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"When Should Manufacturers Want Fair Trade?": New Insights from Asymmetric Information and Non-Market Externalities when Supply Chains Compete

Jakub Kastl[♥], David Martimort[♣], and Salvatore Piccolo[♠]

Abstract
We study a specific model of competing manufacturer-retailer pairs where adverse selection and moral hazard are coupled with non-market externalities at the downstream level. In this simple framework we show that a "laissez- faire" approach towards vertical price control might harm consumers as long as privately informed retailers impose non-market externalities on each other. Giving manufacturers freedom to control retail prices harms consumers when retailers impose positive non-market externalities on each other, and the converse is true otherwise. Moreover, in contrast to previous work, we show that, in these instances, consumers' and suppliers' preferences over contractual choices are not necessarily aligned.

Keywords: Competing hierarchies, resale price maintenance, retail externalities.

JEL classification: D2, D23, D82, K21.

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Table of contents

1 Introduction

When retailers are privately informed about relevant aspects of their market, the wedge between wholesale prices and marginal costs results from the fundamental trade-off between efficiency and rent extraction that uninformed manufacturers face when designing (non-linear) wholesale contracts. To save on information rents, manufacturers must cut back the supply of intermediate inputs, whereby generating upward price distortions that penalize final consumers.

Building on this insight, a recent strand of the vertical contracting literature has shown that retail price restrictions improve manufacturers' profits under asymmetric information. Indeed, by allowing better inference on the retailers' private information, vertical price control mitigates the negative incentive effects that flow from a non-linear transfer scheme. Hence, manufacturers reach a better position when trading off extraction of their retailers' information rent and efficiency. This benefits consumers because of lower input supply distortions and, thus, less double marginalization: a view in line with the Chicago School stance arguing in favor of vertical price control.[1]

The agency approach taken in these papers is supported by a large and growing empirical literature that has documented a number of regularities consistent with the predictions of the basic principal-agent theory — see, e.g., Lafontaine and Slade (1997). However, existing models mainly consider a bilateral monopoly framework where each manufacturer/retailer pair is taken in isolation. They are thus mute on how their predictions carry over in more competitive contexts where different manufacturer/retailer pairs compete and each downstream firm exerts non-market externalities on its competitors. Such investigation is clearly of prime importance to put policy recommendations on firmer foundations. Lafontaine and Slade (1997), for instance, pointed out that the standard agency model applied to vertical contracting deceptively fails to account for the fact that each manufacturer/retailer pair operates in a competitive environment, and that decisions in any such vertical structure have an equilibrium impact on competitors. As a consequence, most empirical studies rely solely on attributes of the upstream firm and its outlet when evaluating the costs and benefits of a ban on vertical price control, whereby ignoring potential effects stemming from intrabrand competition. Such partial perspective may introduce some significant bias in the analysis by erroneously interpreting data and market behavior as coming from isolated choices and not being the equilibrium outcome of a more complex game.

Introducing competition between manufacturer/retailer pairs and non-market externalities across retailers not only offers a more complete picture, but it also raises a number of important questions. The corresponding answers, as we argue below, are less stark than what is predicted by the bilateral monopoly model. What are the forces shaping the retail market equilibrium in games with competing supply chains? Is vertical price control still beneficial to consumers? Does the Chicago School argument apply under these circumstances? What are the empirical variables reflecting interbrand competition that, in principle, should be used to asses the welfare effects of RPM?

[1] See, e.g., Spengler (1950) and Telser (1960).

The present paper offers some simple answers to these questions in a tractable, although specific game between competing manufacturer/retailer pairs. More precisely, we set up an agency model with linear demands allowing both for adverse selection and moral hazard,[2] competing supply chains and non-market externalities at the downstream level. Retailers privately observe final demands and exert nonverifiable efforts (after-sale services, promotional efforts, advertising etc.) that create cross-demand externalities. Such externalities can be either positive or negative depending on the nature of the retailer's activity. Two legal regimes are compared: one where resale price maintenance is allowed (*laissez-faire*); the other where this practice is forbidden (ban on RPM).

In this framework, we first show that equilibrium quantities are lower under laissez-faire than with a ban on RPM if retailers' non-market activities create positive externalities — i.e., if an increase in one retailer's effort also improves his competitors' demand. Instead, the opposite conclusion obtains with negative externalities. Building on this comparison of outputs, we then show that manufacturers and consumers might have conflicting views about the opportunity of banning vertical price control. Consumers prefer RPM if and only if non-market externalities are negative whereas manufacturers achieve in some cases higher equilibrium profits with RPM even with positive non-market externalities.

To gain some intuition on why this additional instrument would always be chosen by manufacturers in equilibrium, note first that, whatever other supply chains are doing and whether these pairs are using RPM or not, a given manufacturer would always want to expand the means of controlling his retailer, so as to limit his information rent. Using both controls — i.e., on retail price and output — allows indeed to better track the retailer's effort which, in turn, stifles his rent. When comparing equilibrium profits with and without a ban on RPM, this effect drives the manufacturers' preferences over those regimes.

The existence of a possible conflict between consumers and manufacturers is due to the interplay between non-market externalities, competition between supply chains and asymmetric information. In the case of a bilateral monopoly, and much in line with the Chicago School dogma, manufacturers' and consumers' preferences are instead aligned over the choice of contractual modes — see, e.g., Gal-Or (1991a) and Martimort and Piccolo (2007). From a competition policy viewpoint, this underscores the scarce appeal of *per se* rules in markets where interbrand competition is non-negligible and promotional activities play a substantial role in determining final demands.

Put differently, our model is simple enough to drive all the output and welfare comparisons between contracting modes from the sole analysis of the nature of non-market externalities and its consequences on competition between vertical structures, keeping as a reference point the case

[2]This model has been a work-horse of the earlier literature on vertical control under adverse selection. See for instance, Gal-Or (1991a, b, 1999), Martimort (1996), Martimort and Piccolo (2010) among others. Note that a model with linear demands and with demand shocks being uniformly distributed as we assume below can also be viewed as a correct approximation of some more general nonlinear demand systems when uncertainty of demand parameters is not too large. This alternative approach certainly broadens the scope of our analysis.

where, in the absence of any such externalities, the two modes would be equivalent.[3] Even if derived in a simplified setting, these predictions are novel in the vertical contracting literature. Since our predictions on when retail price restrictions are more likely to harm consumers are based only on the sign of the non-market externality, they provide a ready-to-use tool for policy.

In view of this result, our model is also particularly relevant to assess the existing limits of some recent empirical works and where further such works should be heading. The importance of promotional effort in manufacturer/retailer relationships is indeed documented by an expanding body of empirical studies. However, these papers often fail to account for the cross-demand externalities that such non-market activities may generate — see, e.g., Lafontaine and Slade (1997). For instance, when respectively studying resale price maintenance in the French retail market for bottled water and in the German coffee market, Bonnet and Dubois (2010), Bonnet, Dubois and Simioni (2006) and Bonnet, Dubois and Villas Boas (2009), account for the extent of retailers' promotional activities — such as brand image conveyed through advertising — but do not explicitly consider cross-demand externalities in their structural models. Our model suggests that the nature and degree of retailers' externalities imposed on each other might be an important omitted variable in these studies which could potentially lead to a bias in the estimates of interest.

To understand the logic behind our results it is worth explaining the source of the agency problem faced by manufacturers when dealing with retailers who hold private information on demand shocks and exert nonverifiable efforts to boost demand. First, a typical wholesale contract asks the retailer to pay some franchise fee to get access to the right of selling the manufacturer's product. When the bargaining power is on the manufacturers' side, this fee extracts as much profits as possible from the retailer, although he can still pocket an information rent. Of course, this payment is smaller when demand is low and downstream profit small. Precisely this wedge creates incentives for a retailer to pretend that downstream demand is lower than it really is. By doing so, he would pay a lower amount and grasp some information rent.

Differences in contractual modes significantly affect the rent grasped by the retailer at equilibrium. Consider, for instance, a situation where RPM is banned. First, retailers enjoy higher rents relative to the laissez-faire regime. Indeed, with such a limited control, a manufacturer is unable to decipher and control the non-verifiable effort of his retailer towards improving own demand from observed contractual variables like retail prices and input sales. Retailers have now enough freedom in choosing this effort and fully internalize its impact on profits. Conditionally on a given wholesale contract, the retailer's effort is efficient from the point of view of the manufacturer-retailer pair: a *demand-enhancing* effect that pushes effort up. Second, boosting own demand makes it also more valuable for a retailer to manipulate his private information on demand. Extracting the retailer's information rent requires stronger distortions of the wholesale contract, which reduces the retailer's

[3] More complex specifications of demand, information structures and disutility functions could start by already introducing a bias towards one contractual mode versus the other even when non-market externalities are absent. The effects that we unveil in this paper would superimpose to such analysis to attenuate or reinforce the comparison between those modes.

demand and in turn dampens the level of his non-verifiable effort: a *rent-extraction* effect that decreases effort. Third, with competing supply chains, there is also a *horizontal externality* effect: changing one retailer's effort has a direct impact on the competitor's demand, and this effect might backfire into the retail market equilibrium outcome. Essentially, depending on the sign of the retail non-market externalities the downstream game may feature either strategic complementarities or substitutabilities in effort — i.e., increasing effort by one retailer also leads to an increase (resp. decrease) in his competitor's effort.

In the model that we develop below demand is linear and the disutility of effort quadratic, so that the demand-enhancing and the rent-extraction effects exactly compensate each other. Only cross-demand externalities matter to assess the impact of each legal regime on the equilibrium quantities, and therefore on consumer surplus. Following Martimort and Piccolo (2007), we know that this is precisely with such functional forms that RPM and quantity forcing contracts are just equivalent when a single manufacturer/retailer pair is active. Hence, these modeling choices allow us to focus on the novel insights that competition between such pairs may bring to explain the performances of different legal regimes.

If effort externalities are positive, a ban on RPM spurs equilibrium quantities relative to the laissez-faire regime. This is because retailers' equilibrium effort diminishes under RPM for rent-extraction reasons, which lowers in turn the rival's effort and thus own demand via a negative cross-demand spillover.[4] Hence, when non-market externalities are positive a laissez-faire regime limits the positive complementarities among competing retailers, whereby stifling equilibrium quantities and penalizing final consumers. This also explains why manufacturers' and consumers' preferences might be not aligned in these games: manufacturers prefer vertical price control because it improves screening, but consumers dislike this practice because it reduces the equilibrium promotional effort and therefore quantity.

In contrast, if effort spillovers are negative, RPM enables manufacturers to limit the negative externalities between retailers: reducing one retailer's effort also reduces the rivals' effort, this mitigates the negative cross-demand externalities so as to promote productive efficiency and benefit consumers.

Our analysis complements earlier contributions on vertical contracting under asymmetric information and expands their scope. In a model with adverse selection but without promotional effort, Gal-Or (1991a) was the first to argue that nonlinear wholesale prices might not suffice to eliminate downstream rents and double marginalization. She showed that vertical price control plays a novel efficiency role. Indeed, it helps manufacturers to better extract retailers' rents and promote productive efficiency. While under complete information, there is a priori no feasibility constraints imposed on the fixed-fees that can be used by manufacturers to extract the retailer's downstream profit, asymmetric information puts such limits on the ability of upstream manufacturers to capture

[4] In contrast to what could be expected, a wider range of contractual instruments leads to a reduction rather than to an increase of effort in our example. The reverse could be possible if effort were verifiable.

downstream profits.[5] Essentially, as long as vertical price fixing provides an additional screening instrument, the retail price comes closer to marginal costs. A laissez-faire approach cannot harm consumers. In contrast, we show that this simple point may no longer be always true with competing supply chains. Its validity depends on the nature of effort externalities across those chains.

Building on Gal-Or (1991a), Martimort and Piccolo (2007) studied contracts with and without RPM in a bilateral monopoly model where downstream effort is non-verifiable and retailers have private information on demand. They showed that when RPM is privately optimal for the vertical structure, it also enhances consumer welfare: a result very much in the spirit of the Chicago School approach. However, their main conclusion depends upon fine details of the marginal disutility of effort (its convexity or concavity). One striking result is that the two contractual regimes are equivalent from the consumer's point of view when the retailer's disutility of effort is quadratic and demand is linear. This neutrality is precisely our starting point for introducing competition between supply chains and test whether their findings survive with competing supply chains and effort externalities. This allows us to nail down an unbiased example where the link between downstream non-market externalities, consumer surplus and vertical control depends exclusively on the nature of effort externalities. Of course, the effects emphasized here and those underlined in Gal-Or (1991a) and Martimort and Piccolo (2007), might be at play simultaneously in practice. However, understanding which of them end up dominating seems an empirical question that is clearly beyond the scope of this paper.

Finally, it is interesting to compare our result concerning the impact of RPM on retailers' promotional effort to the earlier vertical contracting literature that analyzed the role of non-market externalities. Marvel and McCafferty (1985, 1986), for instance, argued that vertical price control should enhance efficiency by promoting retailers' non-market activities. There is one major difference between this latter view and ours. While we allow for nonlinear contracts which would enable manufacturers to internalize all vertical externalities in the case of complete information, these earlier papers only consider linear prices and artificially created a vertical externality by imposing this arbitrary restriction. In Marvel and McCafferty (1985, 1986), for instance, the beneficial effect of RPM stems from a simple free-riding argument. In the absence of vertical control, downstream competition cannot support the efficient provision of services because retailers free-ride on competitors by reducing the costly non-market services so as to reduce prices and poach competitors' demand. In equilibrium, the market will be completely dominated by outlets offering no service. Minimal retail price requirements, instead, prevent competitive forces from cutting down those costly non-market services and thus enhance efficiency. The logic of this mechanism relies

[5] Many scholars have criticized the Chicago school approach by pointing out the artificial nature of double marginalization in complete information environments. For example, in Blair and Lewis (1994), Kuhn (1997), Gal-Or (1991a) and (1991b), Martimort and Piccolo (2007), Rey and Tirole (1986), double marginalization is endogenous. Instead of being inherited from an exogenous constraint on instruments that restricts the manufacturer to impose linear wholesale pricing, asymmetric information generates distortions which are similar in spirit but those distortions are now induced by incentive compatibility constraints.

on the double-marginalization effect generated by linear pricing: retailers free-ride one on another because by doing so they can grab market rents. When manufacturers can use two-part tariffs, instead, this is no longer true. Under complete information, the whole downstream surplus can be extracted with fixed fees, retailers are then indifferent between all levels of services and implement those recommended by the manufacturers. This does not happen in our model where retailers enjoy information rents and these rents are endogenously derived from the information structure.

Section 2 sets up the model and provides the complete information benchmark. We characterize the incentive feasible allocations under each legal regime in Section 4. Comparative statics and welfare results are derived in Section 5. Section 6 concludes and discusses various robustness checks. Proofs are in the Appendix.

2 The Model

Industry. Consider a downstream industry where two retailers, R_1 and R_2, compete by selling differentiated goods (brands). Let q_i denote the quantity supplied of this good by R_i on the final market. The production of each unit of final output q_i requires one unit of an essential raw input which is supplied by an upstream manufacturer, M_i, each being in an exclusive relationship with retailer R_i. Let $p_i(\theta, e_i, e_{-i}, q_i, q_{-i})$ be the inverse market demand for good i. The common shock affecting both downstream demands θ is uniformly distributed on the compact support $\Theta \equiv [\underline{\theta}, \overline{\theta}]$, with $\Delta\theta = \overline{\theta} - \underline{\theta}$ denoting the spread of demand uncertainty. Retailers privately know the realization of θ at the time contracts are signed. The variable e_i denotes a non-verifiable demand-enhancing activity (effort) performed by each retailer R_i. This effort may generate positive or negative spillovers on his competitor.

To highlight the effect of non-market externalities on the retail market equilibrium outcome we choose the linear specification:[6]

$$p_i(\theta, e_i, e_{-i}, q_i, q_{-i}) = \theta + e_i + \sigma e_{-i} - q_i - \rho q_{-i}, \text{ for each } i = 1, 2.$$

The parameter $\rho \in [0, 1]$ is the standard measure of products' differentiation. The parameter σ, instead, determines whether retailers impose positive ($\sigma > 0$) or negative externalities ($\sigma < 0$) on each other through their non-market activities. Essentially, the effort variable is meant to capture all retailers' non-market activities which may help retailers to differentiate their products, e.g., production of indivisible services, investments in advertising or pre-sale advices to potential buyers.

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

$$V(q_1, q_2, I, \theta) = \sum_{i=1,2} q_i(e_i + \sigma e_{-i}) + \theta \left(\sum_{i=1,2} q_i \right) - \frac{1}{2} \sum_{i=1,2} q_i^2 - \rho q_1 q_2 + I.$$

This specification is standard in IO models — see, e.g., Vives (2000).

It has two effects on the demand system: it enhances own consumers' willingness to pay, but it may also influence the competitor's demand. This assumption seems reasonable at least in two cases. First, when effort is interpreted as production of indivisible services bundled with the final product, it might have a negative impact on competitors' demand. Differently, as argued by Mathewson and Winter (1984), when effort captures pre-sale services or generic advertising, it could well be the case that information on the product's existence benefits also competitors: a free-riding story. Following Che and Hausch (1999), we shall say that effort has either a *cooperative* value if $\sigma \geq 0$ or a *selfish* one if $\sigma < 0$. We shall also assume that $|\sigma| < 1$ in order to guarantee that own-effort effects are larger than cross-effort ones, i.e., $\partial p_i(.)/\partial e_i \geqslant |\partial p_i(.)/\partial e_{-i}|$.

Exerting effort is costly for retailers and $\Psi(e_i) = \psi e_i^2/2$ is the quadratic disutility of effort incurred by retailer i. Finally, production technologies are linear for both upstream and downstream firms, and marginal costs are normalized at zero with no loss of generality.

Legal regimes and contracts. The social planner (antitrust or competition authority) chooses among two possible legal regimes:

- *Laissez-faire* where manufacturers face no restrictions on the type of contracts they can design;
- *Ban on RPM* where retail price restrictions are forbidden.

These regimes capture in the simplest possible way the kinds of vertical price control regulations that are found in practice. Although the Chicago School critique has often advocated for a laissez-faire approach towards vertical restraints, by supporting the view that these instruments remove double marginalization, this practice is generally treated as illegal per se in the U.S. and most OECD countries.

Accordingly, manufacturers can use two different types of vertical contracts depending on the legal regime that prevails: resale price maintenance (RPM) or quantity forcing (QF) contracts. 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 RPM is chosen, a contract is a menu $\{t_i(q_i), p_i(q_i)\}$ which now specifies also a retail price $p_i(q_i)$ to be charged downstream as a function of R_i's output. We follow the earlier literature[7] in assuming that these contracts cannot depend on the output produced by competing retailers. This incompleteness in contracts can be either due to the fact that manufacturer M_i has no auditing rights to verify such information, or simply because conditioning the transfer $t_i(.)$ on the rival's output q_{-i} would be often treated as an anticompetitive practice by an antitrust authority. The next section describes in more detail how these contracts can be reinterpreted in terms of direct truthful revelation mechanisms.

Timing and equilibrium concept. The sequence of events unfolds as follows:

T=0. The planner announces a legal regime, laissez-faire or ban on RPM.

[7] See Gal-Or (1991b, 1999), and Martimort (1996).

T=1. The demand shock θ is realized and only R_1 and R_2 observe this piece of information.

T=2. Upon observing the announced regime, each manufacturer offers a menu of contracts to his retailer. Contracts can be accepted or rejected. If R_i turns down M_i's offer, these two players get an outside option which, for simplicity, is normalized to zero. The pair M_{-i}-R_{-i} then acts as a sequential monopoly as long as R_{-i} accepts the offer received by M_{-i}.[8]

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.

Under both legal regimes, bilateral contracting is secret. Members of a given hierarchy cannot observe the specific trading rules specified in the contract ruling the competing hierarchy.[9] The equilibrium concept we use is *Perfect Bayesian Equilibrium* with the added "passive beliefs" refinement (in short 'equilibrium'). Provided R_i receives any unexpected offer from M_i, he still believes that R_{-i} produces the same equilibrium quantity. Under both legal regimes we shall look for symmetric, pure strategies equilibria.

Technical assumptions. To deal with well-behaved programs under each regime, we develop the analysis under the following hypothesis:

Assumption 1 ***(Monotonicity).*** *The effort disutility is sufficiently convex:*

$$\psi \geq \begin{cases} \frac{1}{2} & \text{if } \rho \geq 2\sigma \\ \frac{1+\sigma}{2(1+\rho-\sigma)} & \text{if } \rho < 2\sigma. \end{cases}$$

Assumption 1 rules out the possibility of having bunching and makes sure that output and efforts are increasing in θ for all pairs $(\sigma, \rho) \in [-1, 1] \times [0, 1]$.

Assumption 2 ***(Small uncertainty).*** *$\Delta\theta$ is not too large compared to $\bar{\theta}$:*

$$\frac{\Delta\theta}{\bar{\theta}} \leq \frac{2\psi\left(1+\rho-\sigma\right)-\left(1+\sigma\right)}{\left(2\psi+1\right)\left(\psi\left(2+\rho\right)-\left(1+\sigma\right)\right)}.$$

Assumption 2 guarantees that the optimization programs that we solve under both legal regimes feature positive efforts and quantities for all demand realizations.

[8] In what follows, we focus on equilibria where both retailers remain active for all demand realizations which arises when $\Delta\theta$ is sufficiently small.

[9] This assumption simplifies modeling by avoiding strategic considerations that would arise with public contracts or even public commitment to either a RPM or a QF contract.

3 Benchmarks

To clarify the importance of both asymmetric information and interbrand competition for our results, in this section we briefly present the retail market equilibrium outcome when: (i) there is a single monopolistic manufacturer/retailer pair; and (ii) there are two competing supply chains but information about demand is common knowledge.

Bilateral monopoly. When $\rho = \sigma = 0$ the model is similar to that studied in Martimort and Piccolo (2007), who analyzed the welfare effect of RPM in a bilateral monopoly setting with asymmetric information. With a quadratic disutility of effort, they show that vertical price control has no impact on consumer surplus — i.e., consumers are indifferent between laissez-faire and a ban on RPM. Our objective here is to study how this conclusion changes when both downstream product market competition and non-market externalities are simultaneously at play.

Complete information with competing hierarchies. Consider first the case where the demand shock θ is common knowledge. In this scenario, retail prices, quantities and downstream efforts are the same under both legal regimes and solve the following set of first-order conditions:

$$\theta + (1+\sigma)e^*(\theta) - (2+\rho)\, q^*(\theta) = 0,\ p^*(\theta) = q^*(\theta) = \psi e^*(\theta) = \frac{\theta\psi}{\psi\,(2+\rho) - (1+\sigma)}.$$

Whether a manufacturer lets his retailer choose his downstream effort or controls it through a secret contract, the effort level remains the same thanks to the absence of any vertical externality. When fixed-fees are allowed, there is no double marginalization and the retailer's incentive to provide effort can be easily aligned with that of the vertical structure he forms with the upstream manufacturer. The marginal cost of effort must equal own market sales. Under complete information, the choice of a legal regime has no impact on market allocations. We shall see that this is no longer true under asymmetric information.

4 Asymmetric Information and Competing Supply Chains

Before starting the analysis it is worth emphasizing that downstream moral hazard has two different effects in our setting.

First, even when the retail price can be contracted upon, M_i cannot disentangle the impact of the intercept parameter θ from his retailer's effort e_i on the residual demand the retailer faces. The possibility that R_i claims that large sales are due to high effort although demand is low, even if in reality these large sales result from a higher demand and less effort, forces M_i to give up information rent to the retailer in order to induce information revelation. As a result, the second-best allocation will feature downward distortions of both quantity and effort. The information rent, of course, depends on the chosen contractual mode: a vertical contractual externality that is induced by asymmetric information.

Second, effort in enhancing own demand may have an impact on the competing brand's demand. RPM and QF may affect differently the demand faced by competing retailers: a horizontal contractual externality.

4.1 Direct Revelation Mechanisms

Following Myerson (1982) and Martimort (1996), we use a version of the Revelation Principle in competing hierarchies to characterize the set of incentive feasible allocations for each manufacturer/retailer pair. With bilateral secret contracts and for any output choice made by R_{-i}, there is no loss of generality in looking for M_i's best response to M_{-i}'s contractual offer within the class of direct and truthful mechanisms to characterize pure-strategy equilibria. Under QF, for instance, a direct revelation mechanism is a menu of the form $\left\{t_i(\hat{\theta}_i), q_i(\hat{\theta}_i)\right\}_{\hat{\theta}_i \in \Theta}$ where $\hat{\theta}_i$ is R_i's report on the demand parameter. Similarly, if RPM is chosen, an incentive mechanism is of form $\left\{t_i(\hat{\theta}_i), q_i(\hat{\theta}_i), p_i(\hat{\theta}_i)\right\}_{\hat{\theta}_i \in \Theta}$ where the extra contracting variable $p_i(\hat{\theta}_i)$ denotes now the retail price of good-i following report $\hat{\theta}_i$.[10]

Note that a QF arrangement is less complete relative to RPM because it restricts the set of screening instruments available to manufacturers by leaving the retail market price unspecified. With a QF contract, the upstream manufacturer does not have enough instruments to control the retailer's effort. In contrast, by dictating the retail price and the quantity sold to the retailer, the upstream manufacturer can control directly the retailer's effort level under RPM.[11]

4.2 Laissez-faire

This section characterizes the equilibrium of the game under laissez-faire. As discussed before, since contracts are unobservable, each manufacturer finds it always optimal to use all contracting variables irrespective of what the other manufacturer's contract is. This leads to the following

[10] When manufacturers no longer control the level of final output sold in the market, but can only fix the retail price in case of RPM, the analysis remains the same as if output was observable. The argument is formally developed in Martimort and Piccolo (2007). The idea is that the optimal RPM mechanism reduces the input supply below what would be optimal under complete information for screening purposes. Indeed, consider the output choice of each retailer when instead the final quantity is non verifiable. The retailer would ideally like to expand output up to the point where the marginal benefit of one extra unit (the retail price) equals the marginal disutility of effort. Thus each retailer would like to expand output above the second-best level implemented by our mechanism $\{t_i(.), q_i(.), p_i(.)\}$. This implies that the retailers have no incentives to sell quantities lower than those supplied by the manufacturers. Our mechanism is thus robust to the lack of verifiability of the final quantities sold by the retailers. Including the quantity as an explicit contracting variables nevertheless eases presentation of our model.

[11] Even an RPM contract is incomplete. Indeed, a given manufacturer cannot contract on the output and retail price chosen by rival hierarchies. The justification for this is that a given manufacturer may not have the auditing rights to check out the sales of other retailers than his own or that the exact retail price charged by other retailers includes non-observable rebates. It is worth noticing that, if such information on rivals' output and retail price was available, the logic of the mechanism design literature on implementation in complete information environment would apply: a given manufacturer could achieve the first-best allocation just by matching his own retailer's announcement with what he learns indirectly from others' choices. In such a world that boils down de facto to a perfect information environment, there would be no difference between RPM and quantity forcing.

preliminary result:

Lemma 1 *In the laissez-faire regime, the equilibrium always features RPM.*

Building on Lemma 1, we can easily characterize symmetric equilibria under laissez-faire 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, i.e., $e_i = p_i + q_i - \sigma e_{-i} + \rho q_{-i} - \theta$. Intuitively, RPM is less flexible than QF simply because, when retailer R_i faces a retail price target, he is indirectly forced to choose the effort level in a way that might be suboptimal from his viewpoint.[12]

Let us define R_i's information rent as:

$$U_i(\theta) = \max_{\hat{\theta}_i \in \Theta} \left\{ p_i(\hat{\theta}_i) q_i(\hat{\theta}_i) - \Psi(p_i(\hat{\theta}_i) + q_i(\hat{\theta}_i) - \sigma e_{-i}(\theta) + \rho q_{-i}(\theta) - \theta) - t_i(\hat{\theta}_i) \right\}.$$

Describing the set of incentive feasible allocations for the M_i-R_i pair is straightforward (see the Appendix). Those allocations satisfy the following first- and second-order local conditions for incentive compatibility:

$$\dot{U}_i(\theta) = \psi(1 + \sigma \dot{e}_{-i}(\theta) - \rho \dot{q}_{-i}(\theta)) e_i(\theta), \tag{1}$$

$$(\dot{p}_i(\theta) + \dot{q}_i(\theta))(1 + \sigma \dot{e}_{-i}(\theta) - \rho \dot{q}_{-i}(\theta)) \geqslant 0. \tag{2}$$

Incentive feasible allocations must also satisfy the usual participation constraint:

$$U_i(\theta) \geqslant 0, \quad \forall \theta \in \Theta. \tag{3}$$

Equipped with this characterization, we now turn to the optimal contracting problem. 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:

$$\max_{\{q_i(.), e_i(.), t_i(.)\}} \int_{\underline{\theta}}^{\overline{\theta}} t_i(\theta)\, d\theta \equiv \int_{\underline{\theta}}^{\overline{\theta}} \left\{ p_i(\theta, e_i(\theta), e_{-i}(\theta), q_i(\theta), q_{-i}(\theta)) q_i(\theta) - \frac{\psi}{2} e_i^2(\theta) - U_i(\theta) \right\} d\theta.$$

subject to (1), (2) and (3).

Assuming that the term $1 + \sigma \dot{e}_{-i}(\theta) - \rho \dot{q}_{-i}(\theta)$ remains positive for all θ (a condition to be checked ex post), $U_i(\theta)$ is increasing and the participation constraint (3) binds only at $\underline{\theta}$. This leads to the following expression:

$$U_i(\theta) = \int_{\underline{\theta}}^{\theta} \psi(1 + \sigma \dot{e}_{-i}(x) - \rho \dot{q}_{-i}(x)) e_i(x) dx. \tag{4}$$

[12] See also Blair and Lewis (1994) and Martimort and Piccolo (2007) for similar arguments.

With competing supply chains, the retailer's information rent is not the same as that emerging in a bilateral monopoly setting (the expression of the retailer's rent in that latter case would be obtained by simply setting $\sigma = \rho = 0$ in the above equation). Remember that in a monopoly setting, the retailer has some incentives to claim that demand is lower than what it really is. By doing so, the fee he pays is lower and he can reduce his own effort while still selling the same quantity at the same price. This (marginal) incentive to pretend demand is low is of course modified when competing retailers do not deviate and still maintain their own effort and output. When $\rho > 0$ (goods are substitutes) or/and when $\sigma < 0$ (non-market externalities are negative), the residual demand that the deviating retailer considers when evaluating the benefits of such strategy is less steep, which reduces his own incentives to claim demand is low. Intuitively, the more the rival produces of a substitute good or the higher his effort in a selfish environment, the lower are the retailer's incentives to claim that demand is low because less stakes can then be grabbed from the market by doing so. Instead, when $\rho < 0$ (goods are complements) or/and when $\sigma > 0$ (non-market externalities are positive), the residual demand is steeper making the claim that demand is low more attractive. More generally, since types are perfectly correlated, the incentives to underestimate demand of a given retailer depend on the output and effort of his rival. Those competing-contracts effects are now well-known from the existing literature since Martimort (1996) and Gal-Or (1999), although they apply here in a framework with both market and non-market externalities.

Integrating by parts to evaluate the expected rent left to R_i and neglecting the second-order local condition (2), we get the following relaxed program $(\mathcal{P}_i^P)$:

$$\max_{\{q_i(.),e_i(.)\}} \int_{\underline{\theta}}^{\overline{\theta}} (p_i(\theta, e_i(\theta), e_{-i}(\theta), q_i(\theta), q_{-i}(\theta))q_i(\theta) - \frac{\psi}{2}e_i^2(\theta) \\ - \psi\left(\overline{\theta} - \theta\right)(1 + \sigma\dot{e}_{-i}(\theta) - \rho\dot{q}_{-i}(\theta))e_i(\theta))d\theta.$$

At a best response to the schedule $q_{-i}(\theta)$ and effort $e_{-i}(\theta)$ implemented by the competing pair M_{-i}-R_{-i}, the output $q_i(\theta)$ and effort $e_i(\theta)$ in M_i-R_i hierarchy are respectively given by the following first-order conditions obtained by pointwise optimization:[13]

$$q_i(\theta) = p_i(\theta) = \theta + e_i(\theta) + \sigma e_{-i}(\theta) - q_i(\theta) - \rho q_{-i}(\theta), \tag{5}$$

$$q_i(\theta) = \psi\left[e_i(\theta) + \left(\overline{\theta} - \theta\right)(1 + \sigma\dot{e}_{-i}(\theta) - \rho\dot{q}_{-i}(\theta))\right]. \tag{6}$$

Under RPM, the only variable which is really useful to reduce R_i's information rent is his own effort as one can see by inspection of (5) and (6). First, the marginal disutility of effort is lower than the output; a downward distortion of effort with respect to the rule that would be followed under complete information. Second, (5) implies that the pricing rule satisfies the same expression as under complete information. Output is produced according to the efficient rule conditionally on

[13] Given Assumption 1, the objective is concave and these conditions are also sufficient.

a given effort which is nevertheless distorted downward under asymmetric information.[14] This leads to the following lemma:

Lemma 2 *Under laissez-faire, the pricing rule is efficient. The effort is distorted for rent-extraction purposes.*

In a symmetric equilibrium where both manufacturers adopt RPM, the efforts and outputs satisfy the following system of differential equations:

$$(2+\rho)\, q^P(\theta) = \theta + e^P(\theta)(1+\sigma), \tag{7}$$

$$q^P(\theta) = \psi\left[e^P(\theta) + \left(\overline{\theta} - \theta\right)\left(1 + \sigma \dot{e}^P(\theta) - \rho \dot{q}^P(\theta)\right)\right], \tag{8}$$

with boundary conditions $q^P(\overline{\theta}) = q^*(\overline{\theta})$ and $e^P(\overline{\theta}) = e^*(\overline{\theta})$, which state that there are no distortions for the highest realization of demand.

Given the structure of these differential equations, we are now looking for a *linear equilibrium* where both $q^P(\theta)$ and $e^P(\theta)$ are linear in θ,[15] so we have:

$$q^P(\theta) = q^*(\overline{\theta}) - \frac{2\psi\left(\overline{\theta} - \theta\right)}{2\psi\,(1+\rho-\sigma) - (1+\sigma)}, \tag{9}$$

and

$$e^P(\theta) = e^*(\overline{\theta}) - \frac{(2\psi+1)\left(\overline{\theta} - \theta\right)}{2\psi\,(1+\rho-\sigma) - (1+\sigma)}. \tag{10}$$

It is immediate to see that Assumption 1 ensures that the equilibrium effort and output are monotonically increasing and satisfy the second-order condition (2). These schedules are downward distorted with respect to the complete information outcome: $q^P(\theta) \leq q^*(\theta)$ and $e^P(\theta) \leq q^*(\theta)$ for each θ (with equality at $\overline{\theta}$ only). Moreover, Assumption 2 guarantees that these outputs and efforts remain non-negative.

4.3 Ban on RPM

When RPM is banned, manufacturers are bound to use QF contracts. Since an upstream manufacturer can no longer use the retail price, only sales can be used as a screening device. This has some consequences both on allocative efficiency — the retailer being now free to choose effort — and on the distribution of information rent within each supply chain.

[14] This feature echoes the "dichotomy" result underscored by Laffont and Tirole (1993, Chapter 3) in some regulatory environments.

[15] Martimort (1996) showed that the only symmetric equilibrium is linear when $\rho > 0$ in a model without non-market externalities.

Proceeding as before, the retailer R_i's information rent under a QF regime can be rewritten as:

$$U_i(\theta) = \max_{\hat{\theta}_i \in \Theta} \left\{ -t_i(\hat{\theta}_i) + \max_{e_i \in \mathbb{R}_+} \left\{ (\theta + e_i + \sigma e_{-i}(\theta) - q_i(\hat{\theta}_i) - \rho q_{-i}(\theta)) q_i(\hat{\theta}_i) - \Psi(e_i) \right\} \right\}.$$

First, observe that the retailer's chooses optimally his effort, that is:

$$q_i(\theta) = \psi e_i(\theta). \tag{11}$$

This simple condition is the same as under complete information. It shows that now the agent fully internalizes the impact of his effort choice on the overall profit of vertical chain.

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

$$\dot{U}_i(\theta) = (1 + \sigma \dot{e}_{-i}(\theta) - \rho \dot{q}_{-i}(\theta)) q_i(\theta), \tag{12}$$

$$(1 + \sigma \dot{e}_{-i}(\theta) - \rho \dot{q}_{-i}(\theta)) \dot{q}_i(\theta) \geqslant 0. \tag{13}$$

Incentive feasible allocations must also satisfy the usual participation constraint (3).

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

$$\max_{\{q_i(.), t_i(.)\}} \int_{\underline{\theta}}^{\overline{\theta}} t_i(\theta)\, d\theta \equiv \int_{\underline{\theta}}^{\overline{\theta}} \left\{ p_i(\theta, e_i(\theta), e_{-i}(\theta), q_i(\theta), q_{-i}(\theta)) q_i(\theta) - \frac{\psi}{2} e_i^2(\theta) - U_i(\theta) \right\} d\theta$$

subject to (11), (12), (13) and (3).

Assuming that $1 + \sigma \dot{e}_{-i}(\theta) - \rho \dot{q}_{-i}(\theta)$ remains positive for all θ — a condition to be also checked ex post — $U_i(\theta)$ is increasing and thus (3) binds again at $\underline{\theta}$ only. Hence, we get:

$$U_i(\theta) = \int_{\underline{\theta}}^{\theta} (1 + \sigma \dot{e}_{-i}(x) - \rho \dot{q}_{-i}(x)) q_i(x) dx. \tag{14}$$

Again, the retailer's rent depends on the steepness of its rival's effort and output and it does exactly as under RPM as it can be seen from replacing $q_i(x)$ with $\psi e_i(x)$ into (14) and identifying with the expression of the rent given under RPM in (4).

Integrating by parts the expression of the expected rent left to R_i and neglecting the second-order condition (13) yields the following relaxed program $(\mathcal{P}_i^Q)$:

$$\max_{\{q_i(.), e_i(.)\}} \int_{\underline{\theta}}^{\overline{\theta}} (p_i(\theta, e_i(\theta), e_{-i}(\theta), q_i(\theta), q_{-i}(\theta)) q_i(\theta) - \frac{\psi}{2} e_i^2(\theta) \\ - \left(\overline{\theta} - \theta\right) (1 + \sigma \dot{e}_{-i}(\theta) - \rho \dot{q}_{-i}(\theta)) q_i(\theta)) d\theta$$

subject to (11).

Optimizing pointwise yields the following first-order condition for the equilibrium output:

$$\theta + \frac{q_i(\theta)}{\psi} + \sigma e_{-i}(\theta) - 2q_i(\theta) - \rho q_{-i}(\theta) - \left(\overline{\theta} - \theta\right)(1 + \sigma \dot{e}_{-i}(\theta) - \rho \dot{q}_{-i}(\theta)) = 0. \tag{15}$$

In contrast with the laissez-faire regime, effort is now chosen efficiently by the retailer. Indeed, the retailer fully internalizes the impact of his effort choice on the downstream profit: he oversupplies effort relative to RPM (everything else being equal). Still, the first-order condition (15) shows that output must be downward distorted for rent extraction purposes. For any given quantity specified by the direct revelation mechanism QF, R_i gains flexibility under a quantity-fixing arrangement since he chooses now optimally his effort level. More specifically, while choosing the optimal effort level, the retailer does not internalize the impact of his effort on the information rent given up by the upstream manufacturer. Asymmetric information introduces de facto a vertical externality between the manufacturer and his retailer which is induced by the choice of a QF regime. Summarizing, we can state:

Lemma 3 *When RPM is banned, the retailer's level of effort is chosen efficiently conditionally on the equilibrium output. The output is downward distorted for rent-extraction reasons.*

In a symmetric equilibrium, the output schedule is described by the following system of differential equations:

$$\theta + (1+\sigma)e^Q(\theta) - (2+\rho)\, q^Q(\theta) = \left(\overline{\theta} - \theta\right)(1 + \sigma \dot{e}^Q(\theta) - \rho \dot{q}^Q(\theta)), \tag{16}$$

$$q^Q(\theta) = \psi e^Q(\theta), \tag{17}$$

with the boundary conditions $q^Q(\overline{\theta}) = q^*(\overline{\theta})$ and $e^Q(\overline{\theta}) = e^*(\overline{\theta})$ — i.e., there is again no distortion for the highest level of demand. Again, looking for the (unique) linear equilibrium, we obtain:

$$q^Q(\theta) = q^*\left(\overline{\theta}\right) - \frac{2\psi\left(\overline{\theta} - \theta\right)}{2\psi(1+\rho) - (1+2\sigma)},$$

and

$$e^Q(\theta) = e^*\left(\overline{\theta}\right) - \frac{2\left(\overline{\theta} - \theta\right)}{2\psi(1+\rho) - (1+2\sigma)}.$$

When Assumption 1 holds, the equilibrium effort and output are below their complete information levels: $q^Q(\theta) \leq q^*(\theta)$ and $e^Q(\theta) \leq e^*(\theta)$ for each θ (with equality at $\overline{\theta}$ only) and the second-order condition (13) holds. Similarly, with Assumption 2, the equilibrium output and effort remain non-negative.

5 Comparative Statics and Consumer Welfare

The goal of this section is to describe the impact of the two legal regimes characterized above on consumers. As will soon become clear, the comparison of the levels of effort in both regimes is a key driver of our results.

Proposition 1 *A ban on RPM spurs the equilibrium effort relative to laissez-faire.*

To explain that RPM reduces the equilibrium effort relative to the laissez-faire regime, remember that under QF retailers fully internalize the impact of their efforts in improving own demand and downstream profit: a demand-enhancing effect. Under RPM, a given manufacturer is better able to infer his retailer's non-market activities by looking at the observed price and the quantities of intermediate goods sold to that retailer. The retailer no longer fully internalizes the impact of his effort's contribution on downstream profit and the demand-enhancing effect disappears which leads to less provision of the non-verifiable effort.

Instead, the ranking of equilibrium quantities turns out to be ambiguous.

Proposition 2 *A ban on RPM spurs the equilibrium quantity relative to laissez-faire if effort has a cooperative value ($\sigma > 0$), and the opposite is true otherwise ($\sigma < 0$). Both legal regimes deliver the same quantities if there are no effort externalities ($\sigma = 0$).*

A ban on RPM has the following effects on the equilibrium quantity. First, as just explained, for any given output level, each retailer R_i will exert more effort under QF relative to RPM: a *demand-enhancing* effect which increases quantities. Second, since final output is the only screening instrument available under QF, each manufacturer M_i reduces it downward for rent extraction reasons: a *rent-extraction* effect. Finally, because effort generates demand spillovers, the output of R_{-i} is shifted upward when efforts have a cooperative value and downward when they are selfish: a *horizontal externality* effect.

When there are no externalities ($\sigma = 0$) the horizontal externality effect is absent. The demand-enhancing and the rent-extraction effects exactly compensate each other in this environment with a quadratic disutility of effort and linear demand, exactly as in Martimort and Piccolo (2007). Roughly, a manufacturer who can control both the retail price and the quantity sold by his retailer keeps some indirect control over the retailer's effort. Putting a ban on RPM forces a manufacturer to give up any such control. As a result, the retailer increases his effort to boost own demand and therefore enjoys a higher information rent. Anticipating this demand-enhancing effect, the manufacturer further reduces output for rent-extraction reason, in such a way that these two effects just compensate each other precisely when there are no non-market externalities.

Hence, as long as σ is different from 0, the difference between quantities in the two legal regimes is determined only by the horizontal externality effect. When effort is cooperative a ban on RPM stimulates production since it magnifies the positive externalities between retailers — i.e., increasing the effort of one retailer leads his opponent to increase his own effort as well because the game features strategic complementarities in effort. The increase in efforts then boosts own demand and thus leads to a higher equilibrium quantity. The opposite obtains with negative externalities.

Building on these results we now study whether the Chicago School argument, which claims that RPM should be lawful per se, is still vindicated under asymmetric information and competing hierarchies. This approach takes as main welfare criterion consumer surplus[16] and its basic economic insight rests on the following simple idea: as long as manufacturers choose to control retail prices, consumers cannot be hurt because upstream profit maximization necessarily requires avoiding any source of double marginalization.

This conjecture has been confirmed by Gal-Or (1991a) in a related model that entails a single manufacturer/retailer pair, also adverse selection but no moral hazard. When there is no moral hazard downstream, contracting on price and quantities through RPM allows manufacturers to infer perfectly the value of demand and to enforce de facto the complete information outcome. In such a model, consumers prefer a laissez-faire regime as well. This is because, in the absence of vertical price control, prices would be excessively high owing to the input supply distortions induced by asymmetric information. The results of Gal-Or (1991a)'s model can be easily obtained in our framework also by making effort infinitely costly; the limiting case where ψ gets to infinity. Summarizing, we get:

Lemma 4 (Extension of Gal-Or, 1991a) *When retailers do not exert effort, manufacturers extract all information rent from retailers with RPM. A laissez-faire regime always makes consumers better off relative to a ban on RPM.*

When manufacturers cannot control retail prices, the standard rent extraction/efficiency trade-off drives prices up for screening reasons. The quantity is downward distorted and consumers are worse off relative to laissez-faire which delivers the complete information outcome.

Yet, when the retailers' effort becomes important, the above prediction is no longer true. Although manufacturers find it a dominant strategy to choose RPM whenever it is allowed, double marginalization remains with RPM as shown in the first-order conditions (8) and (16). Moreover, this double marginalization increases (resp. decreases) when retail non-market externalities are positive (resp. negative). The following proposition summarizes the result:

Proposition 3 *A ban on RPM harms consumers if effort has a selfish value ($\sigma < 0$), and the converse is true in the cooperative case ($\sigma > 0$). If there are no effort externalities ($\sigma = 0$) consumers are indifferent between the two legal regimes.*

The economic intuition of this result is straightforward. First, consumers' well-being is only shaped by retailers' output supply. Second, as shown in Proposition 3, the sign of effort externalities

[16] Many scholars have indeed advocated that the sole role of Antitrust policies should be to promote consumers' surplus. See Bork (1978, Chapter 2, pp. 51) for instance.

is key to sign the difference between equilibrium quantities under the two legal regimes. As discussed earlier, positive externalities between retailers might describe instances where effort captures pre-sale services or generic advertising as information on the product's existence benefits also competitors. In these cases forbidding RPM increases consumer surplus because it leads to higher aggregate effort which, in turn, encourages retailers to expand production. Differently, indivisible services bundled with the final product might capture the case of negative externalities. In these instances retail price restrictions would benefit consumers because they mitigate the 'business stealing effect' that works through the retail promotional and advertising channel, which is precisely what limits retailers' equilibrium production choices in a regime forbidding vertical control.

It is interesting to notice that per se rules would be suboptimal in our model. One might in fact wonder whether manufacturers and consumers have congruent preferences over contractual regimes in the set-up developed above. Specifically, is it possible to show that whenever manufacturers jointly prefer laissez-faire to a ban on RPM, consumers also prefer the laissez-faire regime and *vice versa*? Next proposition shows that this is not typically true. There exists a non empty region of parameters where a laissez-faire policy would fail to maximize consumers surplus.

Proposition 4 *Manufacturers' and consumers' preferences are not always aligned over legal regimes. In particular, when consumers prefer a ban on RPM ($\sigma > 0$) manufacturers would jointly gain from vertical price control if σ is not too large.*

This result suggests that the conclusions about the desirability of a laissez-faire attitude in environments with asymmetric information should be at least taken with a word of caution with competing vertical chains and when retailers exert non-market externalities one on another. The fact that manufacturers prefer RPM for σ positive and not too large hinges on the simple idea that whatever other supply chains are doing and whether these pairs are using RPM or not, a given manufacturer would always want to expand the means of controlling his retailer, so as to limit his information rent. Using both controls — i.e., on retail price and output — allows indeed to better track the retailer's effort that, in turn, stifles his rent. When comparing equilibrium profits with and without a ban on RPM, this effect is of first magnitude. Even though the contract offered by the competing pair changes as we compare legal regimes, this effect drives the manufacturers' preferences over legal regimes when the profit enhancing effect of the positive non-market externalities (that is amplified under a ban on RPM) is negligible — i.e., when σ is not too large.

6 Conclusion

We developed a simple model of competing supply chains with asymmetric information to show that downstream non-market externalities can play an important role in determining the welfare effects of different legal approaches towards RPM. Our results undermine the view that vertical price fixing stifles double marginalization when retailers have privileged information relative to manufacturers.

Although developed in a very specific setting, our results are robust to a number of extensions. First, our predictions remain qualitatively the same with: (i) nonlinear demands and small uncertainty, or (ii) non-uniform distributions of demand shocks and small support of types. Indeed, our results would be obtained in the limiting case where Taylor expansions are valid.

Second, as explained in the Appendix, although we focused on substitute goods, our results go through with complements — i.e., when $\rho < 0$. Indeed, the existence of linear equilibria in both contractual regimes does not rely on the sign of the market externalities.[17] Neither the output comparisons between the two regimes nor the welfare comparison change.

Third, introducing intrabrand competition simplifies significantly the analysis but it also voids it of its interest. Indeed, if different retailers sell the same product on behalf of a given manufacturer and face the same demand — i.e., there is no exclusive territories constraint — the latter can use the reports of those two retailers on their common demand to cross-check their announcements in the tradition of the implementation literature. Each manufacturer could thereby extract all surplus from each retailer and implement the complete information outcome. This is so irrespective of the contractual mode. The question of whether RPM should be banned or not is not even relevant (at least from a theoretical viewpoint).

Finally, consider the possibility that each retailer contracts with both manufacturers at the same time — i.e., common agency. Although such an extension is beyond the scope of the paper, some interesting considerations can be made already here without being too specific about the game form that induces such complex contractual arrangements. Martimort (1996) shows that when goods are substitutes ($\rho > 0$) both principals would prefer to have exclusive dealings rather than contracting with a common agent, in this case our analysis would not change. By contrast, if goods are complements ($\rho < 0$), dealing with a common agent might be preferred to exclusive dealing contracts. Is our mechanism still at play in such cases? The answer to this question typically depends on the type of equilibria that emerge — e.g., equilibria where only one retailer is active with both manufacturers or those where both retailers are active and each deals with both manufacturers. In the first case, we do believe that our insights would, to some extent, carry over. Contracting on retail price has to reduce the effort for rent-extraction reasons even in a common agency model and this reduction in effort will impact the produced quantity through non-market externalities. Clearly, there might be also other forces at play, but our conjecture is that the sign of the non-market externalities will be still relevant to study the impact of vertical price control on consumers. Equilibria where both retailers are active and each deals with both principals are likely to be easily characterized because, again, under the hypothesis of perfect correlation between types, each manufacturer can fully extract the retailers' rent by pitting one retailer against the other at the revelation stage. This would lead again to the uninteresting case of complete information so as

[17] As shown in Martimort (1996) in a related model, there may exist a continuum of symmetric of equilibria with nonlinear outputs in the case of complements but only the linear one is robust to significant perturbations of the spread of demand uncertainty.

to void the question addressed by the paper of its interest.

In conclusion, although we acknowledge that introducing RPM in a common agency framework could severely complicate the analysis, our conjecture is that the non-market externality channel will still matter in the welfare analysis. We hope to address these questions more carefully in future research.

7 Appendix

Proof of Lemma 1. The proof is immediate from the text. ■

Market equilibrium with laissez-faire. Using (7) and (8), differentiating w.r.t. θ we obtain:

$$\dot{q}^P = \frac{2\psi}{2\psi\left(1+\rho-\sigma\right)-\left(1+\sigma\right)} \quad \text{and} \quad \dot{e}^P = \frac{2\psi+1}{2\psi\left(1+\rho-\sigma\right)-\left(1+\sigma\right)}, \tag{18}$$

monotonicity is then guaranteed under Assumption 1 since $\dot{q}^P > 0$ and $\dot{e}^P > 0$ if

$$\psi > \frac{1+\sigma}{2(1+\rho-\sigma)}.$$

Using (18) we then obtain:

$$1+\sigma\dot{e}^P-\rho\dot{q}^P = \frac{\left(1+2\sigma\right)\left(2\psi-1\right)}{2\psi\left(1+\rho-\sigma\right)-\left(1+\sigma\right)},$$

which is positive when Assumption 1 holds.

Now, the slope of the complete information allocation is:

$$\dot{q}^* = \frac{\psi}{\psi(2+\rho)-(1+\sigma)} \quad \text{and} \quad \dot{e}^* = \frac{1}{\psi(2+\rho)-(1+\sigma)},$$

with $\dot{q}^* > 0$ and $\dot{e}^* > 0$ since $\psi > (1+\sigma)/(2+\rho)$ by Assumption 1. Moreover, notice that since $q^P(\overline{\theta}) = q^*(\overline{\theta})$, the inequality $\dot{q}^P > \dot{q}^*$ must imply $q^P(\theta) \leq q^*(\theta)$ for all $\theta \leq \overline{\theta}$ with equality at $\overline{\theta}$ only. Simple algebra in fact yields:

$$\dot{q}^P - \dot{q}^* = \frac{\left(2\psi-1\right)\left(1+\sigma\right)\psi}{(\psi(2+\rho)-(1+\sigma))(2\psi\left(1+\rho-\sigma\right)-\left(1+\sigma\right))},$$

which directly delivers the result since, from Assumption 1, we have $\psi > 1/2$. By using the same argument, one also has $e^P(\theta) \leq e^*(\theta)$ for all $\theta \leq \overline{\theta}$ with equality at $\overline{\theta}$ only. Finally, notice that for $\Delta\theta$ small enough (i.e., Assumption 2), effort and output are positive. Showing that, under Assumption 1, the global incentive constraint is met follows the arguments developed in Martimort (1996) and will be thus omitted.

Note that this characterization does not depend on ρ, so it remains true also if goods are complements under Assumption 1 — i.e., $\rho < 0$. ■

Proof of Lemma 2. The proof follows from the expressions of $q^P(\theta)$ and $e^P(\theta)$. ■

Market equilibrium with ban on RPM. Differentiating (16) and (17) w.r.t. θ one obtains:

$$\dot{q}^Q = \frac{2\psi}{2\psi(1+\rho)-(1+2\sigma)} \quad \text{and} \quad \dot{e}^Q = \frac{2}{2\psi(1+\rho)-(1+2\sigma)},$$

which satisfy the monotonicity condition since, by Assumption 1, $\psi > \frac{1+2\sigma}{2(1+\rho)}$.

Also observe that

$$1+\sigma\dot{e}^Q - \rho\dot{q}^Q = \frac{2\psi - 1}{2\psi(1+\rho)-(1+2\sigma)} > 0,$$

when Assumption 1 holds. Moreover, simple algebra yields:

$$\dot{q}^Q - \dot{q}^* = \frac{(2\psi-1)\,\psi}{(2\psi(1+\rho)-(1+2\sigma))\,(\psi(2+\rho)-(1+\sigma))} > 0,$$

and the same logic used before immediately implies $q^Q(\theta) \leq q^*(\theta)$ for all θ with equality at $\overline{\theta}$ only. A similar argument allows to verify that $e^Q(\theta) \leq e^*(\theta)$ for all θ with equality at $\overline{\theta}$ only. Finally, $\mathcal{P}_i^Q$ has interior solutions whenever $\Delta\theta$ is small enough, that is, under Assumption 2. Global incentive compatibility can be proved as in Martimort (1996).

Again, this characterization does not change with complements under Assumption 1. ■

Proof of Lemma 3. The proof follows from the expressions of $q^Q(\theta)$ and $e^Q(\theta)$. ■

Proof of Proposition 1. Taking the difference between $e^Q(\theta)$ and $e^P(\theta)$, one gets:

$$e^Q(\theta) - e^P(\theta) = \frac{(2\psi(1+\rho)-1)\,(2\psi-1)\left(\overline{\theta}-\theta\right)}{(2\psi(1+\rho-\sigma)-(1+\sigma))\,(2\psi(1+\rho)-(1+2\sigma))}, \quad \forall\, \theta \in \Theta,$$

which immediately proves the result since $\psi > 1/2$ when Assumption 1 holds. Note that the sign of the above expression does not depend on ρ under Assumption 1, so the result remains true also if goods are complements — i.e., $\rho < 0$. ■

Proof of Proposition 2. Taking the difference between $q^Q(\theta)$ and $q^P(\theta)$, one gets:

$$q^Q(\theta) - q^P(\theta) = \frac{2\sigma\psi(2\psi-1)\left(\overline{\theta}-\theta\right)}{(2\psi(1+\rho)-(1+2\sigma))\,(2\psi(1+\rho-\sigma)-(1+\sigma))}, \quad \forall\, \theta \in \Theta.$$

which immediately proves the result since $\psi > 1/2$ when Assumption 1 holds. Note that the sign of the above expression does not depend on ρ under Assumption 1, so the result remains true also if goods are complements — i.e., $\rho < 0$. ■

Proof of Lemma 4. Observe that, when ψ goes to $+\infty$, we obtain $q^P(\theta) = q^*(\theta)$ and $e^P(\theta) = e^*(\theta) = 0$ for all θ. Hence, RPM allows to achieve the complete information outcome in each manufacturer/retailer hierarchy. The result then follows immediately. ■

Proof of Proposition 3. Remember that demands are those of a representative consumer whose preferences are:

$$V(q_1, q_2, I, \theta) = \sum_{i=1,2} e_i(q_i + \sigma q_{-i}) + \theta \sum_{i=1,2} q_i - \frac{1}{2} \sum_{i=1,2} q_i^2 - \rho q_1 q_2 + I.$$

It is immediate to derive the consumer surplus when his type is θ as

$$C^s(\theta) = (1+\rho)\left[q^s(\theta)\right]^2, \quad \text{where } s \in \{Q, P\},$$

then, taking expectations over θ and using Proposition 2 yields the result. Again since the result in Proposition 2 does not depend on the sign of ρ under Assumption 1. Hence, also this result does not depend on whether goods are complements or substitutes. ■

Proof of Proposition 4. To show this result it is enough to verify that there exists a non-empty region of parameters where manufacturers prefer one legal regime while consumers prefer the other. First, recall that:

$$\pi^P = \mathrm{E}_\theta\left[p(\theta, e^P(\theta), e^P(\theta), q^P(\theta), p^P(\theta))q^P(\theta) - \frac{\psi}{2}\left(e^P(\theta)\right)^2 - \psi\left(\overline{\theta} - \theta\right)(1 + \sigma\dot{e}^P(\theta) - \rho\dot{q}^P(\theta))e^P(\theta)\right],$$

and

$$\pi^Q = \mathrm{E}_\theta\left[p(\theta, e^Q(\theta), e^Q(\theta), q^Q(\theta), q^Q(\theta))q^Q(\theta) - \frac{\psi}{2}\left(e^Q(\theta)\right)^2 - \left(\overline{\theta} - \theta\right)(1 + \sigma\dot{e}^Q(\theta) - \rho\dot{q}^Q(\theta))q^Q(\theta)\right].$$

Then, using the first order condition (8), one then has:

$$\frac{\psi}{2}\left(e^P(\theta)\right)^2 + \psi\left(\overline{\theta} - \theta\right)(1 + \sigma\dot{e}^P(\theta) - \rho\dot{q}^P(\theta))e^P(\theta) = q^P(\theta)\,e^P(\theta) - \frac{\psi}{2}\left(e^P(\theta)\right)^2,$$

by the same token, (16) implies:

$$p(\theta, e^Q(\theta), e^Q(\theta), q^Q(\theta), q^Q(\theta))q^Q(\theta) - \left(\overline{\theta} - \theta\right)(1 + \sigma\dot{e}^Q(\theta) - \rho\dot{q}^Q(\theta))q^Q(\theta) = \left(q^Q(\theta)\right)^2.$$

Since $p^P(\theta) = q^P(\theta)$, the manufacturers' expected profit under "laissez-faire" is:

$$\pi^P = \frac{1}{\Delta\theta}\int_{\underline{\theta}}^{\overline{\theta}}\left[\left(q^P(\theta)\right)^2 - q^P(\theta)\,e^P(\theta) + \frac{\psi}{2}\left(e^P(\theta)\right)^2\right] d\theta.$$

Under a ban on RPM we have instead:

$$\pi^{Q}=\frac{1}{\Delta\theta}\int_{\underline{\theta}}^{\overline{\theta}}\left[\left(q^{Q}\left(\theta\right)\right)^{2}-\frac{\psi}{2}\left(e^{Q}\left(\theta\right)\right)^{2}\right]d\theta,$$

then, assuming $\sigma=0$ — i.e., no externality, one immediately obtains:

$$\pi^{P}-\pi^{Q}\big|_{\sigma=0}=\frac{\psi\Delta\theta^{2}\left(2\psi-1\right)^{2}}{6\left(2\psi(1+\rho)-1\right)^{2}}>0. \tag{19}$$

Since the difference $\pi^{P}-\pi^{Q}$ is continuous in σ, this implies that manufacturers would jointly prefer a regime with laissez-faire in a neighborhood of $\sigma=0$, hence also for σ positive but not too large. But, as seen in Proposition 3, consumers strictly prefer a ban on RPM for $\sigma>0$. Hence the result on their conflicting preferences.

Note also that the sign of (19) does not depend on ρ, so the result remains true also for complements — i.e., $\rho<0$. ■

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