transparent market.

The reasoning is the following: retailers rents are positively related to both transportation costs and degree of transparency; indeed, the eventual increase in the transportation costs combined with the increase in σ reduces the impact of the negative second order effect, analyzed in the Taylor expasion, and strenghtens the first order positive effect on the information rent, which tends to prevail.

The two final cases of comparative statics that I present are those regarding the hierachy's market choice in both the scenarios of different transportation costs and different degree of transparency. First of all, let us consider what happens when the supply chain chooses in which market to positionate when these have different transportation costs; we already know that if the asymmetry between the two markets is sufficiently small, then hierarchies prefer to locate in the less competitive market (i.e. if $d\tau < d\widetilde{\tau}$ then $N > \frac{M}{2}$).

Allowing for changes in the level of uncertainty in both markets makes the threshold increase and indeed the condition becomes less stringent: it is easier for the supply chain to locate in the less competitive market if there is also a worsening in the level of transparency in both cirlces. This is mainly due to the amplified effect that a raise in σ has on the profit of the supply chain.

A similar situation arises when the hierachies choose in which market to enter when those have different level of transparency; in particular, recall that if $d\sigma < d\widetilde{\sigma}$ then $N > \frac{M}{2}$, meaning that when the asymmetry between the markets is small enough, the hierachy chooses the less transparent market. With the comparative statics analysis, the findings show that the threshold increases in the transportation costs, so that if there is an increase of the parameter t in both markets, the joint decision of upstream and downstream firm is determined by the combined effect of the increase in transportation costs and level of uncertainty that boost sales revenues. In this set up the role of the negative second order effect becomes marginal, and the positive first order effect on the sales revenues prevails.

These results can be summarized in the following Lemma:

Lemma 4. If there is an increase in both transportation costs and level of uncertainty in one of the two markets, then the majority of the supply chains prefers to locate in the less competitive and less transparent market.

In the second part of this section I analyze the social planner choice for the two scenarios, that is when the two markets have different transportation costs, and when they have different level of uncertainty.

First of all, as it is clear from previous literature, the total welfare is the difference between consumers' value for the good and total costs. The costs that matter for the welfare are the transportation costs (i.e. how far consumers travel to reach the firms from which they actually buy) and the production costs of the firms (i.e., how much each firms produce). I compare the behaviour of the function which describes the actual number of firms in the different cases (derived in Section IV(i) and IV(ii)) with the behaviour of the function that identifies the socially optimal number of products (derived in the Appendix).

Lemma 5. When the two markets have different level of uncertainty, the actual number of firms choosing the less transparent market is higher than the socially optimal number.

Within this framework, there are always too many firms entering in the less transparent market compared to the social optimum. This result is consistent with the standard argument of " excessive entry" in the Salop model and implies that the social welfare is never maximized where market choice is decided by the manufacturers.

However, in this work I have considered also the market choice of other economic players. In fact, when retailers or hierarchies take their decision and there is a large asymmetry between the two markets in terms of level of uncertainty, it has been shown that firms choose the more transparent market. In that cases, their choice is aligned with the social planner preferences and the welfare will be maximized.

When instead the two markets have different transportation costs, then the welfare is maximized when the majority of firms choose to locate in the market which is characterized by higher transportation costs. Given the results found in Section IV, it is possible to say that in each of the three cases (i.e., when the market choice is taken by retailers, manufacturers, hierarchies) it is possible to reach situations that ensure higher welfare, depending on how large or small is the asymmetry between the two markets.

VI. CONCLUSIONS

This second chapter has provided a theoretical model of circular competition a' la Salop, with the aim to study the endogenous market choice of competing supply chains. The results contribute to the industrial organization literature and to the vertical contracting literature, by considering an endogenous market structure in a incomplete information environment. The findings show that there exist circumstances under which the economic agents (i.e.manufacturers, retailers, hierarchies) choose to locate in the more transparent or more competitive market, and that their decision is determined by the asymmetry that there exists between the two circles in terms of transportation costs and level of uncertainty.

In all the cases presented, save the manufacture's market choice with different level of transparency among the markets, it has been possible to distinguish a first and second order effects on information rent, sales revenues and demad with opposite signs, and to identify a cut-off on the asymmetry between the two circles such that, if the difference between the two markets in the parameters of interest is above or below this threshold, then the majority of firms may choose to locate in the more transparent or in the more competitive market.

The attention is restricted to two-part tariffs contracts because of their relevance, but studying other forms of vertical restrains may indicate venues for future research.

This simple environment may help interpretating the effects of varying degree of competition or level of uncertainty in the economic player's market choice and, since for each scenario it has been presented retailer, or manufacturer or hierarchy market choice, it has multiple interpretations and can be used in a variety of applications.

APPENDIX

In the first part of the Appendix, there are the proofs for section IV which follow the reference paper (Bassi, Pagnozzi and Piccolo, 2016). In the second part, instead, there are the proofs of the Proposition in reference to subsections IV(i), IV(ii) and section V.

Proof of manufacturers' profits.

The first-order condition associated for R_i's maximization problem is

$$\frac{\partial D_{i,j}\left(p_{i,j},\overline{p}^e_{T,j}\right)}{\partial p_{i.j}}(p_{i,j}-w_{i,j}(m_i)-\theta_i)+D_{i,j}\left(p_{i,j},\overline{p}^e_{T,j}\right)=0, \tag{70}$$

$$\Leftrightarrow \quad w_{i,j}(m_i)+\theta_i+\overline{p}^e_{T,j}-2p_i+\frac{T_j}{N}=0,$$

where it has been used (49) and $\frac{\partial D_{i,j}\left(p_{i,j},\overline{p}^e_{T,j}\right)}{\partial p_{i,j}}=\frac{1}{t_j}$. Rearranging yields (50).

Consider now R_i's information disclosure problem. To characterize the set of incentive feasible contracts let

$$u_i(\theta_i,m_i)\equiv(p^e_{i,j}(w_{i,j}(m_i),\theta_i)-w_{i,j}(m_i)-\theta_i)D_{i,j}(p^e_{i,j}(w_{i,j}(m_i),\theta_i),\overline{p}^e_{T,j})-T_{i,j}(m_i), \tag{71}$$

with $u_i(\theta_i)\equiv\max_{\theta_i\in\Theta}u_i(\theta_i,m_i)$. R_i truthfully reveals his cost only if the following first-order condition holds

$$\left.\frac{\partial u_i(\theta_i,m_i)}{\partial m_i}\right|_{m_i=\theta_i}=0 \quad\Leftrightarrow\quad \left.-\dot{w}_{i,j}(m_i)D_{i.j}(p^e_{i,j}(w_{i,j}(m_i),\theta_i),\overline{p}^e_{T,j})-\dot{T}_{i,j}(m_i)\right|_{m_i=\theta_i}=0 \quad \forall\theta_i\in\Theta. \tag{72}$$

Differentiating $u_i(x)$ with respect to x and using (72) yields

$$\dot{u}_i\left(x\right)=-D_{i,j}(p^e_{i,j}(w_{i,j}(x),x),\overline{p}^e_{T,j}),$$

and integrating $\dot{u}_i\left(x\right)$ between θ_i and $\mu+\sigma$ yields

$$u_i\left(\theta_i\right)=u_i\left(\mu+\sigma\right)+\int_{\theta_i}^{\mu+\sigma}D_{i,j}(p^e_{i,j}(w_{i,j}(x),x),\overline{p}^e_{T,j})dx.$$

This is equation (55) when the participation constraint binds at $\mu+\sigma$ — i.e., when $u_i\left(\mu+\sigma\right)=0$.

However, $m_i=\theta_i$ is an optimum for R_i only if $u_i(\theta_i,m_i)$ is concave in m_i at $m_i=\theta_i$. Using standard techniques (see, e.g., Laffont and Martimort, 2000), this requires

$$\left.\frac{\partial^2 u_i(\theta_i,m_i)}{\partial m_i^2}\right|_{m_i=\theta_i}\leq 0,\quad \forall\theta_i\in\Theta. \tag{73}$$

Since (72) must be satisfied for every θ_i, differentiating with respect to θ_i yields

$$\left.\frac{\partial^2 u_i(\theta_i,m_i)}{\partial m_i^2}+\frac{\partial^2 u_i(\theta_i,m_i)}{\partial m_i\partial\theta_i}\right|_{m_i=\theta_i}=0,\quad \forall\theta_i\in\Theta. \tag{74}$$

Condition (73) together with (74) yield

$$\left.\frac{\partial^2 u_i(\theta_i,m_i)}{\partial m_i\partial\theta_i}\right|_{m_i=\theta_i}\geq 0,\quad \forall\theta_i\in\Theta,$$

$$\Rightarrow \quad -\dot{w}_{i,j}(\theta_i)\,\frac{\partial p^e_{i,j}(w_{i,j}(m_i),\theta_i)}{\partial\theta_i}\frac{\partial D_{i,j}(p^e_{i,j}(w_{i,j}(m_i),\theta_i),\overline{p}^e_{T,j})}{\partial p_{i,j}}\bigg|_{m_i=\theta_i} \geq 0, \quad \forall\theta_i \in \Theta. \tag{75}$$

Since $\frac{\partial p^e_{i,j}(w_{i,j}(m_i),\theta_i)}{\partial\theta_i} \geq 0$ by (50) and $\frac{\partial D_{i,j}(.)}{\partial p_{i.j}} < 0$ by (49) equation (75) implies (52).

Next, consider how to the equilibrium wholesale price. The first-order necessary and sufficient condition associated to M_i's relaxed maximization program is:

$$\frac{\partial D_{i,j}\left(p^e_{i,j}(w_{i,j}(\theta_i),\theta_i),\overline{p}^e_{T,j}\right)}{\partial p_{i,j}}\frac{\partial p^e_{i,j}(w_{i,j}(\theta_i),\theta_i)}{\partial w_{i,j}}\left[p^e_{i,j}(w_{i,j}(\theta_i),\theta_i)-\theta_i-\frac{G(\theta_i)}{g(\theta_i)}\right]+$$
$$+D_{i,j}\left(p^e_{i,j}(w_{i,j}(\theta_i),\theta_i),\overline{p}^e_{T,j}\right)\frac{\partial p^e_{i,j}(w_{i,j}(\theta_i),\theta_i)}{\partial w_{i,j}} = 0. \tag{76}$$

Notice that (70) implies

$$D_{i,j}\left(p^e_{i,j}(w_{i,j}(\theta_i),\theta_i),\overline{p}^e_{T,j}\right) = -\frac{\partial D_{i,j}\left(p^e_{i,j}(w_{i,j}(\theta_i),\theta_i),\overline{p}^e_{T,j}\right)}{\partial p_{i,j}}(p^e_{i,j}(w_{i,j}(\theta_i),\theta_i)-w_{i,j}(\theta_i)-\theta_i).$$

Replacing this into (76) yields

$$\frac{\partial D_{i,j}\left(p^e_{i,j}(w_{i.j}(\theta_i),\theta_i),\overline{p}^e_{T,j}\right)}{\partial p_{i,j}}\left[w_{i,j}(\theta_i)-\frac{G(\theta_i)}{g(\theta_i)}\right] = 0$$

which yields the equilibrium wholesale price $w^e_{T,j}(\theta_i)$ in (56). Since $\dot{w}^e_{T,j}(\theta_i) > 0$, the local second-order incentive compatibility constraint (52) is satisfied. Inserting the equilibrium wholesale price into (50), and taking expectations with respect to θ_i, yields $\overline{p}^e_{T,j} = \mu + \sigma + \frac{t_j}{N}$. The equilibrium price (57) is obtained by substituting $\overline{p}^e_{T,j}$ and (56) into (50).

To satisfy the global incentive constraint (71), the equilibrium contract must satisfy

$$u_i(\theta_i) - u_i\left(\theta_i,\theta'_i\right) \geq 0 \quad \forall(\theta_i,\theta'_i) \in \Theta^2$$

$$\Leftrightarrow \quad (p^e_{i,j}(w^e_{T,j}(\theta_i),\theta_i)-w^e_{T,j}(\theta_i)-\theta_i)D_{i,j}(p^e_{i,j}(w^e_{T,j}(\theta_i),\theta_i),\overline{p}^e_{T,j})-T^e_{T,j}(\theta_i) \geq$$
$$(p^e_{i,j}(w^e_{T,j}(\theta'_i),\theta_i)-w^e_{T,j}(\theta'_i)-\theta_i)D_{i,j}(p^e_{i,j}(w^e_{T,j}(\theta'_i),\theta_i),\overline{p}^e_{T,j})-T^e_{T,j}(\theta'_i)$$

$$\Leftrightarrow \quad \int_{\theta_i}^{\theta'_i}\left\{\dot{w}^e_{T,j}(x)D_{i,j}(p^e_{i,j}(w^e_{T,j}(x),\theta_i),\overline{p}^e_{T,j})+\dot{T}^e_{T,j}(x)\right\}dx \geq 0.$$

where $T^e_T(x)$ is the equilibrium fixed fee. Substituting $\dot{T}^e_{T,j}(x) = -\dot{w}^e_{T,j}(x)D_{i,j}(p^e_{i,j}(w^e_{T,j}(x),x),\overline{p}^e_{T,j})$,

$$\int_{\theta_i}^{\theta'_i}\left\{\dot{w}^e_{T,j}(x)D_{i,j}(p^e_{i,j}(w^e_{T,j}(x),\theta_i),\overline{p}^e_{T,j})-\dot{w}^e_{T,j}(x)D_{i,j}(p^e_{i,j}(w^e_{T,j}(x),x),\overline{p}^e_{T,j})\right\}dx \quad =$$
$$-\int_{\theta_i}^{\theta'_i}\left\{\dot{w}^e_{T,j}(x)\int_{\theta_i}^{x}\frac{\partial D_{i.j}(p^e_{i,j}(w^e_{T,j}(x),y),\overline{p}^e_{T,j})}{\partial p_{i,j}}\frac{\partial p^e_{i,j}(w^e_{T,j}(x),y)}{\partial y}dy\right\}dx \quad \geq \quad 0.$$

Suppose, without loss of generality, that $\theta'_i > \theta_i$ (so that $x > \theta_i$). Condition (52) — i.e., $\dot{w}^e_{T,j}(x) > 0$ — and the fact that $\frac{\partial p^e_{i,j}(.)}{\partial y} > 0$ $\frac{\partial D_{i,j}(.)}{\partial p_{i,j}} < 0$ guarantee that the global incentive constraint holds.

This concludes the proof. ■

Briefly I recall the main assumptions that I have imposed in the present work.

There are two markets A and B, they may have different transportation costs, in this case in market A those are τ while in market B are t, and $\tau \geqslant t$ so that market A is less competitive because it has higher transportation costs, while market B is more competitive. Otherwise the two markets can have different degree of transparency. In this last case market A has σ indicating its level of uncertainty, while in market B it is s, and $\sigma \geqslant s$, hence market A is less transparent because it is characterized by a greater level of uncertainty, while market B is more transparent since the asymmetric information is less severe.

Proof of Proposition 1.

I prove that if the asymmetry between the two markets A and B in terms of transportation costs is sufficiently large, so that the raise in the transportation costs in market A is very high, then retailers prefer to locate in the market that is characterized by lower transportation costs (i.e. it is more competitive).

In order to show how the result is obtained, start from the indifference condition that the downstream firms shoudl satisfy to take their market's choice:

$$\begin{gathered}\Gamma_{\tau}(N) = \Gamma_{t}(M-N) \qquad (77)\\ \sigma\left(\frac{1}{N}-\frac{\sigma}{3\tau}\right)-\sigma\left(\frac{1}{M-N}-\frac{\sigma}{3t}\right)= \\ \frac{1}{3Nt}\frac{\sigma}{\tau\left(M-N\right)}\left(3Mt\tau-6Nt\tau+N^{2}t\sigma-N^{2}\sigma\tau-MNt\sigma+MN\sigma\tau\right)\end{gathered}$$

Since it is not possible to find a close form solution for the value of N (i.e. the firms who choose to locate in market A), I outline the second order Taylor expansion for this function.

As when the two markets are equal, firms equally distribute among them (i.e. $N = \frac{M}{2}$), I explore whether there are cases in which $N < \frac{M}{2}$, meaning that those who enter in the more competitive market (i.e. the one that is characterized by lower costs, market B) exceeds the number of those who choose the less competitive market A.

I apply the Implicit Function Theorem to compute the first derivative of the implicit function that I call F (it comes from (77)):

$$\frac{\partial N}{\partial\tau}=-\frac{\partial F/\partial\tau}{\partial F/\partial N}=-\frac{F_{\tau}}{F_{N}}=\frac{1}{3}N^{2}\frac{\sigma}{\tau^{2}}\frac{\left(M-N\right)^{2}}{M^{2}-2MN+2N^{2}}$$

which is evaluted it in the benchmark case:

$$\left.\frac{\partial N}{\partial\tau}\right|_{\substack{\tau=t\\ \sigma=s}}=\frac{1}{24}\frac{M^{2}}{t^{2}}\sigma>0$$

Now I proceed in computing the second derivative:

$$\frac{\partial^2 N}{\partial^2 \tau} = -\frac{2}{3} N^2 \frac{\sigma}{\tau^3} \frac{(M-N)^2}{M^2 - 2MN + 2N^2}$$
$$\left.\frac{\partial^2 N}{\partial^2 \tau}\right|_{\substack{\tau=t \\ \sigma=s}} = -\frac{1}{12} \frac{M^2}{t^3} \sigma < 0$$

Given that, the second order Taylor Expansion for the number of firms entering in market A:

$$N \simeq \frac{M}{2} + \left.\frac{\partial N}{\partial \tau}\right|_{\substack{\tau=t \\ \sigma=s}} d\tau + \frac{1}{2} \left.\frac{\partial^2 N}{\partial^2 \tau}\right|_{\substack{\tau=t \\ \sigma=s}} (d\tau)^2 \Rightarrow \tag{78}$$
$$N \simeq \frac{M}{2} + \frac{1}{24} \frac{M^2}{t^2} \sigma (d\tau) + \frac{1}{2} (-\frac{1}{12} \frac{M^2}{t^3} \sigma)(d\tau)^2 \Rightarrow N - \frac{M}{2} \simeq \frac{1}{24} \frac{M^2}{t^3} d\tau \sigma \left(2t - \tau\right)$$

The above expression suggests that if $t < \frac{\tau}{2}$ meaning that there is large asymmetry between the two markets, then $N - \frac{M}{2} < 0$, which implies that the majority of retailers choose to locate in market B, the one that has a lower transportation costs and it is more competitive. If the condition on t is satisfied then, the second order negative effect prevails on the first order positive effect.

This concludes the proof. ■

Proof of Proposition 2.

In this case consider the upstream firm's market choice.

I proceed in the same way as above: the indifference condition that the upstream firms should satisfy to take their market's choice is the following:

$$\pi_\tau(N) = \pi_t(M - N) \tag{79}$$
$$(\frac{1}{N}\left(\frac{\tau}{N} + \sigma\right) - \sigma \left(\frac{1}{N} - \frac{\sigma}{3\tau}\right)) - \left(\frac{1}{M-N}\left(\frac{t}{M-N} + s\right) - s\left(\frac{1}{M-N} - \frac{s}{3t}\right)\right) =$$
$$\frac{1}{3} \frac{3M^2 t\tau^2 + 3N^2 t\tau^2 - 3N^2 t^2 \tau + N^4 t\sigma^2 - N^4 \sigma^2 \tau - 2MN^3 t\sigma^2 + 2MN^3 \sigma^2 \tau + M^2 N^2 t\sigma^2 - 6MNt\tau^2 - M^2 N^2 \sigma^2 \tau}{N^2 t\tau \left(M-N\right)^2}$$

I apply the implicit function theorem and evaluate the result in the benchmark case (i.e. $\tau = t, \sigma = s$).

$$\frac{\partial N}{\partial \tau} = -\frac{\partial F / \partial \tau}{\partial F / \partial N} = -\frac{F_\tau}{F_N} = -\frac{1}{6} \frac{N}{\tau^2} \left(M - N\right)^3 \frac{N^2 \sigma^2 - 3\tau^2}{N^3 t + M^3 \tau - N^3 \tau + 3MN^2 \tau - 3M^2 N \tau} \tag{80}$$
$$\left.\frac{\partial N}{\partial \tau}\right|_{\substack{\tau=t \\ \sigma=s}} = -\frac{1}{96t^3} \left(M^3 \sigma^2 - 12Mt^2\right) > 0$$

Now I derive the second derivate and present the Taylor expansion of second order:

$$\frac{\partial^2 N}{\partial^2 \tau} = \frac{1}{6}\frac{N}{\tau^3}\frac{(M-N)^3}{\left(N^3 t + M^3\tau - N^3\tau + 3MN^2\tau - 3M^2N\tau\right)^2}$$

$$\left(3M^3N^2\sigma^2\tau - 3M^3\tau^3 - 9M^2N^3\sigma^2\tau + 9M^2N\tau^3 + 9MN^4\sigma^2\tau - 9MN^2\tau^3 - 3N^5\sigma^2\tau + 2tN^5\sigma^2 + 3N^3\tau^3\right)$$

$$\left.\frac{\partial^2 N}{\partial^2 \tau}\right|_{\substack{\tau=t\\ \sigma=s}} = \frac{1}{192}\frac{M}{t^4}\left(5M^2\sigma^2 - 12t^2\right) < 0$$

The Taylor expansion becomes:

$$N \simeq \frac{M}{2} + \left.\frac{\partial N}{\partial \tau}\right|_{\substack{\tau=t\\ \sigma=s}} d\tau + \frac{1}{2}\left.\frac{\partial^2 N}{\partial^2 \tau}\right|_{\substack{\tau=t\\ \sigma=s}} (d\tau)^2 \Rightarrow \tag{81}$$

$$N \simeq \frac{M}{2} + \left(-\frac{1}{96t^3}\left(M^3\sigma^2 - 12Mt^2\right)d\tau\right) + \frac{1}{2}\left(\frac{1}{192}\frac{M}{t^4}\left(5M^2\sigma^2 - 12t^2\right)(d\tau)^2\right)$$

$$N - \frac{M}{2} \simeq \frac{1}{384}M d\tau \frac{-12t^2 d\tau + 48t^3 - 4M^2t\sigma^2 + 5M^2 d\tau\sigma^2}{t^4}$$

The expression is positive when: $d\tau > \frac{-48t^3 + 4M^2t\sigma^2}{5M^2\sigma^2 - 12t^2} = d\widetilde{\tau}$.

In this way I was able to identify a threshold for $d\tau$ allowing to clearly distinguish the cases in which manufacturers prefer to locate either in the less competitive or in the more competitive market.

The results can summarize in the following way:

- If $d\tau > d\widetilde{\tau} \Rightarrow N > \frac{M}{2}$: for large asymmetry between the markets, the upstream firms choose the less competitive market (i.e. market A which has higher transportation costs): the first order effect prevails
- If $d\tau < d\widetilde{\tau} \Rightarrow N < \frac{M}{2}$: for small asymmetry between the markets, the upstream firms choose the more competitive market (i.e. market B which has lower transportation costs): the second order effect prevails

This conclude the proof. ■

Proof of Proposition 3.

The last case that I analyze for the scenario in which the two circles have different transportation costs, is the one that considers the supply chain's market choice.

In deciding in which market to locate, the hierarchy will choose according to the indifference condition:

$$\Pi_\tau(N) = \Pi_t(M-N) \tag{82}$$

$$\left(\frac{1}{N}\left(\frac{\tau}{N} + \sigma\right)\right) - \left(\frac{1}{M-N}\left(\frac{t}{M-N} + s\right)\right) =$$

$$\frac{1}{N^2(M-N)^2}\left(M^2\tau - N^2t + N^2\tau + 2N^3\sigma - 2MN\tau - 3MN^2\sigma + M^2N\sigma\right)$$

I apply the Implicit Function Theorem with the aim to compute the first derivative of the function N, and then I evaulate it in the benchamark case where the two markets are equal (i.e. $\tau = t, \sigma = s$).

$$\frac{\partial N}{\partial \tau} = -\frac{\partial F)/\partial \tau}{\partial F/\partial N} = -\frac{F_\tau}{F_N} = N\frac{(M-N)^3}{2N^3t + 2M^3\tau - 2N^3\tau - 2N^4\sigma - 3M^2N^2\sigma + 6MN^2\tau + 4MN^3\sigma - 6M^2N\tau + M^3N\sigma} \tag{83}$$

$$\left.\frac{\partial N}{\partial \tau}\right|_{\substack{\tau=t\\ \sigma=s}} = \frac{M}{8t + 2M\sigma} > 0$$

The second derivative and its value in the benchmark case are:

$$\frac{\partial^2 N}{\partial^2 \tau} = -2N\frac{(M-N)^6}{\left(2N^3t + 2M^3\tau - 2N^3\tau - 2N^4\sigma - 3M^2N^2\sigma + 6MN^2\tau + 4MN^3\sigma - 6M^2N\tau + M^3N\sigma\right)^2} \tag{84}$$

$$\left.\frac{\partial^2 N}{\partial^2 \tau}\right|_{\substack{\tau=t\\ \sigma=s}} = -\frac{M}{(4t + M\sigma)^2} < 0$$

At this point there are all the elements to derive the second order Taylor expansion and compute the threshold which gives the chance to distinguish when $N > \frac{M}{2}$ (i.e. the hierachies choose the less competitive market, the one that has higher transportation costs), or $N < \frac{M}{2}$ (i.e. the hierachies choose the more competitive market, the one that has lower transportation costs).

$$N \simeq \frac{M}{2} + \left.\frac{\partial N}{\partial \tau}\right|_{\substack{\tau=t\\ \sigma=s}} d\tau + \frac{1}{2}\left.\frac{\partial^2 N}{\partial^2 \tau}\right|_{\substack{\tau=t\\ \sigma=s}} (d\tau)^2 \Rightarrow \tag{85}$$

$$N \simeq \frac{M}{2} + (\frac{M}{8t + 2M\sigma})(d\tau) + \frac{1}{2}(-\frac{M}{(4t + M\sigma)^2})(d\tau)^2 \Rightarrow$$

$$N - \frac{M}{2} \simeq (\frac{M}{8t + 2M\sigma})(d\tau) + \frac{1}{2}(-\frac{M}{(4t + M\sigma)^2})(d\tau)^2 \simeq \frac{1}{2}Md\tau\frac{4t - d\tau + M\sigma}{(4t + M\sigma)^2}$$

The expression is positive if $d\tau < 4t + M\sigma = d\widetilde{\tau}$. Indeed, there is a threshold on $d\tau$ such that:

- if $d\tau < d\widetilde{\tau}$ then $N > \frac{M}{2}$: for small asymmetry between the markets, the supply chains choose the less competitive market (i.e. market A which has higher transportation costs): the first order effect prevails

- if $d\tau > d\widetilde{\tau}$ then $N < \frac{M}{2}$: for large asymmetry between the markets, the supply chains choose the more competitive market (i.e. market B which has lower transportation costs): the second order effect prevails.

This concludes the proof. ■

Proof of Proposition 4.

Consider the economic agent's market choice when the two markets have different degree of transparency. I start with the downstream firm's market choice.

As always if retailers enter they should be indifferent between the two markets:

$$\Gamma_\sigma(N) = \Gamma_s(M-N) \tag{86}$$

$$\sigma\left(\frac{1}{N}-\frac{\sigma}{3\tau}\right) - s\left(\frac{1}{M-N}-\frac{s}{3t}\right) =$$

$$\frac{1}{3}\frac{N^2\sigma^2 - N^2s^2 + 3Mt\sigma - 3Nt\sigma + MNs^2 - MN\sigma^2 - 3Nst}{Nt\,(M-N)}$$

I apply the Implicit Function Theorem in order to compute the first derivative of the function of interest N and evaluate it in the benchmark case:

$$\frac{\partial N}{\partial \sigma} = -\frac{\partial F/\partial \tau}{\partial F/\partial N} = -\frac{F_\sigma}{F_N} = \frac{1}{3}\frac{N}{t}\,(3t - 2N\sigma)\,\frac{(M-N)^2}{N^2s + M^2\sigma + N^2\sigma - 2MN\sigma}$$

$$\left.\frac{\partial N}{\partial \sigma}\right|_{\substack{\sigma=s\\ \tau=t}} = -\frac{1}{12}\frac{M}{st}\,(Ms - 3t) > 0$$

At this point, I proceed by computing the second derivative and derive the second order Taylor expansion:

$$\frac{\partial^2 N}{\partial^2 \sigma} = -\frac{1}{3}\frac{N}{t}\,(M-N)^2\,\frac{3tM^2 - 6tMN + 2sN^3 + 3tN^2}{(N^2s + M^2\sigma + N^2\sigma - 2MN\sigma)^2}$$

$$\left.\frac{\partial^2 N}{\partial^2 \sigma}\right|_{\substack{\sigma=s\\ \tau=t}} = -\frac{1}{24}\frac{M}{s^2t}\,(3t + Ms) < 0$$

The Taylor expansion is the following:

$$N \simeq \frac{M}{2} + \left.\frac{\partial N}{\partial \sigma}\right|_{\substack{\sigma=s\\ \tau=t}}(d\sigma) + \frac{1}{2}\left.\frac{\partial^2 N}{\partial^2 \sigma}\right|_{\substack{\sigma=s\\ \tau=t}}(d\sigma)^2 \Rightarrow \tag{87}$$

$$N \simeq \frac{M}{2} + \frac{1}{12}\frac{M}{st}\,(3t - Ms)\,(d\sigma) + \frac{1}{2}\left(-\frac{1}{24}\frac{M}{s^2t}\,(3t + Ms)\right)(d\sigma)^2 \Rightarrow$$

$$N - \frac{M}{2} \simeq -\frac{1}{48}\frac{M}{s^2t}d\sigma\big((3t + Ms)\,d\sigma + \left(4Ms^2 - 12st\right)\big)$$

The sign of the expression is positive (i.e. $N > \frac{M}{2}$) if $d\sigma < \frac{12st - 4Ms^2}{3t + Ms} = d\widetilde{\sigma}$. This threshold on $d\sigma$ allows to distinguish two cases: when the asymmetry between the two market is small enough so that $d\sigma < d\widetilde{\sigma}$ we have that $N > \frac{M}{2}$, meaning that the majority of retailers prefer to locate in the less transparent market, and the first order effect associated to the increase that the information rents experience due to the worsening of the asymmetric information problem, prevails. When instead, $d\sigma > d\widetilde{\sigma}$ then $N < \frac{M}{2}$, meaning that the majority of retailers choose to enter in the more transparent market, the one that is characterized by lower uncertainty. In this context the negative second order effect associated with the increase in the wholesale price following the raise of σ, prevails.

This concludes the proof. ■

Proof of Lemma 1.

Now I analyze the manufacturers' market choice in the set-up of different level of transparency across the two markets. Before choosing in which market to locate, upstream firms should be indifferent between the two circles:

$$\pi_\sigma(N) = \pi_s(M-N) \tag{88}$$

$$(\frac{1}{N}\left(\frac{\tau}{N}+\sigma\right) - \sigma\left(\frac{1}{N}-\frac{\sigma}{3\tau}\right)) - (\frac{1}{M-N}\left(\frac{t}{M-N}+s\right) - s\left(\frac{1}{M-N}-\frac{s}{3t}\right)) =$$

$$-\frac{1}{3}\frac{-N^4\sigma^2 - 3M^2t^2 + N^4s^2 + 2MN^3\sigma^2 + M^2N^2s^2 + 6MNt^2 - M^2N^2\sigma^2 - 2MN^3s^2}{N^2t\left(M-N\right)^2}$$

As always I apply the Implicit Function Theorem to obtain the first derivative for the number of firms entering in market A, and I evaluate it in the benchmark case (i.e. $\sigma = s, \tau = t$).

$$\frac{\partial N}{\partial \sigma} = -\frac{\partial F/\partial \sigma}{\partial F/\partial N} = -\frac{F_\sigma}{F_N} = \frac{1}{3M}\frac{N^3}{t^2}\sigma\frac{\left(M-N\right)^3}{M^2-3MN+3N^2}$$

$$\left.\frac{\partial N}{\partial \sigma}\right|_{\substack{\sigma=s\\ \tau=t}} = \frac{1}{48}M^3\frac{s}{t^2} > 0$$

I now compute the second derivative and outline the Taylor expansion:

$$\frac{\partial^2 N}{\partial^2 \sigma} = \frac{1}{3M}\frac{N^3}{t^2}\frac{\left(M-N\right)^3}{M^2-3MN+3N^2}$$

$$\left.\frac{\partial^2 N}{\partial^2 \sigma}\right|_{\substack{\sigma=s\\ \tau=t}} = \frac{1}{48}\frac{M^3}{t^2} > 0$$

Taylor expansion:

$$N \simeq \frac{M}{2} + \left.\frac{\partial N}{\partial \sigma}\right|_{\substack{\sigma=s\\ \tau=t}}(d\sigma) + \frac{1}{2}\left.\frac{\partial^2 N}{\partial^2 \sigma}\right|_{\substack{\sigma=s\\ \tau=t}}(d\sigma)^2 \Rightarrow$$

$$N \simeq \frac{M}{2} + \frac{1}{48}M^3\frac{s}{t^2}(d\sigma) + \frac{1}{2}\frac{1}{48}\frac{M^3}{t^2}(d\sigma)^2 \Rightarrow N - \frac{M}{2} \simeq \frac{1}{96}\frac{M^3}{t^2}d\sigma\left(2s + d\sigma\right)$$

In this case the expression is always positive; the first and second order effect have the same sign. Indeed, manufacturers always choose to locate in the less transparent market.

This concludes the proof. ■

Proof of Proposition 5.

The last case is the one that considers the hierarchy's entry choice, when the two markets have different degree of transparency.

The indifference condition for the entry's decision is the following:

$$\Pi_\sigma(N) = \Pi_s(M-N) \tag{89}$$

$$(\frac{1}{N}\left(\frac{\tau}{N}+\sigma\right)) - (\frac{1}{M-N}\left(\frac{t}{M-N}+s\right)) =$$

$$\frac{M^2t + N^3s + N^3\sigma - MN^2s - 2MN^2\sigma + M^2N\sigma - 2MNt}{N^2\left(M-N\right)^2}$$

As usual, I exploit the Implicit Function Theorem and derive the first and second derivative of the implicit function. Each of them will be evaluated in the benchmark case, and the results obtained will be used to derive the second order Taylor expansion.

$$\frac{\partial N}{\partial \sigma} = -\frac{\partial F/\partial \sigma}{\partial F/\partial N} = -\frac{F_\sigma}{F_N} = N^2\frac{\left(M-N\right)^3}{2M^3t - N^4s - N^4\sigma - 3M^2N^2\sigma + MN^3s + 6MN^2t - 6M^2Nt + 3MN^3\sigma + M^3N\sigma}$$

$$\left.\frac{\partial N}{\partial \sigma}\right|_{\substack{\sigma=s\\ \tau=t}} = \frac{M^2}{16t+4Ms} > 0$$

The second derivative is:

$$\frac{\partial^2 N}{\partial^2 \sigma} = -N^3\frac{\left(M-N\right)^6}{\left(2M^3t - N^4s - N^4\sigma - 3M^2N^2\sigma + MN^3s + 6MN^2t - 6M^2Nt + 3MN^3\sigma + M^3N\sigma\right)^2}$$

$$\left.\frac{\partial^2 N}{\partial^2 \sigma}\right|_{\substack{\sigma=s\\ \tau=t}} = -\frac{1}{8}\frac{M^3}{\left(4t+Ms\right)^2} < 0$$

The Taylor expansion is presented below:

$$N \simeq \frac{M}{2} + \left.\frac{\partial N}{\partial \sigma}\right|_{\substack{\sigma=s\\ \tau=t}}(d\sigma) + \frac{1}{2}\left.\frac{\partial^2 N}{\partial^2 \sigma}\right|_{\substack{\sigma=s\\ \tau=t}}(d\sigma)^2 \Rightarrow \tag{90}$$

$$N \simeq \frac{M}{2} + \frac{M^2}{16t+4Ms}(d\sigma) + \frac{1}{2}(-\frac{1}{8}\frac{M^3}{\left(4t+Ms\right)^2})(d\sigma)^2 \Rightarrow$$

$$N - \frac{M}{2} \simeq \frac{1}{16}M^2 d\sigma\frac{16t+4Ms-M(d\sigma)}{\left(4t+Ms\right)^2}$$

In order to establish the sign of this expression, consider the numerator, it is positive when $d\sigma < \frac{16t+4Ms}{M} = \frac{16t}{M} + 4s = d\widetilde{\sigma}$. This threshold allows to distinguish to cases:

- if $d\sigma < d\widetilde{\sigma}$ then $N > \frac{M}{2}$: if the asymmetry between the two markets is small enough, the supply chains decide to locate in the less transparent market, the positive first order effect prevails.
- if $d\sigma > d\widetilde{\sigma}$ then $N < \frac{M}{2}$: if the asymmetry between the two markets is large enough, the supply chains decide to locate in the more transparent market, B, the negative second order effect prevails.

This concludes the proof. ■

Comparative Statics.

The proofs of the following *Lemmas* have the aim to do some comparative statics on the thresholds that I have found above, in order to understand how the conditions determining the economic agents' market choice, relax or become more stringent, depending on the parameter that changes.

Proof of Lemma 2.

Consider the manufacturers' market choice when the two markets have different transportation costs. I have identified a threshold $d\widetilde{\tau}$ below which the upstream firms prefer to locate in the more competitive market. I consider the derivative of the threshold with respect to σ in order to understand how it varies when I allow for changes not only in the transportation costs but also in the level of transparency in both markets.

$$\frac{\partial(d\widetilde{\tau})}{\partial\sigma} = 384M^2t^3\frac{\sigma}{\left(12t^2 - 5M^2\sigma^2\right)^2} > 0$$

Since the derivative is positive, this means that the condition ensuring $N > \frac{M}{2}$ (i.e. manufacturers choose the less competitive market) becomes more stringent. It is likely that if after the increase in the transportation costs in one market, both experience also a raise in the level of uncertainty, then manufactures prefer to locate in the more competitive market rather than in the less competitive one.

This concludes the proof. ■

Proof of Lemma 3.

Below I present the comparative statics on the threshold $d\widetilde{\sigma}$ that affects retailers' market choice in the context for different level of transparency across the two circles.

I consider the derivative of the sill with respect to variations in the transportation costs.

$$\frac{\partial(d\widetilde{\sigma})}{\partial t} = 24M\frac{s^2}{\left(3t + Ms\right)^2} > 0$$

The positive derivative implies that when the transportation costs increases in both markets, after the worsening of the asymmetric information problem in market A, then the condition which ensures that retailers prefer to locate in the less transparent market becomes less stringent, it relaxes. In fact, retailers' rents are increasing in both transportation costs and level of uncertainty, so if they both raise, downstream firms would mainly locate in the less competitive and less transparent market.

This concludes the proof. ■

Proof of Lemma 4.

The two last cases of comparative statics are those concerning the hierarchies' decision. I consider the derivative of the threshold $d\widetilde{\tau}$ with respect to σ, and the derivative of $d\widetilde{\sigma}$ with respect to t.

$$\begin{aligned}\frac{\partial(d\widetilde{\tau})}{\partial\sigma} &= M > 0\\ \frac{\partial(d\widetilde{\sigma})}{\partial t} &= \frac{16}{M} > 0\end{aligned}$$

Since these are both positive, we deduce that the condition which ensures that supply chains prefer to locate in the less transparent and less competitive market become less stringent, they both relax.

In fact, sales revenues that determine hierarchies' market choice, are positively related with both t and σ, so either there is a raise in the transportation costs in one market and a subsequent increase in the level of uncertainty or viceversa; if both grow in one market that it is more likely that the supply chains choose to enter in the less competitive and less transparent market.

This concludes the proof. ■

Welfare analysis.

We are interested in the behaviour of the social planner who wishes to choose the optimal number of firms N^* in order to maximize the social welfare, that is:

$$W^e(N) = v - TC^e(N) - PC^e(N)$$

I took as reference the paper of Bassi et al. (2016):

Firm's i production costs are:

$$PC = \frac{1}{8\sigma^3}\sum_{i=1}^{N}\int_{\mu-\sigma}^{\mu+\sigma}\int_{\mu-\sigma}^{\mu+\sigma}\int_{\mu-\sigma}^{\mu+\sigma}\theta_i(\frac{\theta_{i-1}\theta_{i+1}-2\theta_i}{2t}+\frac{1}{N})d\theta_{i+1}d\theta_{i-1}d\theta_i = \frac{1}{8\sigma^3}\sum_{i=1}^{N}\frac{4}{Nt}\sigma^3\theta_i\left(N\mu^2+2t-2N\theta_i\right)$$

Total expected transportation costs are the sum of the transportation costs paid by consumers of all firms:

$$\begin{aligned}TC &= \frac{t}{4\sigma^2}\sum_{i=1}^{N}(\int_{\mu-\sigma}^{\mu+\sigma}\int_{\mu-\sigma}^{\mu+\sigma}\int_{0}^{x(\theta_i,\theta_{i+1})}(\frac{\theta_{i-1}\theta_{i+1}-2\theta_i}{2t}+\frac{1}{N})dzd\theta_i d\theta_{i+1} + \\ &\int_{\mu-\sigma}^{\mu+\sigma}\int_{\mu-\sigma}^{\mu+\sigma}\int_{0}^{x(\theta_i,\theta_{i-1})}(\frac{\theta_{i-1}\theta_{i+1}-2\theta_i}{2t}+\frac{1}{N})dzd\theta_i d\theta_{i-1})\end{aligned}$$

Given that the result is:

$$W^e(N) = v - \frac{-2N^2\sigma^2 + 3\tau^2 + 12N\tau\mu}{12N\tau}$$

Once we have these main results, we can proceed to analyze the two scenarios:

- *Different Transportation Costs*

The social planner wants to maximize the welfare generated in both markets. Indeed, consider the sum of the welfare generated in the two markets:

$$W^T = W^e(N)_\tau + W^e(M-N)_t$$

Since there is not an explicit solution for N (i.e. the equilibrium number of firm in market A), I apply the Implicit Function Theorem and evaluate the expression in the benchmark case (symmetry across the market $N \to \frac{M}{2}$). In this case I can study the behaviour of the fucntion for slightly variations on the parameter of interest τ :

$$\frac{\partial N}{\partial \tau} = -\frac{\partial F/\partial \tau}{\partial F/\partial N} = -\frac{F_\tau}{F_N}$$

The result shows that

$$\lim_{N \to \frac{M}{2}} \left(-\frac{F_\tau}{F_N}\right) > 0$$

This means that when τ increases in market A, so that it becomes less competitive the optimal number of firms increases.

This concludes the proof. ■

- *Different degree of transparency*

I now repeat the same procedure of the previous case, within the set-up that the two markets have different degree of asymmetric information..

The sum of the welfare generated in the two markets is the following:

$$iW^T = W^e(N)_\sigma + W^e(M-N)_s$$

As before, I apply the Implicit Function Theorem and consider the behaviour of the function that describes the optimal number of firms N^* in the neighborhood of the benchmark case ($N \to \frac{M}{2}$).

$$\frac{\partial N}{\partial \sigma} = -\frac{\partial F/\partial \sigma}{\partial F/\partial N} = -\frac{F_\sigma}{F_N}$$

Results show that

$$\lim_{N \to \frac{M}{2}} \left(-\frac{F_\sigma}{F_N}\right) < 0$$

This means that when σ increases, so that the market becomes less transparent and indeed, the uncertainty in the market grows, the optimal number of firms decreases.

As expected, the social planner wants that less firms go in the less transparent market.

This concludes the proof. ■

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