

On the Antitrust Economics of the Electronic Books Industry*

Germain Gaudin[†] Alexander White[‡]

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Abstract

When Apple entered the ebook market, prices rose. A recent court decision found Apple guilty of colluding with publishers, blaming the price hike, in part, on *agency* agreements and prohibiting their use. Building a model to compare these with traditional *wholesale* agreements, we identify a single, pivotal condition that leads prices under agency to be higher than under wholesale with two-part tariffs but lower with linear pricing. Our model shows that the increase in ebook prices can be explained, instead, by heightened competition for reading devices, and it guides our understanding of when restricting agency agreements is advisable.

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[†]Düsseldorf Institute for Competition Economics, Heinrich Heine University, Universitätsstr. 1, 40225 Düsseldorf, Germany (email: germain.gaudin@dice.hhu.de)

[‡]School of Economics and Management, Tsinghua University, Weilun Building, 100084 Beijing, China (email: awhite@sem.tsinghua.edu.cn)

1 Introduction

Apple incited two shifts in the electronic books industry when it entered the market in 2010. It convinced book publishers to adopt so-called “agency” agreements, under which the publishers set final ebook prices, in lieu of traditional “wholesale” agreements that gave this power to retailers. It also introduced the iPad tablet computer, increasing competition in the market for ebook reading devices.

Around this time, the retail price of ebooks sold by Amazon, the dominant retailer throughout the period in question,¹ rose by about 18 percent on average, and the price of *New York Times* bestsellers rose by about 40 percent (Cote, 2013, p. 94). Also, during the months just before and after the iPad’s release, Amazon lowered the price of its reading device, the Kindle, from \$299 to \$139 (and would later cut it further). Amazon also developed free software allowing its ebooks to be read on the iPad and other devices.

In 2012, the U.S. Department of Justice (DOJ) sued Apple and a group of major publishers for illegally conspiring to raise ebook prices, claiming that agency agreements played an instrumental role. The DOJ won the case against Apple and reached a settlement with the publishers. Both the court’s order and the settlement prohibited further use of agency agreements, although, at the time of this writing, Apple is appealing the judgment.² In its defense, Apple claimed that its introduction of the iPad represented a major innovation that should be taken into account.³ In response, the DOJ persuaded the judge that the relevant market included only ebooks, thereby excluding reading devices from the antitrust analysis.

This case deserves attention for three reasons, beyond the fact that Apple is currently the world’s most valuable company. It involves the prosecution of a firm

¹Amazon’s share of revenue in the U.S. electronic books market was 80% in the first quarter of 2010 (Gilbert, 2013, Table 2, p. 10). A 2013 survey lists Amazon as the “primary source” of ebooks for 67% of ebook buyers with Barnes & Noble second (11.8%) and Apple third (8.2%). See <http://www.digitalbookworld.com/2013/bisg-report-a-few-more-ebook-stats/>.

²In July 2014, Apple reached a settlement for a class action brought by attorneys general in 33 U.S. states, in which the amount of the fine it will have to pay depends on the outcome of its appeal.

³Kevin M. Murphy, testifying on behalf of Apple, emphasizes the impact of Apple’s software innovations and Amazon’s compatibility decisions on consumer surplus following the switch to agency agreements and Apple’s introduction of the iPad and the iBookstore (Gilbert, 2013, ¶250, ¶253). Daniel L. Rubinfeld, testifying on behalf of publishers Macmillan and Penguin Group, states that “there are good reasons to include the effects of the move to agency on sales of dedicated e-readers in the evaluation of competitive effects” (Gilbert, 2013, ¶216). To the best of our knowledge, professors Murphy and Rubinfeld’s testimonies are not publicly available but excerpts are quoted in the “Direct Testimony of Richard J. Gilbert, Ph.D” (Gilbert, 2013), brought by the DOJ.

for price-fixing (i) at the time of its initial entry into a market (for ebooks), (ii) that apparently occurred in synchronization with its introduction of an unquestionably innovative product (the iPad), and (iii) in concert with *vertically* related firms (publishers).⁴ Moreover, the case raises the general question of how vertical agreements in the market for a “usage good” (ebooks) interact with competition in the market for an “access good” (reading devices). How do these combine to influence observed ebook prices, and what is the overall impact on welfare?

In this paper, we build a model that addresses these questions, capturing key features of both the pre- and post-2010 ebook industry. Pre-2010, a dominant retailer (Amazon) controlled an essential access device (the Kindle) and agreements regarding ebook pricing were of the wholesale variety. Post-2010, no device was essential, and Amazon’s pricing agreements with publishers took the agency form.

Agency and wholesale agreements differ from one another in the following way. Under wholesale, the upstream firm (here, a publisher) charges a wholesale price for the good to the downstream retailer who then sets a final price for the good. By contrast, under agency, the retailer sets a percentage commission that it will collect from sales of the good, and the upstream firm is free to set the good’s final price. Our model captures the underlying forces that determine equilibrium prices under these two types of agreement, both in the presence and in the absence of an essential device sold by the retailer.

Two implications of our model are, first, that an increase in competition in the reading device market that drives device prices down also causes a rise in ebook prices, regardless of whether agreements for distributing ebooks were to switch from wholesale to agency form. While not particularly surprising, this result provides an explanation for the observed rise in ebook prices that is notable, because it does not rely on any claim of anticompetitive behavior of the sort alleged in the trial, yet it appears quite salient to the case. Second, and of greater economic subtlety, we derive a general condition determining whether Amazon and ebook publishers’ adoption of agency agreements will *taper* or *exacerbate* this rise in ebook prices, compared to a counterfactual situation in which they continued to use wholesale agreements.

⁴Also note that similar events unfolded in Europe. The European Commission initiated an antitrust proceeding in December 2011 (case COMP/39.847). Apple and the main publishers reached settlements with the Commission between December 2012 and July 2013, terminating agency agreements.

From a theoretical perspective, our paper makes two contributions. First, it shows that the comparison between price levels arising under agency and wholesale contracting arrangements hinges critically on whether one of the firms controls a complementary market. Second, it identifies Marshall's Second Law of Demand⁵ as a necessary and sufficient condition for this relationship to flip in one direction rather than the other.

To understand the basic argument of our model, consider first a setting where the retailer has monopoly power over an access device (e.g., a Kindle) that is necessary to consume a usage good (e.g., ebooks). In this case, demand for ebooks adhering to Marshall's Second Law of Demand is necessary and sufficient to guarantee that equilibrium ebook prices prevailing under agency agreements are higher than those prevailing under wholesale agreements. Under wholesale, there is no double marginalization, as the retailer prices the variable good at marginal cost and extracts residual surplus through the fixed fee for the device. Under agency, however, the retailer earns a positive commission at equilibrium, which implies double marginalization, if and only if Marshall's Second Law of Demand holds.

By contrast, when the good can be consumed without using such a device (or substitute devices are sold at marginal cost in a competitive market), there is double marginalization under both forms of agreement. In this case, we show that Marshall's Second Law of Demand is necessary and sufficient to guarantee that prices under wholesale are higher than prices under agency.

We recognize that our argument focuses on a specific subset of the issues that are relevant to the ebooks case and do not wish to claim that it necessarily refutes the entire argument made by the DOJ. In particular, the DOJ's focus seemed to be directed towards the possible use of agency agreements in facilitating collusion among publishers. We, on the other hand, abstract from such questions, in order to isolate the relative merits of wholesale and agency agreements in the absence of any variation in the dimension of horizontal conduct. Our model thus clarifies *vertical* issues with significant bearing on the economics of the case that do not appear to have received attention. Moreover, under the premise that horizontal issues are important to the case, our results help to clarify when, from a policymaker's perspective, there is a trade-off between addressing vertical and horizontal concerns and when these two objectives are aligned.

⁵See Condition 1.

More broadly, we believe that policymakers' intervention in this case deserves scrutiny, given the significant drop that occurred in the price for *access* to ebooks (see Figure 1). To establish a ballpark sense of the numbers in play, consider a very simple comparison between the situation facing a consumer considering starting to read ebooks in November 2009 versus that facing her in November 2010. At the later point, she would save \$160 on the Kindle device over the prior year's price, so, even if each ebook were \$4 more expensive, she could buy up to 39 ebooks and still be better off.⁶

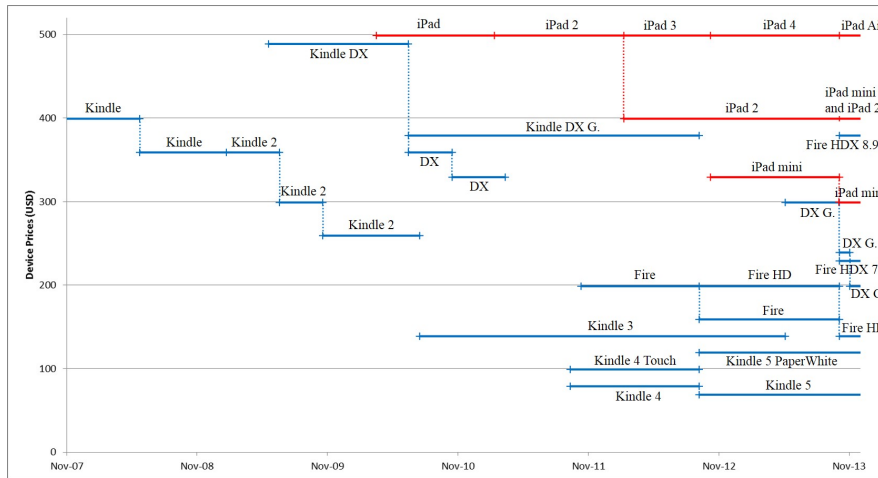


Figure 1: Kindle and iPad prices over time in USD, November 2007 - December 2013 (listed price for base model, excluding promotions). (Sources: amazon.com and apple.com, accessed April 8, 2014 via web.archive.org.)

Importantly, our model gives reason to worry that the DOJ's settlement with publishers will, going forward, cause harm to consumers. Amazon's ebooks can now be accessed via many different channels,⁷ and Amazon is unlikely to have an incentive to restrict this, given the ubiquity of devices made not only by Apple but also by other manufacturers. Consequently, the settlement's prohibition on the use of agency agreements between publishers and Amazon would, according to the

⁶Data on the number of ebooks bought per Kindle owner are not publicly available. A *Forbes* analysis of the ebook industry assumes an average Kindle owner buys a total of 15 to 30 ebooks during the device's lifetime. See <http://www.forbes.com/sites/greatspeculations/2014/04/02/estimating-kindle-e-book-sales-for-amazon/>.

⁷On its webpage, Amazon markets its ebooks by stating, "You don't need to own a Kindle device to enjoy Kindle books. Download one of our free Kindle apps to start reading Kindle books on all your devices. The Kindle app is available for every major smartphone, tablet, and computer" (accessed November 10, 2013).

model, put further upward pressure on ebook prices, if demand satisfies Marshall's Second Law of Demand. This is because, in reverting to wholesale agreements, under the current competitive conditions in the device market, there will be an incentive for not just the publisher but also Amazon to charge a markup on ebooks.

Statements by key players support this view of a shift in Amazon's strategy, whereby it turned its focus from Kindle devices to ebooks themselves as a direct source of profits. In the trial, referring to the period prior to Apple's entry, the DOJ asserted that Amazon typically sold *ebooks* for close to cost or even as a "loss leader" (U.S.A., The State of Texas, and The State of Connecticut, 2013, ¶19, ¶210). On the other hand, in 2012, Amazon's CEO, Jeff Bezos, told the BBC "We sell the *hardware* at cost (...) We want to make money when people use our devices, not when they buy them" [emphasis ours].⁸

While our analysis is motivated by the ebook industry, our model is quite general and could have interesting implications for other industries, particularly other forms of digital media, payment systems, and software.⁹ Of particular relevance is the online travel industry, in which booking websites' agreements with hotels sometimes take the wholesale form and sometimes take the agency form. Interestingly, a January 2014 settlement between travel agents and the UK's Office of Fair Trading stipulated that the former discontinue using agency agreements.¹⁰

Relationship to Existing Work. Recent work by Johnson (2013a) examining the ebook industry compares wholesale and agency agreements in a model where consumers face switching costs when purchasing from a new distributor. Johnson

⁸See <http://www.bbc.com/news/technology-19873530>. Estimates of production costs of different eras' Kindle devices are also consistent with this view. *TechHive* estimated in 2009 that the version of the Kindle that Amazon sold for \$359 cost \$185 to produce, while, in 2011, they estimated that the version of the Kindle that Amazon sold for \$79 cost \$84 to produce. See http://www.techhive.com/article/163609/amazon_kindle_markup_cost_revealed.html and http://www.techhive.com/article/243531/report_79_amazon_kindle_costs_84_to_make.html.

⁹In the mobile software application market, both Google and Apple use arrangements resembling agency, where software developers choose a retail price for their application from a large price matrix. In view of our results on the impact of hardware on the relationship between agency and wholesale, it is interesting to note that, while many firms supply devices that run Google's Android operating system, only Apple's devices can run its iOS. In the digital music industry, Apple's iTunes used to offer a unique price of \$0.99 per song, but switch to a three-tiered pricing plan in 2009, giving pricing flexibility to labels and artists. Payment systems often feature an annual fee, which is analogous to the device price in our model, as well as either a percentage commission or a per-transaction fee. For more on a related set of issues, see, e.g., Hagiu and Wright (2013).

¹⁰See OFT's January 2014 "Investigation into the hotel online booking sector".

(2013*b*) focuses the use of “Most Favored Nation” clauses and their impact under both agency and wholesale agreements, which is an important issue in case brought by the DOJ. Abhishek, Jerath and Zhang (2013) study entry and compare equilibrium outcomes under wholesale and agency agreements when a monopolist publisher sells online goods through two competing distributors. Foros, Kind and Shaffer (2013) study the impact of market competition at both the retailing and publishing level. Note that none of the aforementioned papers consider reading devices, nor do they consider a general demand framework, which we argue to play a critical role.¹¹

Regarding the choice of model for comparing agency and wholesale agreements, Johnson (2013*b*) follows the same approach that we do. Meanwhile, Condorelli, Galeotti and Skreta (2013) use the same terms to describe a quite different setting, in which the downstream firm has more information than the upstream firm about demand.¹²

On the empirical side, while there is still little work on this topic, a noteworthy article is by De los Santos and Wildenbeest (2014), who perform a difference-in-differences analysis to estimate the impact of the Court’s enforced switch from agency to wholesale agreements on ebook prices. They find that prices have decreased, on average, even though they report an upward trend at the end of their panel (i.e., early 2014).¹³

The remainder of the paper is organized as follows. Section 2 introduces the model. Section 3 analyzes the case where the retailer controls an essential device, and Section 4 analyzes the case where it does not. Section 5 discusses the model’s interpretation, giving both graphical examples (5.1) and analyzing of the role of our key condition, Marshall’s Second Law of Demand (5.2). Section 6 discusses possible extensions, and Section 7 concludes.

¹¹Gans’ (2012) article, focusing on the market for software applications, models devices but does not compare wholesale and agency agreements.

¹² The agency arrangement we study in this paper, whereby which the publisher is allowed to set the retail price is related to the literature on resale price maintenance (RPM). Whereas RPM is not *per se* forbidden in the U.S., it is still carefully scrutinized by competition authorities, notably because of its collusive power. See, e.g., Jullien and Rey (2007), Dobson and Waterson (2007), Rey and Vergé (2008, 2010), and Asker and Bar-Isaac (2014).

¹³See Section 5.1 for a discussion of these results. Recent empirical analyses also include Baye, De los Santos and Wildenbeest (2013), who show that agency typically led to larger average prices than wholesale in 2012, and Reimers and Waldfogel (2014), who estimate that Amazon’s strategy in selling both ebooks and physical books, in late 2012 and early 2013, entailed pricing below profit maximizing levels.

2 The Model

Consider a model with three types of agents: a publishing house, denoted by H , a retailer, R , and a unit mass of consumers. The publisher owns the exclusive rights to sell electronic books, but, in order to reach consumers, it must go through the distribution channel owned by the retailer.

The two forms of contracting agreement that we are interested in studying are the *wholesale* form and the *agency* form. Under a wholesale agreement, the publishing house sets a wholesale price, w , that the retailer must pay for each ebook it sells. The retailer sets the final ebook price, p_w . Under an agency agreement, the retailer sets the revenue share, $\alpha \in [0, 1)$,¹⁴ that it will retain from the sale of each ebook, while passing the complementary share, $1 - \alpha$, on to the publisher. The publisher sets the final ebook price, p_α .

In particular, our goal is to compare, under two different circumstances, the equilibrium outcomes arising from these two contracting forms. The first circumstance, called the “essential case” is one in which the retailer sells, exclusively, a device that consumers must purchase in order to derive any benefit from owning ebooks. In the second circumstance, called the “non-essential case”, the retailer does not control such an access bottleneck. This latter case arises when, for instance, there is a competitor (not modeled explicitly) who sells devices that can also display ebooks purchased via the retailer. In the essential case, the retailer thus sets a price for the device, denoted by T_w under a wholesale agreement and by T_α under an agency agreement. In the non-essential case, any potential rents stemming from the device are competed away, leaving its price to be zero. (See the assumptions on technology below.)

We assume that consumers are homogeneous and that they have quasilinear preferences giving rise to an individual and aggregate demand curve for ebooks,

¹⁴We rule out the possibility that the retailer sets α equal to one, as allowing for this gives rise to a technical complication in the corresponding continuation game that we believe not to be of economic interest. Specifically, in cases where, for all finite values of p , $D(p) > 0$, if the retailer were to set $\alpha = 1$, then, in the second stage, the publisher’s problem would have no solution, as the latter would prefer the smaller of any two quantities and would thus want to set price “as close to infinity as possible”. Such an outcome would lead the retailer’s profits to be arbitrarily close to zero, and, thus, it would never have an incentive to set $\alpha = 1$.

$D(p, T)$, that can be written

$$D(p, T) = \begin{cases} D(p) & \text{if } T \leq \int_p^\infty D(x) dx \\ 0 & \text{if } T > \int_p^\infty D(x) dx, \end{cases}$$

where p and T denote generic ebook and device prices, respectively. Intuitively, this says that, if the maximal surplus that a consumer can derive from purchasing a positive number of ebooks exceeds the price of a reading device, then he will buy a device as well as this maximizing number of ebooks. Otherwise, he will buy neither. While Proposition 1, dealing with the essential case, relies on consumer homogeneity, Proposition 2, regarding the non-essential case, requires no such assumption. In Section 6, we discuss the impact, in the former case, of relaxing this assumption.

Regarding the function $D(\cdot) : \mathbb{R}_{++} \rightarrow \mathbb{R}_+$, we assume that, throughout the domain for which it takes on nonzero values, it is strictly decreasing and three times continuously differentiable. Let $P(q)$ denote the inverse function of $D(p)$, let $MR(q) \equiv P(q) + qP'(q)$ denote the *marginal revenue* curve, and let $\eta(q) \equiv -P(q) / [qP'(q)]$ denote the *elasticity of demand*. Our main results refer to the following version of *Marshall's Second Law of Demand*, stated in Condition 1.

Condition 1 (Marshall's Second Law of Demand). *The elasticity of demand strictly decreases as quantity increases, up to the point where marginal revenue reaches zero. Formally, $\eta'(q) < 0$, for all q such that $MR(q) > 0$.*¹⁵

To interpret Marshall's Second Law, note, first, that it essentially limits the convexity of the demand. For example, any log-concave demand function satisfies it, while constant-elasticity functions, of the form $D(p) = kp^{-\gamma}$, which are convex, represent a limit case in that they violate it globally with equality. For further intuition, consider the following equivalent expression of this condition. Let $\rho(q) \equiv P'(q) / MR'(q)$ denote the *pass-through rate*, i.e., the rate at which a monopolist, facing $D(\cdot)$, optimally increases its price in response to an increase in its marginal

¹⁵Marshall expressed what he called "the law of the elasticity of demand" as the elasticity of demand being increasing in price: "The elasticity of demand is great for high prices, and great, or at least considerable, for medium prices; but it declines as the price falls; and gradually fades away if the fall goes so far that satiety level is reached;" and that this "appears to hold with regard to nearly all commodities and with regard to the demand of every class" (Marshall, 1920, Book III, Chapter IV, §2). This translates into $\eta'(p) > 0$, with $\eta(p) \equiv -D'(p)p/D(p)$, and Condition 1 simply expresses this condition in units of quantity, for any price such that $p + D(p)/D'(p) > 0 \Leftrightarrow \eta(p) > 1$.

cost. Condition 1 can be expressed as $\rho(q) < P(q)/MR(q)$, for all q such that $MR(q) > 0$. Since, for all $q > 0$, $P > MR$, all demand functions with a pass-through rate bounded by one, as well as a non-trivial set with pass-through rates greater than unity, satisfy this condition.^{16,17}

Regarding the firms' technology, the crucial parameter to account for is the publisher's marginal cost of selling ebooks. We denote this by $c \in (0, \bar{c})$, where \bar{c} is small enough to ensure positive demand in equilibrium. This represents royalties, as well as bandwidth, and order and payment processing costs that the publisher incurs with each copy sold, which we take to be exogenous. Note that, in the case where $c = 0$, the subsequent analysis becomes trivial, as, under agency, the price-setting incentives of the publisher are not distorted from those of a monopolist facing demand $D(p)$, since both parties prefer the price that maximizes total revenue.

Regarding other technological parameters, such as the retailer's marginal cost of distributing ebooks and producing devices, we assume them both to be zero. With respect to the former, this is a good approximation. With respect to the latter, provided that it is constant and not too large, this is without loss of generality.¹⁸

The timing is as follows under each of the two of contracting agreements:

- **Wholesale**

1. The publishing house, H , sets the wholesale price, w .
2. The retailer, R , sets the final ebook price, p_w .
3. In the essential case, R sets the device price, T_w .

- **Agency**

1. R sets the revenue share it will retain, α .
2. H sets the final ebook price, p_α .

¹⁶For example, linear demand functions exhibit a pass-through rate of 1/2. More generally, Amir, Maret and Troege (2004) show that log-concavity of demand is equivalent to a pass-through rate bounded by one. See also Bulow and Pfleiderer (1983), and Weyl and Fabinger (2013), who study the economic significance of the pass-through rate.

¹⁷Marshall's Second Law of Demand is also related to the quantity $-qP''/P'$, sometimes called the "elasticity of the slope" (Seade, 1980; Anderson, de Palma and Kreider, 2001a) or the "curvature" (Aguirre, Cowan and Vickers, 2010) of demand. Specifically, it is equivalent to $-qP''/P' < 1 + 1/\eta$. Also, demand forms which violate Marshall's Second Law of Demand are called "superconvex" by Mrázová and Neary (2013).

¹⁸See footnotes 22 and 24 for precise upper bounds in the essential and non-essential cases, respectively.

3. In the essential case, R sets the device price, T_α .

Before proceeding, one aspect of the timing merits discussion. This is the reversal, between wholesale and agency arrangements, in the order of the two firms' initial actions. A concern might be that this reversal potentially implies a shift, from one agreement to the other, in a dimension of "bargaining power" that is orthogonal to the dimension in which we desire to make a comparison. We believe, however, for the following reasons, that the approach we take is the one that is best-suited for the current analysis.

First, *the* crucial feature of any comparison between these two contracting agreements is that, under wholesale, the retailer sets the final price, whereas, under agency, the publisher does. Second, given this first point, among the "simple" timing arrangements (i.e., permutations of Stackelberg or simultaneous-move), the one that we have chosen for each agreement is the *only* one that leads to a reasonable equilibrium prediction.¹⁹ The only feasible way to "hold fixed" the two firms' bargaining power while comparing the two arrangements would thus involve introducing significant additional machinery to the model (e.g., incorporating bargaining) at the cost of significant additional complication. Moreover, to the extent final prices are, in fact, easier to adjust on a rolling basis than inter-firm transfer arrangements, the timing we assume may indeed be quite realistic.²⁰

We use the solution concept of subgame perfect Nash equilibrium, and, in order to ensure existence and uniqueness, we assume a relevant set of second-order conditions to be satisfied. These are specified in Appendix B. Note that these also imply that the function $(p - c)D(p)$ has a unique solution. In the subsequent analysis, we use, as a benchmark, $p_m \equiv \operatorname{argmax}_p (p - c)D(p)$, the *monopoly price* for a single firm with marginal cost c , facing demand $D(p)$.

¹⁹For example, if, under the agency agreement, the publisher moves first, then, assuming it chooses a price that is both itself nonzero and that leads to positive ebook sales, then the retailer will necessarily set α close to one. In anticipation of this, an optimal price for the publisher to set in the first stage would be any one that leads to zero sales of ebooks.

²⁰Likely stemming from similar motivations, Johnson (2013*b*) adopts the same timing assumptions in his comparison of wholesale and agency pricing.

3 The Essential Case

First consider the case where the retailer exclusively sells an essential reading device. Under wholesale, the retailer does not have an incentive to mark up the ebook price, above whatever wholesale price it pays to the publisher. This is because it can use the price of the reading device to extract all available consumer surplus. Given the availability of this latter instrument, the retailer finds it optimal to set the ebook price equal to the marginal cost it perceives, namely, the wholesale price. In view of the above, the publisher's pricing incentives, when setting the wholesale price in the first stage, are *unaffected* by the presence of both the retailer and the device, compared to the hypothetical case where it was a conventional monopolist facing demand curve $D(\cdot)$, with marginal cost c . The publisher thus finds it optimal to sell quantity q_w satisfying $MR(q_w) = c$, and it does so by setting $w = p_w$. The retailer then sets $p_w = w$ and $T_w = \int_{p_m}^{\infty} D(x) dx$.

Under agency, when the publisher sets the final price for ebooks, p_α , for a given value of α , its profits are

$$((1 - \alpha)p_\alpha - c)D(p_\alpha) = (p_\alpha - (c + \alpha p_\alpha))D(p_\alpha).$$

Thus, provided that the retailer has chosen to retain a strictly positive share, α , of the revenue from ebook sales, the publisher faces incentives of a monopolist whose marginal cost is effectively *greater* than c . Therefore, if $\alpha > 0$, then $p_\alpha > p_m$.

Moreover, whenever Condition 1 holds, for the retailer, the optimal value of α is indeed positive. To see the intuition underlying this latter point, consider the effect on R 's profits of a small increase in α , beginning from zero. If R were to set $\alpha = 0$, H would respond by setting $p_\alpha = p_m$, and R 's profits would be

$$\underbrace{\int_{p_m}^{\infty} D(x) dx}_{T_\alpha} + p_m D(p_m) \times \underbrace{\alpha}_0. \quad (1)$$

The derivative of (1), with respect to α , evaluated at $\alpha = 0$, is

$$\left(p_m - \frac{dp_\alpha}{d\alpha} \right) D(p_m), \quad (2)$$

where $dp_\alpha/d\alpha$ represents the endogenous increase in the final ebook price chosen by the publisher, as the retailer increases α . Expression (2) reflects two forces that affect the retailer's profits in conjunction with such an increase. The positive force, captured by $p_m D(p_m)$, is the slice of ebook revenue that R stands to withhold from H . The negative force, captured by $-(dp_\alpha/d\alpha) D(p_m)$, is the erosion in consumers' willingness to pay for the device. As p_α increases by one dollar, this willingness diminishes by $D(p_m) = q_m$, since a consumer must pay one dollar more for each of the q_m ebooks purchased.

The rate at which p_α increases can be calculated by implicitly differentiating H 's first-order condition with respect to α . This first-order condition, representing H 's best response to a given α , can be written most intuitively as $(1 - \alpha) MR(q_\alpha(\alpha)) = c$, and differentiating it yields

$$-MR(q_\alpha(\alpha)) + (1 - \alpha) \frac{MR'(q_\alpha(\alpha)) dp_\alpha}{P'(q_\alpha(\alpha)) d\alpha} = 0. \quad (3)$$

Evaluating equation (3) at $\alpha = 0$ and rearranging gives

$$\frac{dp_\alpha}{d\alpha} = MR(q_m) \rho(q_m),$$

and thus expression (2) is strictly positive whenever $P(q_m) > MR(q_m) \rho(q_m) \Leftrightarrow \eta'(q_m) < 0$.

The following interpretation, framed in terms of the pass-through rate and the incidence of taxation, can be instructive. In general, when a small, *per-unit* tax is levied on a monopolist (or its marginal cost increases by one unit), the change in consumer surplus following the monopolist's optimal price adjustment is equal to $-\rho(q_m) q_m$.²¹ Hence, if, under agency, the retailer were to increase α by an amount that prompted a reaction by the publisher equivalent to the one the latter would have exhibited in response to a one unit tax increase (holding α fixed), then consumer surplus derived from ebook purchases would fall by $\rho(q_m) q_m$, and T_α must fall by the same amount.²²

It then remains to calculate the local value of $d\alpha/dc$, i.e., the rise in α , beginning

²¹See Weyl and Fabinger's (2013) "Principle of Incidence (Monopoly) 3".

²²Note that, in the essential case, setting to zero the retailer's marginal cost of producing the device is without loss of generality, provided that this cost is smaller than the minimum revenue that the retailer would ever obtain, that is $\int_{p_m}^{\infty} D(x) dx$.

from $\alpha = 0$, that would prompt the same response by the publisher as though a small, per-unit tax were introduced. This can be done by setting $d\alpha (dp_\alpha/d\alpha) = dc \rho(q_m)$, which gives $d\alpha/dc = 1/MR(q_m)$. Therefore, such a change would allow the retailer to retain $1/MR(q_m)$ “percent” of the revenue from ebook sales, and it will find this to be a beneficial move so long as $q_m P(q_m)/MR(q_m) > \rho(q_m) q_m$, which is equivalent to Marshall’s Second Law of Demand holding locally at q_m . We now formally summarize and extend the above discussion in Proposition 1. See Appendix A for all proofs.

Proposition 1. *When the retailer exclusively sells an essential reading device, the equilibrium price of ebooks is strictly greater under an agency contracting agreement than it is under a wholesale agreement, if and only if Condition 1 is satisfied. Formally, $p_\alpha > p_w = p_m$ for any positive marginal cost if and only if Condition 1 is satisfied, and there exists some marginal cost such that $p_\alpha = p_w = p_m$ otherwise.*

This proposition gives rise in a straightforward manner to the following implications, stated in Corollary 1, for the device price, total surplus, consumer surplus, and industry profits.

Corollary 1. *When the retailer exclusively sells an essential reading device, (i) total surplus, (ii) industry profits and (iii) the device price are greater under a wholesale agreement than under an agency one for any marginal cost if and only if Condition 1 is satisfied. Otherwise, there exists some marginal cost such that they are equal under both agreements. Moreover, (iv) consumers receive zero surplus under both arrangements.*

To see this, consider the following. As consumers have no intrinsic valuation for the device, total surplus depends only on ebook sales. We know from Proposition 1 that $q_m = q_w > q_\alpha$ if Condition 1 is satisfied, implying that total surplus is higher under wholesale than under agency. Moreover, when the retailer has monopoly power over an essential device, it extracts all residual consumer surplus using the device price, setting $T = \int_p^\infty D(x) dx$. Thus, the lower ebook price under wholesale than under agency leads to $T_w > T_\alpha$.

4 The Non-Essential Case

Now consider the case where the retailer does not exclusively control an essential reading device. Under wholesale, the arrangement is a classic one of vertical mo-

nopolies.²³ As such, the equilibrium ebook price, p_w , is greater than the monopoly price, p_m , reflecting the well known phenomenon of double marginalization. This contrasts sharply with the results from wholesale contracting in the essential case, discussed above. The crucial point of comparison is that, whereas in the essential case, the retailer has an incentive to maximize consumers' and its *joint* surplus using the ebook price and then to extract consumers' surplus using the device price, here, it has only a single pricing instrument.

In the meantime, under agency, the forces exerting upward pressure on ebook prices that we discuss above are still in place. Namely, when the retailer takes a positive share of ebook revenue by setting $\alpha > 0$, this pushes in the same direction as an increase in marginal cost, lifting p_α above p_m . Furthermore, in the non-essential case, the retailer's incentive to increase α is strengthened, relative to the essential case, as it perceives no opportunity cost in the form of a lower device price.²⁴

Thus, while it is straightforward to see that, compared to monopoly, both agency and wholesale arrangements lead to restrained quantity, it is, *a priori*, not obvious which one does so more strongly. As we establish in Proposition 2, the crucial condition for the ebook price to be *lower* under agency than under wholesale is that Marshall's Second Law of Demand holds.

Proposition 2. *When the retailer does not exclusively control an essential reading device, the equilibrium price of ebooks is strictly greater under a wholesale contracting agreement than it is under an agency agreement, if and only if Condition 1 is satisfied. Formally, $p_w > p_\alpha > p_m$ for any positive marginal cost if and only if Condition 1 is satisfied, and there exists some marginal cost such that $p_\alpha > p_w > p_m$ otherwise.*

A basic implication of Propositions 1 and 2 is the following. Switching from the case where the retailer controls an essential device and contracts are of the wholesale form to the case where it does not have market power over devices will unambiguously cause the ebook price to increase, regardless of the form of agreement. Corollary 2 states several further implications of Proposition 2, regarding the device price, total surplus, consumer surplus, and industry profits.

²³See, for example, chapter IX of Cournot (1838), and Spengler (1950).

²⁴In the non-essential case, the assumption of zero marginal cost for the device is without loss of generality provided that this cost is smaller than the consumer surplus obtained under $\max\{p_w, p_\alpha\}$. This condition is more restrictive than the one pertaining to the essential case (see footnote 22), but it is also an uncontroversial point that, as the device market has become more competitive, their productions costs have declined (see footnote 8).

Corollary 2. *When the retailer does not exclusively control an essential reading device, (i) total surplus, (ii) consumer surplus, and (iii) industry profits are greater under an agency agreement than under a wholesale one for any marginal cost if and only if Condition 1 is satisfied. Otherwise, there exists some marginal cost such that they are greater under a wholesale agreement than under an agency one. Moreover, (iv) consumers receive positive surplus under both arrangements.*

To see this, note, first, that as consumers have no intrinsic valuation for the device, total surplus depends only on ebook sales. From Proposition 2, it holds that $q_\alpha > q_w$ if Condition 1 is satisfied, and, thus, total surplus is greater under agency. Second, consumer surplus is equal to $\int_p^\infty D(x) dx$, which is decreasing in the ebook price, p , which, in turn, is greater under wholesale. Finally, given SOC 1 (see Appendix B), total profits are concave in p , and since $p_w > p_\alpha > p_m$, they are greater under agency.

Finally, note that the results stated in Proposition 2 and Corollary 2 also apply to a model with heterogeneous consumers, as, in the non-essential case, demand for ebooks can be seen as an aggregate across consumers, without regard for their decision to purchase a device. In Section 6, we also discuss the impact of consumer heterogeneity on the essential case.

5 Interpretation of the Model

5.1 Graphical Examples

To help put our results in context, consider the following two inverse demand curves, depicted in Figure 2. Both are sufficiently convex at low quantities so as to break Condition 1. At larger quantities they both satisfy Marshall's Second Law of Demand, but the threshold price where this switch occurs is greater for the left-hand curve than it is for the right-hand curve.^{25,26} Assuming a marginal cost of \$3,

²⁵Both curves fall into the family of functions satisfying $P(q) = K - \sum_{i=1}^4 a_i q^{b_i}$, where $K, a_i, b_i \in \mathbb{R}$. While not designed to be intuitive in an algebraic sense, this specification allows for flexible local properties of concavity and is thus a useful tool for analyzing the mapping between such properties of an inverse demand curve and equilibrium predictions. The left-hand curve is $P(q) = 5.903q^{-1/4} - 10.027q^{15} + 4.124$, and the right-hand curve is $P(q) = 4.672q^{-2/3} - 2.474q^{2/3} + 3.866q^{4/3} - 9.104q^3 + 3.041$.

²⁶Two limitations of most commonly used distribution functions of consumer willingness-to-pay, which both Fabinger and Weyl (2014) and Mrázovà and Neary (2013) point out, are that they inherently prevent demand from being very convex (see Bagnoli and Bergstrom (2005)) and that

both of these curves give rise to “integrated monopoly” prices for ebooks of \$10, which correspond loosely to the (pre-iPad) equilibrium price in the essential case under wholesale.²⁷

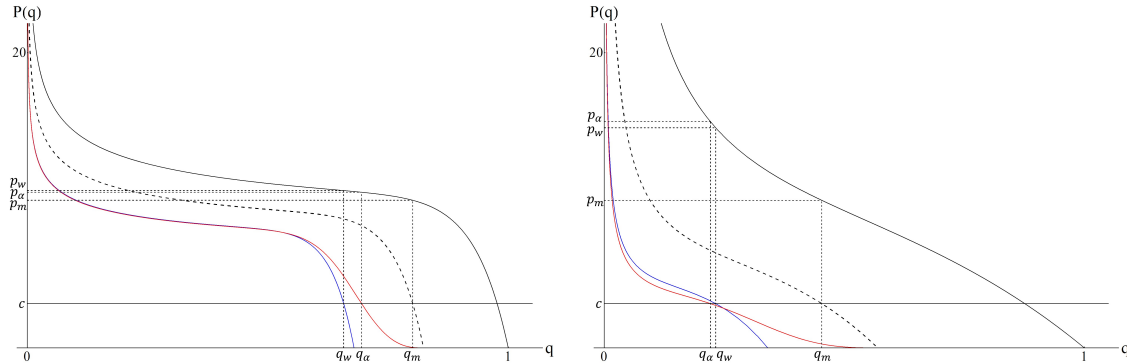


Figure 2: Two inverse demand curves (black) leading to opposite ranking of retail prices under agency and wholesale. The curve on the left gives rise to a price under wholesale that is greater than its agency analog, while the curve on the right does the opposite. Also plotted are marginal revenue (dashed), wholesale-adjusted (blue) and agency-adjusted (red) marginal revenue curves, the latter two of which are defined in Appendix A.

In the non-essential case, given the left-hand curve, the equilibrium book price is \$10.55 under agency and \$10.66 under wholesale. Thus, our model predicts that, *ceteris paribus*, if demand for ebooks took this form, the prohibition of agency in favor of wholesale would harm consumers. In contrast, given the right-hand curve, the equilibrium price is \$15.33 under agency and \$14.91 under wholesale. Thus, if demand took this form, a switch to the latter form would benefit consumers.

An interesting lens through which to view this example comes from the classic paper by Johnson and Myatt (2006),²⁸ which distinguishes between “mass market” and “niche” demand curves, focusing on the fact that clockwise rotation of the former can give rise to the latter. As it exhibits low demand at high prices but contains a region where quantity increases sharply in response to a small decrease

their parameterization does not allow for flexible adjustment of demand curvature. Both of the aforementioned papers show that, nevertheless, comparative static results often hinge on the level of convexity of demand, and they develop techniques to incorporate it more conveniently.

²⁷Note that, in this discussion, there is significant interest in contemplating scenarios involving heterogeneous consumers. However, to the extent we interpret the aggregate demand curves in this way, only the non-essential version of the model applies directly. See Section 6 for discussion of the impact of consumer heterogeneity on the essential case.

²⁸See, also, Bar-Isaac, Caruana and Cuñat (2012), who build on this framework.

in price, the left-hand curve in Figure 2 fits naturally into the former classification, while the right-hand curve fits naturally into the latter. Thus, interpreting our model literally (including the assumption that ebooks are a homogeneous good), one would predict that the merits of prohibiting agency agreements depend on whether the *aggregate* demand for ebooks is better described by a mass market curve or a niche curve.

Going a bit beyond the assumptions our model, it may be useful to consider the possibility of different demand curves for different books. Suppose, for a moment, in the context of the non-essential case, that demand for each book title were independent from that of every other title. Furthermore, suppose that, under either form of agreement, the pricing game we describe was played on a book-by-book basis.

Then it would follow that, after a blanket shift from wholesale to agency, the prices of niche books would decrease while the prices of mass market books would increase. While we are hesitant to put a great deal of emphasis on this point, as it requires strong assumptions, it seems worth further consideration, in view of the fact that the number of readers of a given mass market book is likely to be much larger than the number of readers of a niche book. Thus, even if, in response to the prohibition of agency agreements, prices for a majority of book titles were to decrease, as estimated by De los Santos and Wildenbeest (2014) for the period of 2012-2013, there is reason to suspect that the smaller number of books whose prices were to increase would be the most popular, and thus, that the overall impact on welfare could be negative.

5.2 The Role of Marshall's Second Law of Demand

Condition 1 of Marshall's Second Law of Demand plays a pivotal role in both the essential and non-essential cases. Interestingly, however, from one case to the other, it pushes in opposite directions. In the essential case, wholesale gives rise to a less distorted output level than does agency, while, in the non-essential case, the reverse is true.

The intuition for this is as follows. Condition 1 implies an upper bound on the pass-through rate. This, in turn, implies that, under agency, in *both* the essential and non-essential cases, the retailer has an incentive to increase its revenue share in order to dampen the publisher's market power. On the other hand, under

wholesale, the retailer's incentives differ dramatically between the essential and non-essential cases. In the former, the retailer sets the ebook price to maximize its joint surplus with consumers, regardless of the demand curve. In the latter case, however, low pass-through encourages double marginalization, and this effect is stronger than the market power dampening effect arising under agency.

To see this formally, note that, under agency, one can think of the retailer as selling ebooks that it buys at an input price of $(1 - \alpha)p$. Expressed as a function of q and taking into account the publisher's best response, this input price is given by $cP(q)/MR(q) = c/[1 - 1/\eta(q)]$. Note that, as the retailer increases its own revenue share, α , although the publisher necessarily responds by increasing the ebook price, p , the publisher reduces the level of "market power" it exerts, as measured by $[p - c/(1 - \alpha)]/p = 1/\eta$, if and only if Condition 1 holds. Consequently, as the only costs the retailer pays are for the ebooks it "purchases", its marginal cost function can be written

$$\underbrace{\frac{c}{1 - \frac{1}{\eta(q)}}}_{\text{Input Price}} + q \underbrace{\frac{d}{dq} \left\{ \frac{c}{1 - \frac{1}{\eta(q)}} \right\}}_{\text{Change in Input Price}} \equiv Z(\eta(q)) + \underbrace{qZ'(\eta(q))\eta'(q)}_{<0}. \quad (4)$$

The two terms in this function reflect, in terms of the input price, a marginal and an infra-marginal effect of expanding output by one unit. The term $Z(\eta(q))$ reflects the price that the retailer must pay to the publisher for the additional unit itself, and the term $qZ'(\eta(q))\eta'(q)$ reflects the change in the price that the retailer must pay for all "prior" units.

In the essential case, the first-order derivative of the retailer's profit function, evaluated at the equilibrium quantity under wholesale, q_m , can be written as

$$P(q_m) - Z(\eta(q_m)) - q_m Z'(\eta(q_m))\eta'(q_m). \quad (5)$$

In the non-essential case, letting q_w denote the equilibrium quantity under wholesale in this case, the analogous expression is

$$MR(q_w) - Z(\eta(q_w)) - q_w Z'(\eta(q_w))\eta'(q_w). \quad (6)$$

Regarding expression (5), note that $Z(\eta(q_m)) = cP(q_m)/MR(q_m) = P(q_m)$, and,

therefore, the entire expression is negative if and only if Condition 1 holds. Thus, when Marshall’s Second Law of Demand is satisfied, the retailer’s incentive to set $\alpha > 0$ is driven by an incentive to reduce the market power claimed by the publisher, leading to lower pecuniary costs on infra-marginal units.

In expression (6), on the other hand, this same infra-marginal force exists, but it is no longer dominant. To see this, note that, since $MR(q_w) = w$ and $Z(\eta(q_w)) = cP(q_w)/w$, it holds that $MR(q_w) - Z(\eta(q_w)) > 0$ if and only if $w/c > p_w/w$. Moreover, at equilibrium under wholesale, $(p_w - w)/(w - c) = \rho(q_w)$, that is, the ratio of the retailer’s markup to the publisher’s markup is equal to the pass-through rate.²⁹ Intuitively, this reflects the fact that a low pass-through rate gives greater incentive to the upstream firm to set a high wholesale price. Thus, whenever Condition 1 is satisfied, it holds that $(p_w - w)/(w - c) < p_w/w \Leftrightarrow w/c > p_w/w$.

Therefore, Marshall’s Second Law of Demand holding locally at q_w is the necessary and sufficient condition for both $MR(q_w) > Z(\eta(q_w))$ and $-q_w Z'(\eta(q_w)) \eta'(q_w) < 0$ to hold. The first of these two inequalities represents the difference between the total marginal revenue from the sale of an additional ebook and the input price that the retailer pays the publisher for this unit. Proposition 2 establishes that this is greater than the gain to the retailer from lowering the cost of infra-marginal units.³⁰

6 Discussion

The focus of this paper is to compare wholesale and agency pricing arrangements, in both the case where the downstream retailer controls an essential device and in the case where it does not. Numerous related issues that are beyond the scope of our analysis have bearing on the electronic books industry and are also of broader theoretical interest. We now discuss several of these.

Consumer Heterogeneity. From the perspective of policymaking towards today’s ebook industry, Proposition 2 is the most relevant of our results, as it speaks to the likely impacts of prohibiting agency agreements. As we note in Section 2, this result holds for a general demand curve independently of any assumption that

²⁹See Section VI.B. of Weyl and Fabinger (2013) on “supply chains and optimal taxation” for a discussion of this property in a general environment.

³⁰Note that, if Marshall’s Second Law of Demand were strictly violated at q_w , then the former, “marginal” effect would still be greater than the latter “infra-marginal” one in absolute value, but their signs would be reversed.

consumers be homogeneous. On the other hand, Proposition 1 relies on consumer homogeneity.

Translating a well known result from the literature on two-part tariffs to our model,³¹ one can see that, under wholesale, the equilibrium ebook price in the essential case satisfies $(p_w - w) / p_w = (1 - \hat{q} / \bar{q}) / \eta$, where \hat{q} denotes the number of ebooks bought by “marginal” device purchasers, and \bar{q} denotes the average number of ebooks bought per device purchaser. Thus, if \hat{q} is less than \bar{q} , then the retailer charges a markup over the wholesale price. Moreover, if \hat{q} were to tend to zero, then this formula would match the standard Lerner formula that governs the retailer’s decision in the non-essential case. It could thus be a very interesting, albeit challenging, exercise to develop a full comparison between wholesale and agency in such a setting.

Horizontal Competition. A full analysis of the ebooks case should take into account the role of competition at both the publisher and retailer levels. Of particular significance to the case are the “Most Favored Nation” (MFN) clauses, which publishers granted to Apple, guaranteeing that a given title’s price on Apple’s iBookstore would not be undercut on another outlet.³² In our view, while there is reason to believe that such clauses could potentially serve anticompetitive ends, it is important not to conflate MFN clauses’ effects with the effects of agency pricing on its own.

For example, one might reasonably argue that agency agreements could facilitate Apple’s ability to monitor and enforce MFN agreements. This could be, for example, because, under agency, the (retail) prices set by publishers are publicly visible, whereas wholesale prices are typically private. Nonetheless, such an argument seems essentially to boil down to a claim that when firms can monitor each other better, it will be easier for them to sustain collusion. It does not, however, seem to offer an economic justification for why, in the absence of collusion, when there is no essential device, agency agreements should give rise to incentives leading to higher prices. Thus, even if agency pricing helped to facilitate anticompetitive MFN agreements, once such MFN agreements have been eliminated, abolishing agency in favor of wholesale could curtail a drop in ebook prices that otherwise would occur. A possible (but purely speculative) interpretation of the U.S. Court’s 2013 decision is that it adopts this view, as its ban of agency agreements is only

³¹See, e.g., Varian (1989) as well as Schmalensee (1981).

³²See Johnson (2013*b*) for a detailed analysis of MFN clauses in the ebook industry.

temporary, whereas its prohibition of MFN clauses is not.³³

As discussed in the introduction, our model, with its monopolist publisher, focuses on the *vertical* relative merits of wholesale and agency agreements, disregarding their potential *horizontal* impact on competition at the publishing level. While, if one were to assume that several publishers compete *à la* Bertrand, selling undifferentiated books, then, both vertical and horizontal effects would typically disappear, and the retail price would remain the same under both agreements. Meanwhile, a wide range of potential oligopolistic models could describe situations in between these two polar cases. Therefore, a natural, yet challenging, extension of our work would be to study the potential trade-off between horizontal and vertical impacts of these agreements.

Print Books and Industry Dynamics. While both publishers and Amazon already sold print books, the latter seemed to welcome the emergence of ebooks more than the former. While publishers vocally fretted about ebooks' cannibalization of their print business, Amazon seemingly embraced it. Amazon's enthusiasm for this shift fits with our story wherein the arrival of ebooks allowed it to extract previously untapped rents by selling Kindle devices. It is less clear why economically rational publishers would be so protective of printed books, provided that their market power in the new, electronic publishing world were to remain equally strong as it had been before. It seems quite plausible that publishers' reticence can be explained by a fear that they would lose their relatively privileged positions once ebooks became dominant. This could, in turn, be driven by a view, on the part of publishing executives, that their own comparative advantage lay in the world of print and would not adapt well to electronic delivery.³⁴

Parallel with Specific vs. *Ad Valorem* Taxation. The comparison between wholesale and agency agreements in the non-essential case is, in an important sense, analogous to that between specific (per unit) and *ad valorem* taxation. Under wholesale, the publisher can be seen as a tax authority setting a specific tax, whereas, under agency, the retailer can be seen as an authority setting an *ad valorem* tax.

³³Prohibition of agency contracts, which restrict Apple's ability to set retail prices, expires after a period of two to four years, depending on the publisher, following the effective date of the final judgment. By contrast, the final judgment does not mention any expiration date on the prohibition of MFN clauses. See Final Judgment, Case 1:12-cv-2826, III.

³⁴See Abhishek, Jerath and Zhang (2013) for a model that considers print and ebook markets together, without devices, as well as Baye, De los Santos and Wildenbeest (2013), De los Santos and Wildenbeest (2014), and Hu and Smith (2013), for evidence on the relationship between the print and electronic books markets.

There are, however, two important differences between our model and the classic specific vs. *ad valorem* tax comparison models.³⁵ The first is the fact that the firm playing the role of the “tax authority” switches from one arrangement to the other. The second is that both firms seek to maximize profits. Consequently, the results that we present here do not, as far as we know, appear in the literature on this subject. In a separate work (Gaudin and White, 2014), we investigate the role of Marshall’s Second Law of Demand in determining the relative merits of these forms of taxation.

7 Conclusion

This paper shows that the relationship between agency and wholesale agreements between vertically related firms hinges crucially on whether one of the firms controls a complementary market. Moreover, it establishes that a version of Marshall’s Second Law of Demand is the necessary and sufficient condition for the following statements to be true. When the retailer has monopolistic control over a complementary market, then equilibrium prices under agency are higher than under wholesale. When the retailer exerts no such control, then prices are higher under wholesale.

Using these results, we construct a simple theory that can explain the observed rise in ebook prices that occurred around the time that Apple entered the market. This theory does not depend on any claim of anticompetitive behavior on the part of Apple or of publishers. Furthermore, it is consistent with the rapid decrease in the price of Amazon’s Kindle device and the proliferation of alternative devices that could be used to read ebooks sold by Amazon, both of which took place around the same period. A particularly relevant implication of this theory is that the imposed remedy of prohibiting agency agreements could, *ceteris paribus*, cause ebook prices to rise even further than they already have, as the market for tablets and other devices that can display ebooks has become, and will likely continue to be, competitive.

³⁵Such works identify conditions under which one taxation regime welfare-dominates the other one. See, e.g., Suits and Musgrave (1953) and Anderson, de Palma and Kreider (2001b) for analyses in monopoly and imperfectly competitive markets, respectively.

Appendices

A Proofs

Proposition 1

The argument in the main text preceding Proposition 1 establishes that, under wholesale, q_w satisfies $c = MR(q_w)$. Under agency, the publisher best-responds to the retailer's choice of α by setting, if feasible,³⁶ a final ebook price leading to quantity, $q_\alpha(\alpha)$, satisfying $(1 - \alpha)MR(q_\alpha(\alpha)) = c$, which is equivalent to $(1 - \alpha) = c/MR(q_\alpha(\alpha))$. Since, for a given pair (p, α) , the retailer's profits are

$$\int_p^\infty D(x) dx + \alpha p D(p) = \int_0^q P(x) dx - qP(q) + \alpha P(q)q = \int_0^q P(x) dx - (1 - \alpha)P(q)q,$$

in setting α , the retailer acts as if were choosing q to maximize total surplus, with perceived production costs determined by the *input price* per ebook sold of $(1 - \alpha)P(q)$ that it pays to the publisher. The publisher's best-response equation implies that this input price is equal to $cP(q)/MR(q)$. Therefore, the retailer's problem, in the first stage, can be written as

$$\max_q \int_0^q P(x) dx - \frac{cP(q)}{MR(q)}q, \text{ subject to } MR(q) \geq c, \quad (7)$$

where the constraint arises from the revenue share's lower bound, $\alpha \geq 0$. If interior, the solution to (7), q_α , satisfies $c = MR(q_\alpha) / \left(1 - q_\alpha \frac{\eta'(q_\alpha)}{\eta(q_\alpha)(\eta(q_\alpha)-1)}\right) \equiv A_E(q_\alpha)$, where $A_E(q)$ is the retailer's *agency-adjusted marginal revenue curve*, for the essential case. In a corner solution, $c = MR(q_\alpha) = MR(q_m)$.

For any value of q such that $MR(q)$ takes on a positive value, $\eta(q) > 1$. Thus, Marshall's Second Law of Demand holding at q is equivalent to $MR(q) > A_E(q)$. Moreover, by SOC 1 and SOC 3, respectively, each of the functions $MR(q)$ and $A_E(q)$ is strictly downward sloping over the interval where it takes on a positive

³⁶If the publisher were to face α equal to or above the threshold defined by $\bar{\alpha} \equiv \lim_{q \rightarrow 0} [1 - c/MR(q)]$, then it would make negative marginal profits on all units and would thus set a p high enough to lead the quantity of ebooks it sells to be zero. Consequently, the retailer always finds it optimal to set $\alpha < \bar{\alpha}$.

value. Therefore, if Condition 1 holds, then $q_\alpha < q_w = q_m$ for all $c \in (0, \bar{c})$, and, if it is violated, there exists some $c \in (0, \bar{c})$ such that $q_\alpha = q_w = q_m$.

Proposition 2

Under wholesale, the retailer best-responds to the publisher's choice of w by setting a final ebook price that leads to quantity, $q_w(w)$, satisfying $MR(q_w(w)) = w$. Thus, the marginal revenue curve represents the schedule of quantity-wholesale price pairs available to the publisher, i.e., its perceived inverse demand curve, when setting w in the first stage. Therefore, the publisher's problem can be written as $\max_q (MR(q) - c)q$, implying solution, q_w , such that $c = MR(q_w) + q_w MR'(q_w) \equiv W(q_w)$, where $W(q)$ is the publisher's *wholesale-adjusted marginal revenue curve*.

Under agency, the publisher best-responds to the retailer's choice of α by setting a final ebook price that leads to quantity, $q_\alpha(\alpha)$, satisfying $(1 - \alpha)MR(q_\alpha(\alpha)) = c$, which is equivalent to $(1 - \alpha) = c/MR(q_\alpha(\alpha))$. Since, for a given pair (p, α) , the retailer's profits are equal to $(p - (1 - \alpha)p)D(p)$, the publisher's best-response equation implies that the retailer's perceived *input price* per ebook sold, $(1 - \alpha)p$, can be written, as a function of q , as $cP(q)/MR(q)$. Therefore, the retailer's problem, in the first stage, can be written as

$$\max_q \left(P(q) - \frac{cP(q)}{MR(q)} \right) q. \quad (8)$$

The solution to (8), q_α , satisfies $c = MR(q_\alpha) \left(1 - \frac{1}{\eta(q_\alpha)} \right) / \left(1 - q_\alpha \frac{\eta'(q_\alpha)}{\eta(q_\alpha)(\eta(q_\alpha)-1)} \right) \equiv A_N(q_\alpha)$, where $A_N(q)$ is the retailer's *agency-adjusted marginal revenue curve*, for the non-essential case.

Note (i) that $W(q)$ can be expressed as $W(q) = MR(q) \left(1 - \frac{1}{\eta(q)} + q \frac{\eta'(q)}{\eta(q)(\eta(q)-1)} \right)$ and (ii) that for any value of q such that $MR(q)$ takes on a positive value, $\eta(q) > 1$. Thus, Marshall's Second Law of Demand holding at q is equivalent to $A_N(q) > W(q)$. Moreover, given SOC 1 that $MR'(q) < 0$, it can be verified that $MR(q) > \max \{A_N(q), W(q)\}$. Finally, by SOC 2 and SOC 4, respectively, each of the functions $W(q)$ and $A_N(q)$ is strictly downward sloping over the interval where it takes on a positive value. Therefore, if Condition 1 holds, then $q_w < q_\alpha < q_m$ for all $c \in (0, \bar{c})$, and, if it is violated, there exists some $c \in (0, \bar{c})$ such that $q_\alpha < q_w < q_m$. This completes the proof.

B Second-Order Conditions

In this appendix, we specify second-order conditions that guarantee, in each of the environments we consider, the existence and uniqueness of subgame-perfect equilibrium. We take all of the assumptions listed below to hold throughout the analysis.

In the essential case, under wholesale, the retailer chooses the ebook price as if it were maximizing total surplus and the marginal cost of producing ebooks were w . This gives first-order condition $P(q) = w$, which is sufficient, as demand is strictly decreasing. The publisher's optimization problem in the first stage is equivalent to that of a conventional monopolist, giving first-order condition $MR(q) = c$. This is sufficient for all $c \in (0, \bar{c})$ if and only if SOC 1 is satisfied.

SOC 1 (Decreasing Marginal Revenue). $MR'(q) < 0$ for all q such that $MR(q) > 0$.³⁷

Furthermore, in the non-essential case, under wholesale, the retailer's first-order condition in the second stage is $MR(q) = w$, and, thus, SOC 1 guarantees that this is sufficient. In the first stage, the publisher's first-order condition can be written $W(q) \equiv MR(q) + qMR'(q) = c$, and this is sufficient for all $c \in (0, \bar{c})$ if and only if SOC 2 holds.

SOC 2 (Decreasing Wholesale-Adjusted Marginal Revenue). $W'(q) = 2MR'(q) + qMR''(q) < 0$ for all q such that $W(q) > 0$.

Under agency, in both the essential and the non-essential case, the publisher's choice of the ebook price, in the second stage, gives first-order condition $(1 - \alpha)MR(q) = c$. This is sufficient, provided that $\alpha < 1$, if and only if Condition 1 holds. In the essential case, the first-order condition associated with the retailers' choice of revenue share, α , in the first stage, can be written $A_E(q) \equiv MR(q) / \left(1 - q \frac{\eta'(q)}{\eta(q)(\eta(q)-1)}\right) = c$. This is sufficient, for all $c \in (0, \bar{c})$, if and only if SOC 3 is satisfied.

SOC 3 (Decreasing Agency-Adjusted Marginal Revenue (Essential)). $A'_E(q) < 0$ for all q such that $A_E(q) > 0$.

³⁷Note that SOC 1 is strictly weaker than Marshall's Second Law of Demand, posited by Condition 1. Positing SOC 1, in conjunction with SOC 2, 3 and 4, allows us to consider the case where Condition 1 is violated while still ensuring that the game has a unique equilibrium, as the former ensures that $A_E(q)$ and $A_N(q)$ exist for all q such that $MR(q) > 0$.

In the non-essential case, the analogous first-order condition is given by $A_N(q) \equiv MR(q) \left(1 - \frac{1}{\eta(q)}\right) / \left(1 - q \frac{\eta'(q)}{\eta(q)(\eta(q)-1)}\right) = c$. This is sufficient, for all $c \in (0, \bar{c})$, if and only if SOC 4 is satisfied.

SOC 4 (Decreasing Agency-Adjusted Marginal Revenue (Non-Essential)). $A'_N(q) < 0$ for all q such that $A_N(q) > 0$.

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