"When Should Manufacturers Want Fair Trade?": New Insights from Asymmetric Information*

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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, externalities.

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1 Introduction

When retailers are privately informed about relevant aspects of their market, the wedge between wholesale prices and marginal costs is determined by the fundamental trade-off between efficiency and rent extraction that uninformed upstream manufacturers face when designing wholesale contracts. Information rent minimization requires cutbacks on the supply of intermediate inputs, whereby creating excessive upward price distortions which penalize final consumers. The size of those distortions and, in turn, the welfare properties of alternative forms of vertical arrangements depend on the "screening power" of the contractual instruments that manufacturers might use to induce information revelation by their retailers.

Building on this idea, a recent trend of the vertical contracting literature has studied the welfare effects of various vertical arrangements (for instance resale price maintenance or quantity forcing) in settings where downstream units have privileged access to market information relative to their suppliers. Stemming from Gal-Or (1991a), this agency literature has attempted to rationalize the Chicago School conjecture, arguing that resale price maintenance should be per se legal, by showing that, under incomplete information, retail price restrictions improve the screening ability of manufacturers, whereby stifling input supply distortions and thus double marginalization.

This insight has been developed mainly in a framework where a given manufacturer/retailer pair is taken in isolation. Therefore, existing models neglect competition by other manufacturers-retailers pairs. More specifically, the existing literature is mute on the interplay between asymmetric information and the nature of retailers' non-market activities and, perhaps more importantly, on the question of whether vertical price control is desirable for consumers once downstream externalities across retailers are taken into account.

The objective of this paper is to study a simple example clarifying what are the welfare effects of resale price maintenance (RPM) on consumer surplus in a framework that allows for asymmetric information, non-market externalities among retailers and competing manufacturer-retailer hierarchies. Although specific to a particular model, such investigation identifies quite clearly the strategic role that the choice of resale price maintenance may have on competing hierarchies. In a nutshell, adopting or not such a practice in a given hierarchy certainly improves screening and mitigates the negative impact on consumers of the asymmetric information that generates double marginalization. But, on the other hand, it alters the nature of competition between retailers and has thus also consequences on the equilibrium level of non-market services they supply. By analyzing this simple trade-off, our results shed new light on the welfare effects that different forms of vertical price fixing regulation produce on consumers.

In our model, retailers privately observe downstream demands and exert unverifiable promotional efforts which create horizontal externalities. Two legal regimes are compared: one where resale price maintenance is allowed ("laissez-faire"); the other where this practice is forbidden (ban on RPM).

To understand the logic behind our model and the impact of various contractual regimes with or without a ban on RPM, it is useful to come back on the source of the agency problem faced by manufacturers when dealing with retailers in an asymmetric information context. First, a typical wholesale contract will ask the retailer to pay some fee to get access to the right of selling the manufacturer's product. Given that the manufacturer has all bargaining power in designing this contract, that fee is set to extract as much as possible of the retailer's downstream profit. Of course, this fee is smaller when demand is low and downstream profit small. This creates incentives for a retailer to pretend that downstream demand is lower than it really is, so that he pays a lower fee and grasps some information rent.

Different contractual arrangements will obviously affect this rent through different channels. Consider first a ban on RPM. Retailers enjoy higher rents when vertical price fixing is forbidden relative to the "laissez-faire" regime. Under this regime, because non-market activities (after-sale services, promotional efforts, advertising etc.) are non-verifiable, retailers become residual claimants for the impact of their efforts in improving own demand. 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. However, boosting own demand makes it also more valuable for a retailer to manipulate information. Extracting the retailer's information rent requires strong distortions of the wholesale contract, which reduces the retailer's demand and in turn dampens the level of his non-verifiable effort: a *rent-extraction* effect that pushes effort down. Of course, in an environment with competing manufacturer-retailer pairs, these two effects must be complemented by strategic considerations. An increase in effort by a retailer in a rival pair generates cross-demand spillovers through downstream externalities, whereby influencing own production and effort and, in turn, the surplus consumers enjoy at equilibrium: a third *strategic* effect to be considered.

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 is no longer residual claimant for his effort and the demand-enhancing effect disappears which leads to less provision of the non-verifiable effort.[1] This in turn will reduce downstream externalities in a strategic context.

The impact of the choice of a particular legal regime on equilibrium quantities depends, of course, on the nature of non-market externalities and their impact on strategic considerations between different manufacturer-retailer pairs. If downstream non-market 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 effort of the rival and thus own demand through a non-market externalities channel. In summary, when non-market externalities are positive a laissez-faire regime limits the non-market complementarities between the competing retailers, whereby stifling equilibrium quantities. If these spillovers are instead negative, allowing for vertical price control enables suppliers to limit negative externalities between retailers so as to promote productive efficiency.

Building on these insights we revisit the conventional theory supporting the view that RPM should enhance consumer surplus in environments with asymmetric information.[2] A "laissez-faire" approach harms consumers as long as retailers non-market activities are *cooperative*, i.e., when the effort of a given retailer also improves the demand of his competitors. Under those circumstances, the need for rent extraction prevents suppliers from exploiting the positive externalities between their retailers, whereby harming consumers. In case these externalities are negative, instead, equilibria where retailers exert more effort are also those where they produce less because larger effort by one outlet means lower demand for his competitor. Then, vertical price control is beneficial to consumers insofar as it mitigates the "business stealing effect" that works through the promotional channel.

Finally, besides providing some new predictions on the circumstances where retail

[1] **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.**

[2] **See for instance Gal-Or (1991a)**.

price restrictions should be more likely to harm consumers, our model also shows that suppliers' and consumers' preferences are not always aligned on the use of vertical price restrictions. This result underscores the scarce appeal of per se rules in games of competing hierarchies as opposed to what happens in the sequential monopoly framework analyzed in Gal-Or (1991a) and Martimort and Piccolo (2007).

Section 2 reviews the earlier literature on the topic and discusses the main differences between us and those papers. Section 3 sets up the model and provides a benchmark where there is complete information. We characterize the incentive feasible allocations under each legal regime in Section 4. Some comparative statics and welfare results are derived in Section 5. Section 6 concludes and proposes various robustness checks. Proofs are in the appendix.

2 Related Literature

Stemming from the pioneering papers by Spengler (1950) and Telser (1960), the theoretical literature on vertical control has offered contrasted views on the opportunity of banning resale price maintenance. The key insight of this literature is the so-called "double marginalization" effect: The inability to use the appropriate restraints to eliminate (or reduce) retailers' rents generates excessive distortions along the production chain, whereby hurting final consumers. In these instances, vertical price fixing has a beneficial role insofar as it eliminates double margins and increases consumers' surplus as well as suppliers' profits at the expense of downstream outlets. This result has been mainly shown under the simplifying hypotheses of linear (wholesale) contracts and complete information. Yet, once manufacturers are allowed to use two-part tariffs, vertical price fixing might lose much of its beneficial role.[3] In other words, an open question is to understand whether the lessons of the complete information literature are due to an a priori (and often unjustified) restriction on the set of feasible contracts, or whether those findings are robust to a better-founded modeling of the "double marginalization problem" based on asymmetric information in manufacturer-retailer pairs as a justifi-

[3] In the basic successive monopolies setting, suppliers could remove double margins simply by pricing the input at marginal costs, and recouping downstream profits by way of a lump-sum fee (see the textbook treatments in Motta, 2004, Ch. 6 and Tirole, 1988, Ch. 4).

cation for limits on the set of feasible contracts.[4]

In a nutshell, when retailers are privately informed on some relevant aspects of their activity, double margins stem from the trade-off between efficiency and rent extraction that uninformed suppliers face when designing wholesale contracts. As argued by Gal-Or (1991a), nonlinear wholesale prices no longer suffice to eliminate downstream rents and double marginalization under asymmetric information. Vertical price control could then play a novel efficiency role insofar as it helps suppliers to better extract retailers' rents, so to relax incentive problems and promote productive efficiency. While under complete information there is no reason a priori to restrict the use of fixed-fees as a mean to extract the retailer's downstream profit, asymmetric information endogenizes the limits on the ability of upstream manufacturers to capture downstream profit, thus providing scope for using more sophisticated wholesale contracts. Essentially, as long as vertical price fixing provides an additional screening instrument, a "laissez-faire" approach cannot harm consumers.

Our analysis complements earlier contributions by Gal-Or (1991a) and Martimort and Piccolo (2007). As we do here, Martimort and Piccolo (2007) studied contracts with and without RPM for manufacturer-retailer pairs in contexts where downstream effort is non-verifiable effort and adverse selection is a concern. Contrary to the present paper, they considered only such pairs taken in isolation and neglected the downstream strategic considerations that arise when non-market externalities are present. In such framework, they provided a justification for the Chicago school approach: Whenever RPM is privately optimal for the vertical structure, it also enhances consumer welfare. However, their main conclusion depends upon fine details of the convexity or concavity of the marginal disutility of effort. As a corollary, one striking result is that the two contractual regimes are equivalent when the retailer's disutility of effort is quadratic and demand is linear. This neutrality is precisely our starting point for introducing strategic considerations and test whether the Chicago School recommendations are vindicated in those strategic contexts. This allows us to nail down an unbiased example where the link between downstream non-market externalities, consumer surplus and vertical

[4]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 and driven by asymmetries of information rather than linear wholesale pricing.

control depends exclusively on the nature of downstream competition.[5] Our model studies for the first time the role that non-market externalities across retailers have on optimal contracting with and without vertical price fixing. This allows us to show that previous conclusions about the validity of the Chicago School argument in environments with asymmetric information should be at least taken with a word of caution when competitive forces kick in.

Finally, it is interesting to compare our result concerning the impact of RPM on retailers' promotional effort to the earlier vertical contracting literature analyzing 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. As discussed above, there is one major difference between this latter view and ours. While we do allow for nonlinear contracts, which 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. 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 cutting back the costly non-market services so as to reduce prices and poach the whole demand. In equilibrium, the market will be completely dominated by homogeneous no-service outlets. 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, once again, on the double marginalization effect generated by linear pricing: retailers free-ride on one 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.

[5]Of course, we do acknowledge that more generally both types of forces, the strategic considerations emphasized here and those underlined in Martimort and Piccolo (2007) might be at play.

3 The Model

Industry. Consider a downstream industry where two retailers, R_1 and R_2, compete by selling differentiated goods. 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 supplier, S_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 make the analysis as simple as possible for our purposes, 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. 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

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

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

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 we denote by $\Psi(e_i) = \psi e_i^2/2$ the quadratic disutility of effort incurred by retailer i. Finally, we assume that both upstream and downstream firms produce at constant marginal costs, which are, still for simplicity, normalized at zero. Observe that when $\rho = \sigma = 0$, the model converges to that in Martimort and Piccolo (2007) who analyzed the welfare effect of RPM in a sequential monopoly setting with asymmetric information. In this quadratic case, they showed that vertical price control has a neutral impact on consumer surplus. Our objective here is to study how this conclusion changes when both downstream product market competition and non-market externalities are simultaneously at play.

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

- *"Laissez-faire"*: Suppliers face no restrictions on the type of contracts they can enforce;
- *RPM bans*: Retail price restrictions are forbidden;

These regimes capture in the simplest possible way the kinds of vertical price control regulations that are enforced 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, in the U.S. and most OECD countries this practice is generally treated as illegal per se.

Accordingly, suppliers 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 S_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

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

contracts cannot depend on the output produced by competing retailers, for instance, because manufacturer S_i has no auditing rights to verify such information, or simply because such contingent contracts are ruled out for antitrust reasons. 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:

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

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

2. Upon observing the announced regime, each supplier offers a menu of contracts to his retailer. Contracts can be accepted or rejected. If R_i turns down S_i's offer, these two players get an outside option which, for simplicity, is normalized to zero. The pair S_{-i}-R_{-i} then acts as a sequential monopoly as long as R_{-i} accepts the offer received by S_{-i}.[8]

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. Provided R_i receives any unexpected offer from S_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 always have well-behaved programs, we shall also assume that:

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

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

[8]Clearly, in what follows, we focus on equilibria where both retailers remain active for each demand realization.

[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.

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 $\bar{\theta}$:*

$$\frac{\Delta\theta}{\overline{\theta}} \leq \frac{2\psi\,(1+\rho-\sigma)-(1+\sigma)}{(2\psi+1)\,(\psi\,(2+\rho)-(1+\sigma))}.$$

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

Complete information benchmark. 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 imposes 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 incentives 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

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, S_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 S_i to give up information rent to the retailer in order to induce information revelation. As a result, the second-best allocation will be characterized by downward distortions of both quantity and effort to reduce that rent. This 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 hierarchy'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 S_i's best response to S_{-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 $p_i(\hat{\theta}_i)$ now denotes 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

[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.

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 earlier, since suppliers do not observe which contracts have been offered by their competitors, contractual choices have no commitment role. Each manufacturer finds it thus always optimal to use all contracting variables to better screen his retailer irrespective of what the other manufacturer does. This leads to the following 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 S_i-R_i pair is straightforward (see the Appendix). Those allocations satisfy the following first- and second-order local conditions for incentive compatibility:

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

[11]Even an RPM contract is incomplete. Indeed, a given manufacturer cannot contract on the output and retail price chosen by rival hierarchies.

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

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

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. S_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:

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

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 S_{-i}-R_{-i}, the output $q_i\,(\theta)$ and effort $e_i\,(\theta)$ in S_i-R_i hierarchy are respectively given by the following first-order conditions obtained by pointwise optimization:[13]

$$q_i(\theta) = p_i\,(\theta) = \theta + e_i(\theta) + \sigma e_{-i}(\theta) - q_i(\theta) - \rho q_{-i}(\theta), \tag{4}$$

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

$$q_i(\theta) = \psi\left[e_i(\theta) + \left(\overline{\theta} - \theta\right)\left(1 + \sigma\dot{e}_{-i}(\theta) - \rho\dot{q}_{-i}(\theta)\right)\right]. \tag{5}$$

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 (4) and (5). 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, (4) implies that the pricing rule satisfies the same expression as under complete information. Output is produced according to the efficient rule conditionally on 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:

$$(2+\rho)\, q^P(\theta) = \theta + e^P(\theta)(1+\sigma), \tag{6}$$

$$q^P(\theta) = \psi\left[e^P(\theta) + \left(\overline{\theta} - \theta\right)\left(1 + \sigma\dot{e}^P(\theta) - \rho\dot{q}^P(\theta)\right)\right], \tag{7}$$

with boundary conditions $q^P(\overline{\theta}) = q^*(\overline{\theta})$ and $e^P(\overline{\theta}) = e^*(\overline{\theta})$, which specify 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:

$$q^P(\theta) = q^*(\overline{\theta}) - \frac{2\psi\left(\overline{\theta} - \theta\right)}{2\psi(1+\rho-\sigma) - (1+\sigma)}, \tag{8}$$

and

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

It is immediate to see that Assumption 1 ensures that the equilibrium features no bunching and these schedules are downward distorted with respect to the complete

[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 $\rho > 0$.

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 supplier can no longer use the retail price, only sales can be used as a screening device. This has consequences both on allocative efficiency, the retailer being now free to choose effort, and on the distribution of information rent in the manufacturer-retailer hierarchy.

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:

$$q_i(\theta) = \psi e_i(\theta). \tag{10}$$

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

$$\dot{U}_i(\theta) = (1 + \sigma \dot{e}_{-i}(\theta) - \rho \dot{q}_{-i}(\theta)) q_i(\theta), \tag{11}$$

$$(1 + \sigma \dot{e}_{-i}(\theta) - \rho \dot{q}_{-i}(\theta)) \dot{q}_i(\theta) \geqslant 0. \tag{12}$$

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

We can now rewrite S_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 (10), (11), (12) 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:

$$U_i(\theta) = \int_{\underline{\theta}}^{\theta} (1 + \sigma \dot{e}_{-i}(x) - \rho \dot{q}_{-i}(x)) q_i(x) dx. \qquad (13)$$

Integrating by parts the expression of the expected rent left to R_i and neglecting the second-order condition (12) 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 (10).

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

$$\theta + \frac{q_i(\theta)}{\psi} + \sigma e_{-i}(\theta) - 2q_i(\theta) - \rho q_{-i}(\theta) - \left(\overline{\theta} - \theta\right) (1 + \sigma \dot{e}_{-i}(\theta) - \rho \dot{q}_{-i}(\theta)) = 0. \qquad (14)$$

In contrast with the "laissez-faire" regime, effort is now chosen efficiently by the retailer. Indeed, the retailer is a residual claimant of the impact of his effort choice on his downstream profit: he oversupplies effort relative to RPM (everything else being equal). Still, the first-order condition (14) 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. QF introduces de facto a vertical externality between the manufacturer and his retailer which is induced by asymmetric information. 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:

$$\theta + (1+\sigma)e^Q(\theta) - (2+\rho)\, q^Q(\theta) = \left(\overline{\theta} - \theta\right)(1 + \sigma\dot{e}^Q(\theta) - \rho\dot{q}^Q(\theta)), \tag{15}$$

$$q^Q(\theta) = \psi e^Q(\theta), \tag{16}$$

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 there is no bunching. Similarly, 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 become residual claimants for the impact of their efforts in improving own demand: 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 is no longer a residual claimant of his effort's contribution to the surplus 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 supplier S_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 *strategic effect*.

When there are no externalities ($\sigma = 0$) the strategic 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). Hence, as long as σ is different from 0, the difference between quantities in the two legal regimes is determined only by the strategic effect. When effort is cooperative, a ban on RPM stimulates production since this legal regime magnifies the positive (negative) externalities between retailers; and the converse is true otherwise.

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 suppliers choose to control retail prices, consumers cannot be hurt because upstream profit maximization necessarily requires avoiding any source of double marginalization.

In a model entailing only adverse selection, successive monopolies, but no moral hazard, this conjecture has been confirmed by Gal-Or (1991a). When there is no moral hazard downstream, contracting on price and quantities through RPM allows suppliers to infer perfectly the value of demand and to enforce de facto the complete information

[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.

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. 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, suppliers extracts 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 suppliers find it a dominant strategy to choose RPM whenever it is allowed, double marginalization remains with RPM as shown in the first-order conditions (7) and (15). 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 rests on two simple facts: First, consumers' well being is only shaped by retailers' output supply. Second, as shown in Proposition 3, the sign of effort externalities 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 suppliers and consumers have congruent preferences over contractual regimes in the set-up developed above. Specifically, is it possible to show that whenever suppliers jointly prefer “laissez-faire” to a ban on RPM, consumers also prefer the “laissez-faire” regime and *vice versa*? The next corollary 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 *Suppliers' and consumers' preferences are not always aligned over legal regimes.*

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 when strategic considerations are at play.

6 Conclusion

This paper has developed a simple model of competing vertical hierarchies to show that retail non-market externalities play a key role in assessing the effects of different legal approaches towards RPM on consumer surplus. With competing hierarchies, the right attitude towards RPM depends on the nature of retail non-market externalities. This result undermines the view that vertical price fixing should stifle double marginalization when retailers are privately informed and suppliers can use any kind of nonlinear wholesale contracts.

Let us close this section with a brief discussion of the robustness of our results. A first line of possible extensions would consider nonlinear demands or non-uniform distribution of demand shocks. Clearly, as long as demand uncertainty is small enough, demand may be well approximated as being linear and a uniform distribution is a relevant approximation. Indeed, all our results would then be obtained in the limiting case where Taylor expansions are valid.

Although we have focused on the case of substitute goods, our results go through when goods are complements ($\rho < 0$).[17] Indeed, the existence of linear equilibria in both contractual regimes does not rely on the sign of the market externalities.[18] Neither the output comparisons between the two regimes nor the welfare comparison changes. The key point of the paper, that is, the fact that the sign of the non-market downstream externalities determines the impact of vertical price control on the consumer surplus remains.

Introducing intra-brand competition would also simplify significantly the analysis and voids it of much of its interest. Indeed, if different retailers sell the same product on behalf of a given manufacturer and face the same demand (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 the retailers and implement the complete information outcome for his own hierarchy. 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 so that common agency emerges. Although such an extension would go far beyond the scope of the paper, some interesting considerations can be made already at this stage even without being too specific about the game form that induces such complex contractual arrangements. From Martimort (1996), we know that in the case where goods are substitutes ($\rho > 0$) both principals would prefer to have exclusive dealings rather than contracting with a common agent, so that our analysis would not change. If goods are complements ($\rho < 0$), instead, dealing with a common agent might be preferred to exclusive dealings. Is our mechanism still at play in such cases? The answer to this question typically depends on the type of equilibria that emerge: for instance, 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

[17] See the Appendix.

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

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 care likely to be easily characterized because, again, under the hypothesis of perfect correlation between types, each manufacturer can then 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 and, again voids the question addressed by this 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 (6) and (7), differentiating w.r.t. θ we obtain:

$$\dot{q}^P = \frac{2\psi}{2\psi\left(1+\rho-\sigma\right)-\left(1+\sigma\right)} \quad \text{and} \quad \dot{e}^P = \frac{2\psi+1}{2\psi\left(1+\rho-\sigma\right)-\left(1+\sigma\right)}, \tag{17}$$

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 (17) 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:

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

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. ■

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 (15) and (16) 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). ■

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. ■

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. ■

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. ■

Proof of Proposition 4. To show this result it is enough to verify that there exists a non-empty region of parameters where suppliers 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 (7), 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, (15) 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 suppliers' expected profit under "laissez-faire" is:

$$\pi^P = \frac{1}{\Delta\theta}\int_{\underline{\theta}}^{\overline{\theta}} \left[\left(q^P(\theta)\right)^2 - q^P(\theta)\, e^P(\theta) + \frac{\psi}{2}\left(e^P(\theta)\right)^2 \right] d\theta. \tag{18}$$

Under a ban on RPM we have instead:

$$\pi^Q = \frac{1}{\Delta\theta}\int_{\underline{\theta}}^{\overline{\theta}} \left[\left(q^Q(\theta)\right)^2 - \frac{\psi}{2}\left(e^Q(\theta)\right)^2 \right] d\theta, \tag{19}$$

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

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

Since the difference $\pi^P - \pi^Q$ is continuous in σ, this implies that suppliers would jointly prefer a regime with laissez-faire in a neighborhood of $\sigma = 0$. But, as seen in Proposition 7, consumers strictly prefer a ban on RPM for $\sigma > 0$. Hence the result. ■

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