# Agency Pricing and Bargaining: Evidence from the E-Book Market[*]

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**Abstract**

This paper examines the pricing implications of two types of vertical contracts under bargaining: wholesale contracts, where downstream firms set retail prices after negotiating wholesale prices, and agency contracts, where upstream firms set retail prices after negotiating sales royalties. We show that agency contracts can lead to higher or lower retail prices than wholesale contracts, depending on the distribution of bargaining power. We propose a methodology to structurally estimate a model with either contract form under Nash-in-Nash bargaining. We apply our model to the e-book industry, which transitioned from wholesale to agency contracts after the expiration of a ban on agency contracting imposed in the antitrust settlement between the U.S. Department of Justice and the major publishers. Using a unique dataset of e-book prices, we show that the transition to agency contracting increased Amazon prices substantially but had little effect on Barnes & Noble prices. We find that the assumption of Nash-in-Nash bargaining explains the data better than an assumption of take-it or leave-it input contracts. Counterfactual simulations indicate that reinstitution of most favored nation clauses, which were banned for five years in the 2012 settlement, would raise the prices of e-books by 8 percent but would lower the profits of the publishers and Amazon.

**Keywords:** e-books, agency agreements, vertical restraints, bargaining, most favored nation clause

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# 1 Introduction

In many retail markets, the distribution arrangement involves suppliers charging retailers wholesale prices and retailers setting final prices to consumers (the "wholesale" model). The wholesale model has been extensively studied in the literature and forms the foundation for much of the economics of vertical contracting, particularly that which informs antitrust policy.[1] Another distribution arrangement that has received much less attention involves agency relationships where suppliers pay retailers sales royalties to distribute products at prices determined by suppliers (the "agency" model).[2] Agency arrangements are used in some conventional markets (e.g., newspapers sold at kiosks, insurance sold by independent agents), but they are especially prevalent in online markets.[3]

Agency arrangements raise interesting questions for both price theory and policy. Key questions include how the choice of pricing institution affects prices and profits. In a recent antitrust case, the Department of Justice (DOJ) alleged that Apple and major book publishers engineered a shift from wholesale to agency pricing in the market for e-books and that this shift, in combination with retail price most favored nation ("MFN") clauses, raised the prices of e-books. Empirical evidence (De los Santos and Wildenbeest, 2017) confirms the price increase. A natural question is whether the shift to the agency model, the MFN clause, or both caused the price increase.

Recent theoretical literature has begun to address this question, but the literature to date has a significant gap: it abstracts from bargaining, which is an important feature of many intermediate markets, including the e-book market. Johnson (2017) compares the wholesale and agency models under the assumption that input terms are established through take-it or leave-it offers by the entity that is not responsible for setting the downstream price.[4] Under a reasonably weak condition on demand, he finds that the agency model generates lower retail prices than the wholesale model. But suppose that instead of having the non price-setting firm making take-it or leave-it offers, the downstream firm makes the offers instead. In the wholesale model, the downstream firm would set the wholesale price equal to the upstream marginal cost and thereby eliminate double marginalization. In the agency model, by contrast, the downstream firm would set the royalty looking ahead to the impact on the upstream firm's pricing decision, and this would generally lead to a degree of double marginalization.[5] Thus, the comparison between wholesale and agency arrangements is sensitive to the distribution of bargaining power. Yet, the theoretical literature on agency

[1] For example, the wholesale model forms the basis for most of the discussion of antitrust treatment of vertical integration and restraints in leading industrial organization textbooks (e.g., Carlton and Perloff, 2004). Note that wholesale pricing is also commonly referred to as linear pricing.

[2] Johnson (2017) distinguishes two other pricing arrangements: the "franchise" model, where the suppliers collect sales royalties from retailers that set the retailer price, and the "consignment" model, where suppliers charge a wholesale price and also control retail prices. Our focus in this paper is on the wholesale and agency models.

[3] For example, third-party sellers on Amazon Marketplace (the "upstream" firms) set the retail price for their products, while Amazon (the "downstream" firm) receives a percentage of the revenue. Other examples include eBay Buy It Now and the Apple App Store.

[4] If the entity with all bargaining power also controls retail prices, then it can achieve the vertically integrated outcome. Hence, take-it or leave-it offers in this context are assumed to be made by the entity without control of retail prices.

[5] A form of double marginalization arises in the agency model unless the upstream firm has zero marginal cost.

pricing (Gans, 2012; Gaudin and White, 2014; Abhishek, Jerath, and Zhang, 2015; Foros, Kind, and Shaffer, 2017; Johnson, 2017; Condorelli, Galeotti, and Skreta, 2018; Johnson, 2020) abstracts from bargaining. The literature on the wholesale model, in contrast, has focused extensively on bargaining and considers it to be a fundamental economic factor determining outcomes in many situations.[6]

In this paper, we examine the relationship between agency contracts and retail prices when intermediate pricing terms are determined through bargaining, and we propose and estimate a structural model that allows examining both arrangements empirically. We begin in Section 2 by extending the bilateral monopoly models of wholesale and agency pricing in Johnson (2017) to allow for bargaining between the supplier and retailer. We show that agency contracts can lead to higher or lower retail prices depending upon the relative bargaining power between upstream and downstream firms. When the upstream firm has high bargaining power, the wholesale price is relatively high in the wholesale model, but the royalty paid to the retailer is relatively low in the agency model. In the wholesale model, retailers pass the high input price on to consumers in the form of higher retail prices. In the agency model, by contrast, low royalties give the supplier a larger share of the retail price and reduce double marginalization, leading to a lower price than in the wholesale case. The opposite is true when the downstream firm has high bargaining power. In this case, a low wholesale price in the wholesale model reduces double marginalization and leads to a low retail price, while a high royalty paid to the retailer in the agency model causes significant double marginalization and a high retail price. In summary, the retail price tends to be lower in either arrangement when the firm with high bargaining power also determines the retail price, as the price-setting firm has an incentive to establish input terms that mitigate double marginalization. This relationship between bargaining power and retail prices in the wholesale and agency models plays an important role in the identification strategy in our structural model, as we explain in more detail below.

In Section 3, we adapt the theoretical model to make it amenable to estimation by allowing for multi-product firms and multiple suppliers and retailers, using a logit demand structure. Following recent literature, we use the Nash-in-Nash solution to model bargaining.[7] In this framework, each

[6] Examples include Horn and Wolinsky (1988) [mergers]; Dobson and Waterson (1997) [countervailing power], O'Brien and Shaffer (2005) [mergers], O'Brien (2014) [price discrimination], Crawford, Lee, Whinston, and Yurukoglu (2018) [vertical integration], and Ho and Lee (2019) [hospital and health insurance pricing].

[7] The Nash-in-Nash solution concept was first applied in the wholesale model by Horn and Wolinsky (1988) to study mergers and by Davidson (1988) to study multi-unit bargaining in labor markets (neither set of authors used the term Nash-in-Nash, which appears to have arisen in the folklore). Non-cooperative foundations for this solution concept were derived in the late eighties and include Binmore, Rubinstein, and Wolinsky (1986), who show that the Rubinstein bargaining game converges to the Nash bargaining solution as the time between offers goes to zero, and O'Brien (1989; 2014), who provides non-cooperative foundations based on an extension of Rubinstein's (1982) bargaining model to environments with upstream monopoly, downstream oligopoly, and linear input pricing. Most relevant for our paper is O'Brien (2014), who uses the alternating-offer bargaining model of Rubinstein (1982) to motivate the role of bargaining weights and disagreement payoffs. Although his noncooperative bargaining game motivation assumes two retailers and a single supplier (see the appendix of O'Brien, 2014), the extension to our setting of multiple retailers and upstream firms requires some small modifications. Collard-Wexler, Gowrisankaran, and Lee (2019) provide a non-cooperative foundation for the Nash-in-Nash solution concept for bargaining that is

pair of firms reaches an asymmetric Nash bargaining solution while taking the terms negotiated by other pairs as given. We extend this literature, which has focused on wholesale pricing contracts, to allow for agency contracts between upstream and downstream firms.

We apply our model to the e-book industry. This industry is uniquely suited to study the effects of bargaining under wholesale and agency contracts because the industry has experienced various transitions between these vertical contracts since the introduction of the Kindle e-reader in 2007. Up to 2010, e-books were sold using wholesale contracts, but with the introduction of the iPad in 2010, major publishers negotiated agency contracts with Apple to offer e-books for sale in Apple's new iBookstore. The terms of the agency contracts with Apple, particularly the MFN clause that required publishers to match lower retail prices at other retailers, prompted five of the six major publishers (the "Big Six") to compel the adoption of agency contracts on Amazon, which led to higher prices for e-books. In 2012, the Department of Justice sued Apple and five of the Big Six publishers for conspiring to raise e-book prices. All five publishers that were sued settled the lawsuit and agreed to a two-year ban on publisher-set prices, which effectively meant a return to traditional wholesale contracts. De los Santos and Wildenbeest (2017) analyze the transition from agency to wholesale contracts following the ban and find that retail prices decreased by 18 percent at Amazon and 8 percent at Barnes & Noble as a result.

The expiration of the two-year ban on agency pricing meant that, by the end of 2014, publishers could again negotiate agency contracts with Amazon and other retailers that would allow them to control retail prices directly.[8] Bargaining between publishers and retailers played an important role in renegotiating existing contracts. In Section 4, we describe some aspects of the bargaining dispute between Amazon and Hachette, which included inventory reductions and price increases for Hachette titles. These negotiations took over six months, were extensively covered by the media, and they involved public pressure by some of Hachette's bestselling authors. Despite the lengthy bargaining period, by the end of 2015, all of the major publishers had returned to agency contracts with Amazon with publisher-set prices. In Section 4, we also investigate the effect on retail prices following this latest shift towards agency contracts, using price data for e-books sold at Amazon and Barnes & Noble in the period 2014-2015. We exploit the variation in the timing of the implementation of the new agency contracts to estimate the change in retail prices resulting from the switch to the new agency arrangements using a difference-in-differences approach. Our findings indicate that, on average, Amazon prices increased by 13 percent, and Barnes & Noble prices decreased by 2 percent. The estimates also show substantial heterogeneity in price effects across publishers. These findings are difficult to explain using take-it or leave-it contracting models but are consistent with a bargaining model in which publishers have different bargaining weights.[9]

over fixed transfers that do not affect downstream firms' pricing decisions. Our model is different because we allow wholesale prices and royalties to affect downstream pricing decisions.

[8] Apple did not settle the case and was subject to a separate court injunction that banned the use of agency contracts for a longer period.

[9] An important difference between the reduced form analysis in this paper and that in De los Santos and Wildenbeest (2017) is that we study transitions between the wholesale and agency model in the absence of an alleged

In Section 5, we discuss how to structurally estimate the empirical model developed in Section 3 in light of the industry transitions discussed in Section 4, and we present estimates of the bargaining model by jointly estimating demand and supply. The extent to which prices change following a shift to agency contracts is related to the relative bargaining power of the firms involved. To fully exploit this mechanism for identification and estimation, we use data from both before and after the latest switch to agency pricing. Our goal is to obtain estimates of the demand side parameters as well as supply side parameters, which include a bargaining parameter for each publisher-retailer pair. Although the supply model varies between wholesale and agency contracts, we assume the bargaining parameters do not change when switching. This assumption abstracts away from an initial stage of bargaining between publishers and retailers over the type of contracts (wholesale or agency) in order to make the model tractable. Then, for a given set of demand and supply parameters, we can use the pricing and bargaining first-order conditions for each model to solve for the margins of the upstream and downstream firms in both periods. We use the margins to back out upstream marginal costs, which, assuming a log-linear relation between marginal cost and cost shifters, allows us to obtain estimates of both demand and supply side unobservables.

We use a covariance restriction approach to deal with price endogeneity in the demand equation. MacKay and Miller (2024) show a link between the demand and supply side unobservables and the endogenous price coefficient, and that instrument-free identification of the price coefficient can be achieved by using a covariance restriction on the unobserved shocks. MacKay and Miller develop a three-stage estimator for the price coefficient in the simple logit model that is computationally trivial, assuming constant marginal cost and Bertrand competition. Since the bargaining parameters enter our supply side model nonlinearly, we use a GMM estimator that exploits cross-covariance restrictions to create additional moments that are necessary to estimate the additional nonlinear parameters, following the approach put forward by MacKay and Miller (2024) for the case of nonlinear parameters. We assume zero cross-covariance between the unobserved demand and cost shocks and use Monte Carlo experiments to show that this approach effectively deals with price endogeneity in small samples while also allowing us to recover the nonlinear bargaining parameters of the supply-side model.

According to our estimates, the price coefficient for the logit specification implies an average own-price demand elasticity of $-1.9$ for our main specification. The supply-side estimates suggest that the retailers have more bargaining power than the publishers. However, there are substantial differences in bargaining parameters between different retailer-publisher pairs, and Amazon generally has more bargaining power than Barnes & Noble. The estimates imply an agency royalty of 37 percent, on average, which is higher than the 30 percent royalty that was common during the first agency period. We compare the fit of the bargaining model to an alternative model with take-it or

conspiracy, whereas De los Santos and Wildenbeest analyze transitions that resulted from an alleged conspiracy involving Apple and competing publishers. In addition, retail price MFN clauses were not used during the period we study, allowing us to isolate the effect of agency pricing from the effect of the MFN. This is important, as the theoretical results of Johnson (2017) indicate that the MFN would have had a positive effect on prices.

leave-it offers by the party that does not control retail prices and find that the bargaining model gives a better fit to the data than the take-it or leave-it specification.

It is important to note that these results rely on several simplifying assumptions regarding the demand specification and the bargaining process. This is mainly due to data limitations: we observe sales rank data at Amazon and Barnes and Noble but not quantities sold or any data from Apple. Moreover, in electronic markets such as the market for e-books it is difficult to construct a good price instrument, and the alternative identification strategy we use relies on stronger assumptions regarding the correlation between demand and supply side residuals. To show robustness with respect to these assumptions, we estimate several alternative specifications. We estimate a specification in which we allow for retailer-specific price parameters and find that the bargaining parameters change very little compared to the main specification, which assumes logit demand with a single price coefficient. Moreover, supply-side estimates that are obtained by calibrating the price coefficient to Amazon's higher internal estimate of the average price elasticity for e-books give similar bargaining parameter estimates, suggesting our bargaining estimates do not rely critically on the covariance restriction approach of MacKay and Miller (2024). We have also used several alternative approaches for translating sales rank into sales and find that the supply-side estimates are not very sensitive to the method by which we estimate sales.

An important aspect of the e-book market is that the initial agency contracts that were used between 2010 and 2012 were litigated, and the industry-wide switch from wholesale to the agency between 2014 and 2015 was a direct result of the two-year ban on agency contracts that followed the settlements of the publishers with DOJ. Although the lawsuit created useful variation for studying the competitive effects of agency versus wholesale contracts, it does imply that our findings do not necessarily generalize to other, non-litigated markets in which agency contracts are being used. Nevertheless, certain aspects of the initial lawsuit, including the focus on the role MFN clauses played in making the industry switch to agency contracts, are relevant for recent antitrust cases against digital platforms in the U.S. and elsewhere. MFN-type price-parity clauses have been used by other online platforms in which agency contracts are used, such as online travel agencies, and even though U.S. courts have mostly upheld MFN clauses (Dennis, 1995), they have been under scrutiny by competition authorities around the world for their potential to reduce price competition.

Since the settlements between the DOJ and publishers banned the use of MFN clauses for a period of five years, MFN clauses could not be used during the period of study. To investigate the impact MFN clauses could have in the market for e-books, at the end of Section 5, we discuss the results of a counterfactual analysis in which we use the estimates of the bargaining model to simulate the effect of MFN clauses on retail prices. The role of MFN in agency contracts has been explored theoretically by Johnson (2017), who finds that it tends to raise retail prices. In line with this theoretical finding, our counterfactual simulations indicate that prices would increase an additional 8 percent, on average, if retail price MFN clauses were added to the agency contracts. This finding is consistent with recent work by Mantovani, Piga, and Reggiani (2021), who analyze the price effects of laws in several European countries that banned the use of price-parity clauses by online travel agencies and find significant price reductions in the medium run, especially for hotels affiliated with a chain. Our simulations also show that reinstatement of MFN clauses would lower the profits of Amazon and the publishers, which could be a factor that explains why, as far as we know, MFN clauses have not been adopted despite the ban being lifted.

### Related Literature

As laid out by Johnson (2017), vertical arrangements between a retailer and supplier can be classified according to who sets the retail price (retailer vs. supplier) and the allocation of rents (revenue sharing vs. wholesale pricing), which leads to four possible business models: the wholesale model, the consignment model, the franchise model, and the agency model. As in the wholesale model, a wholesale (or linear) price is used in the consignment model, but the retail price is set by the upstream firm instead of the retailer. As shown by Johnson (2017), as long as the firm that sets the retail prices is not also setting the wholesale price, the equilibrium retail price will be the same for the two models. The difference between the franchise model and the agency model is that the retail price is set by the retailer in the franchise model and by the upstream firm in the agency model. An important focus of the empirical literature on franchising has been on agency-theoretic explanations for franchising, such as moral hazard and risk sharing (see Lafontaine, 1992, and the references therein).

The empirical literature on the agency model is scant—one notable exception is Li and Moul (2015), who study the impact of a switch from wholesale to agency agreements using sales data for mobile phones in a Chinese department store. The focus of Li and Moul (2015) is on how the switch affected service provision—using a structural demand and supply model, they find that demand went up sharply when moving to agency contracts while prices remained relatively flat, which suggests customer service had improved following the switch. This shows that costly retailer effort might be more efficiently coordinated when the upstream firm sets prices (see also Conlon and Mortimer, 2021, for a model of retailer effort provision). Although costly retailer effort provision could play a role in the e-book market as well, a big difference is that because the retailers in our setting are operating online, the upstream firms cannot directly control the retailing environment, which makes it more difficult to coordinate prices and service efforts.

Our paper also fits into a broader empirical literature that studies the role of contracts in vertical markets. Villas-Boas (2007) develops a method to determine which vertical model fits the data best that only requires price and cost data. Part of this literature has focused on the efficiency of revenue-sharing, which, in addition to prices being set by the upstream firm, is an important feature of agency agreements. Mortimer (2008) studies the welfare effects of revenue-sharing contracts in the video rental industry and finds that both upstream and downstream profits increase when revenue-sharing contracts are adopted. Note that revenue-sharing contracts can usually be written as a two-part tariff contract (see, for instance, Cachon and Lariviere, 2005)—Bonnet and Dubois (2015) and Hristakeva (2022) estimate structural models in which two-part tariff contracts are used to redistribute profits that can be estimated using limited data.

Our paper is also related to a growing empirical literature that uses some variant of the Nash-in-Nash bargaining solution to estimate demand and supply models in oligopolistic markets (Draganska, Klapper, and Villas-Boas, 2010; Crawford and Yurukoglu, 2012; Grennan, 2013; Gowrisankaran, Nevo, and Town, 2015; Crawford, Lee, Whinston, and Yurukoglu, 2018; Ho and Lee, 2019; Donna, Pereira, Pu, Trindade, and Yoshida, 2024). This literature has focused on wholesale pricing contracts and we extend it to allow for agency contracts between upstream and downstream firms. Moreover, our identification strategy for the bargaining parameters is based on the observation that the magnitude of retail price changes following a change from wholesale to agency contracts directly relates to how bargaining power is distributed across upstream and downstream firms, and by estimating the model for both agency and wholesale arrangements the bargaining parameters can be identified in a more direct way than in most of the literature.

Related empirical work on the e-book market includes De los Santos and Wildenbeest (2017), Reimers and Waldfogel (2017), and Li (2021). De los Santos and Wildenbeest (2017) find that the switch from agency to wholesale following the ban on agency pricing in 2012 reduced retail prices by 18 percent at Amazon and 8 percent at Barnes & Noble. Reimers and Waldfogel (2017) find that e-books are priced below *static* profit maximizing levels. Li (2021) estimates a structural model where consumers choose how many books to buy, their format, and platform and finds that over seventy percent of e-book sales come from cannibalizing print book sales. We refer to Gilbert (2015) for an overview of recent developments in the e-book industry and Baker (2018) for an overview of the lawsuit against Apple and the publishers that led to the switch from the wholesale model to the agency model we study in this paper.

## 2 Bilateral Monopoly Bargaining Model

In this section, we extend the bilateral monopoly models of wholesale and agency pricing in Johnson (2017) to allow for bargaining over input terms. The bilateral monopoly setting allows us to illustrate in the simplest possible setting that whether prices are higher or lower under agency agreements depends on the relative bargaining power of the firms involved.

Suppose there are two firms, an upstream firm $U$ and a downstream firm $D$, that produce and sell a product to consumers at retail price $p$. Consumer demand is given by a continuously differentiable and strictly decreasing function $Q(p)$. Marginal cost is $c^U > 0$ for the upstream firm and $c^D \geq 0$ for the downstream firm. We consider two pricing structures: a wholesale arrangement and an agency arrangement. In the wholesale arrangement, firms first agree to a per-unit wholesale price to be paid by the downstream firm to the upstream firm when units of the product are sold, and then the downstream firm sets the retail price. In the agency model, firms first agree to an ad valorem (percent of the price) royalty to be paid by the upstream firm to the downstream firm when units are sold, and then the upstream firm sets the retail price.

## 2.1 Wholesale Model

In the wholesale model, upstream and downstream profits are

$$\pi^U = (w - c^U)Q(p) \text{ and } \pi^D = (p - w - c^D)Q(p).$$

Given a wholesale price $w$, the downstream firm chooses a retail price $p$ to maximize its profits. The first-order condition is

$$p - w - c^D = \phi(p), \tag{1}$$

where $\phi(p) = -Q(p)/Q'(p)$ is a measure of demand price sensitivity. As in Johnson (2017), we assume that $\phi(p)$ and $\phi(p)(2 - \phi'(p))$ have slopes strictly less than 1.[10]

The wholesale price $w$ is determined through asymmetric Nash bargaining (Nash, 1950) between the upstream and downstream firms. Let $p^*(w)$ solve equation (1). Assuming zero disagreement payoff, the Nash product is

$$NP = \left(\pi^U\right)^\lambda \left(\pi^D\right)^{1-\lambda},$$

where the profit functions are evaluated at $(w, p^*(w))$ and $\lambda \in [0, 1]$ is a bargaining parameter that represents the upstream firm's bargaining weight. This weight is 0 if the downstream firm has all the bargaining power and 1 if the upstream firm has all the bargaining power (which corresponds to the take-it or leave-it case). The bargaining solution is found by maximizing the Nash product. The first-order condition is

$$\lambda \pi^D \pi^{U'} + (1 - \lambda)\, \pi^U \pi^{D'} = 0, \tag{2}$$

where primes ordinarily indicate derivatives with respect to $w$. In Appendix A, we show that the first-order conditions in equations (1) and (2) can be combined into the following optimality condition for the retail price:

$$p = c^U + c^D + \phi(p) \left( \frac{\lambda + 1 - \phi'(p)}{\lambda + (1 - \lambda)(1 - \phi'(p))} \right). \tag{3}$$

## 2.2 Agency Model

In the agency model, upstream and downstream profits are[11]

$$\pi^U = \left((1 - r)p - c^U\right) Q(p) \text{ and } \pi^D = (rp - c^D)Q(p). \tag{4}$$

[10] As is well-known (Bagnoli and Bergstrom, 2005; Weyl and Fabinger, 2013), the sign of $\phi'(p)$ determines whether the demand function is log-concave ($\phi'(p) < 0$), log-convex ($\phi'(p) > 0$), or log-linear ($\phi'(p) = 0$). The assumption $\phi'(p) < 1$ ensures that the pass-through rate is positive. The assumption that $\phi(p)(2 - \phi'(p))$ has a slope less than 1 implies a unique solution to the pricing problem in the case where the upstream firm has all the bargaining power.

[11] For brevity, we use $\pi^U$ and $\pi^D$ to indicate profits in both regimes and will be clear whenever it might cause confusion.

Given royalty $r$, the upstream firm chooses retail price $p$ to maximize its profits. The first-order condition is

$$(1-r)p - c^U = (1-r)\phi(p). \tag{5}$$

The agency royalty is determined through bargaining. The bargaining first-order condition is similar to equation (2), but with primes now indicating derivatives with respect to the agency royalty $r$. As shown in Appendix A, combining the retail price and bargaining first-order conditions results in the following optimality condition for the retail price in the agency model:

$$p = c^U + c^D + \phi(p)\left(\frac{(1-\lambda)(p-\phi(p))^2 + c^U p(1-\phi'(p))}{(p-\phi(p))\big(p(1-\lambda\phi'(p)) - \phi(p)(1-\lambda)\big)}\right). \tag{6}$$

### 2.3 Comparison of Vertical Contracts

Proposition 1 shows that whether prices are higher or lower under agency compared to wholesale pricing depends on the relative bargaining power of the two firms.

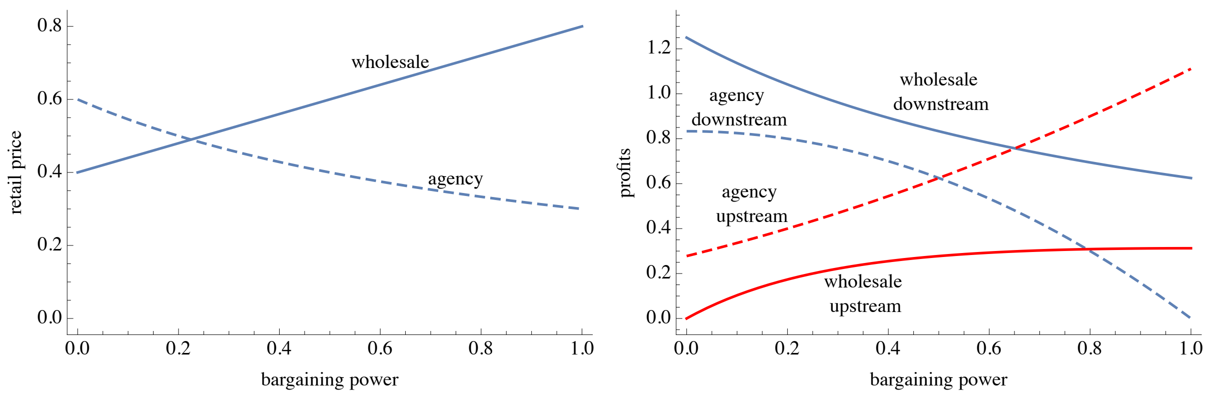
**Proposition 1** *There exist critical bargaining parameters $\lambda^* \in (0,1)$ and $\lambda^{**} \in [\lambda^*, 1)$ such that if the upstream firm's bargaining weight exceeds $\lambda^{**}$, the equilibrium retail price is higher under wholesale pricing than under agency pricing, and if the upstream firm's bargaining weight is less than $\lambda^*$, the opposite is true.*

The proof of Proposition 1 is in Appendix A. To illustrate this proposition, Figure 1 shows optimal retail prices and profits when the demand has the constant-elasticity form $Q(p) = p^{-1/\kappa}$. In this case, the optimality condition (3) for the wholesale model implies a retail price $p^w = (c^U + c^D)(1+\kappa(\lambda-1))/(\kappa-1)^2$, and condition (6) corresponds to an agency retail rice of $p^a = 2(c^U + c^D(1-\kappa))/((1-\kappa)\cdot(1+\kappa(\lambda-1)))$.

In Figure 1(a), we set $\kappa = 0.5$ and $c^U = c^D = 0.1$ and plot the equilibrium price as a function of the bargaining power parameter $\lambda$. Retail prices are increasing in $\lambda$ in the wholesale model—the more bargaining power the upstream firm has, the higher the negotiated wholesale price, with higher retail prices as a result. On the other hand, retail prices are decreasing in $\lambda$ in the agency model as a better bargaining position for the upstream firm leads to lower royalties, which in turn reduces the double marginalization problem and leads to lower prices. Figure 1(a) also illustrates that whether retail prices are higher or lower under agency depends on the exact value of the bargaining parameter. In this example, prices are higher under agency than under wholesale for bargaining power parameters that are less than 0.23 and lower otherwise. Also note that in the case of take-it or leave-it offers, which corresponds to $\lambda = 1$ for the wholesale model and $\lambda = 0$ for the agency model, prices under wholesale are higher than prices under agency.[12]

[12]This result is consistent with the conditions of Lemma 2 of Johnson (2017) for lower retail prices under the agency model compared to the wholesale model.

Figure 1: Retail prices and profits as a function of bargaining power




(a) Retail price (b) Profits

*Notes:* Retail price (figure a) and upstream and downstream profits (figure b) as a function of the bargaining weight for the wholesale model and agency model. Demand is $Q(p) = p^{-2}$ and $c^U = c^D = 0.1$.

Figure 1(b) compares the upstream and downstream firm's profits under the two types of vertical contracts for the same demand parameters. In this example, the upstream firm always prefers agency pricing, whereas the downstream firm prefers wholesale pricing. However, it can be shown that it depends on the parameters whether the downstream firm prefers wholesale agreements. For instance, for $c^D = 0.6$ instead of 0.1, both firms prefer agency pricing for intermediate values of the bargaining parameter.

# 3 Empirical Model

To make the model amenable for estimation, in this section, we extend the model to allow for multiple upstream and downstream firms and multi-product firms. In addition, we model consumer demand using a logit discrete choice framework and derive the model's equilibrium conditions.

## 3.1 Demand

We consider an industry with multiple upstream suppliers where each produces one or more goods and sells a set of these goods non-exclusively through multiple downstream retailers. Upstream producers can sell the same good through different retailers, and retailers can sell goods from different suppliers. We define a product as a good-retailer pair. The utility consumer $i$ derives from product $j$ is given by

$$u_{ij} = \alpha \log(p_j) + x_j'\beta + \xi_j + \varepsilon_{ij}, \tag{7}$$

where $p_j$ is the price of product $j$, $x_j$ and $\xi_j$ are observed and unobserved characteristics of product $j$, $\alpha$ and $\beta$ are demand parameters, and $\varepsilon_{ij}$ is a consumer-product specific utility shock. We allow for an outside option with utility $u_{i0} = \varepsilon_{ij}$. Assuming $\varepsilon_{ij}$ follows a Type I Extreme Value distribution, and letting $\delta_j = \alpha \log(p_j) + x_j'\beta + \xi_j$, the market share of product $j$ is

$$s_j(p) = \frac{\exp(\delta_j)}{1 + \sum_{k=1}^{N} \exp(\delta_k)},$$

where $p$ is a price vector. Next, we consider both the wholesale model and the agency model to determine equilibrium prices.

## 3.2 Wholesale Model

We model wholesale and retail pricing as a two-stage game. In stage one, the upstream supplier and downstream retailer of each product $j$ agree to a wholesale contract in which the retailer pays the supplier a wholesale input price $w_j$ for product $j$.[13] All contracts are determined simultaneously in stage one. In stage two, retailers simultaneously choose retail prices given the wholesale terms established in stage one.

Normalizing the size of the market to one, the downstream and upstream variable profits from selling product $j$ are given by

$$\pi_j^D(p) = \left(p_j - w_j - c_j^D\right) s_j(p) \quad \text{and} \quad \pi_j^U(p) = \left(w_j - c_j^U\right) s_j(p), \tag{8}$$

where $p_j$ is the price of product $j$, $w_j$ is the wholesale price, and $c_j^D$ and $c_j^U$ are the retailer's and upstream supplier's marginal product cost $j$.

### Downstream Market

Overall profits of the retailer that sells products in the set $\Omega^D$ are given by

$$\pi^D = \sum_{j \in \Omega^D} \left(p_j - w_j - c_j^D\right) s_j(p).$$

We assume a pure-strategy Nash equilibrium in retail prices. The first-order condition for product $j$ is given by

$$s_j + \sum_{k \in \Omega^D} m_k^D \frac{\partial s_k}{\partial p_j} = 0, \tag{9}$$

[13] The actual wholesale contracts that were used for e-books in the period 2012-2014 are typically called agency contracts because the retailer keeps a fraction $r_j$ of the recommended price $\rho_j$ for every product sold and the supplier receives the remainder. However, during this period, the retailer was free to set a discount, which means that these contracts are equivalent to wholesale agreements. To see this, observe that the variable profit of the retailer from selling product $j$ is $\pi_j^D(p) = \left(r_j\rho_j - (\rho_j - p_j) - c_j^D\right) s_j(p)$, where $\rho_j - p_j$ reflects the discount the retailer may set. This can be rewritten as $\pi_j^D(p) = \left(p_j - (1 - r_j)\rho_j - c_j^D\right) s_j(p)$. Note that the term $(1 - r_j)\rho_j$ is effectively a per-product wholesale price $w_j$ paid to the supplier, which is the notation we use in this section. To distinguish between the two types of agency agreements (with and without discounting), in the remainder of the paper, we will use the term agency agreements only for agency agreements that do not allow the retailers to give discounts, whereas we will use the term wholesale agreements when discounting is allowed.

where $m_k^D = p_k - w_k - c_k^D$ is the downstream margin on product $k$. The derivative of the market share of product $k$ with respect to price $p_j$ is given by

$$\frac{\partial s_k}{\partial p_j} = \begin{cases} \alpha s_k \left(1 - s_k\right)/p_k & \text{if } k = j; \\ -\alpha s_j s_k / p_j & \text{if } k \neq j. \end{cases} \tag{10}$$

**Upstream Market**

We assume that wholesale prices are the outcome of a bilateral bargaining process between suppliers and retailers, and separate wholesale prices are chosen for each product. Overall profits of an upstream firm that sells products in the set $\Omega^U$ are given by

$$\pi^U = \sum_{j \in \Omega^U} m_j^U s_j(p),$$

where $m_j^U = w_j - c_j^U$ is the upstream margin for product $j$ and $c_j^U$ is the upstream firm's marginal cost for product $j$.

We assume that wholesale prices are determined through simultaneous Nash bargaining ("Nash-in-Nash" bargaining) between the upstream and downstream firm associated with each product. The Nash product for downstream firm $d$ and upstream firm $u$ is

$$NP_{du}(w_{du}; w_{-du}) = \left(\pi^U - d_{du}^U\right)^\lambda \left(\pi^D - d_{du}^D\right)^{1-\lambda}, \tag{11}$$

where $w_{du}$ is the vector of wholesale prices of the products associated with the upstream-downstream pair $du$, $w_{-du}$ is the vector of wholesale prices for products associated with other upstream-downstream pairs, $d_{du}^U$ and $d_{du}^D$ are disagreement payoffs (discussed below), and $\lambda \in [0,1]$ is the bargaining weight of upstream firm $u$. Although we do not index $\lambda$ to keep the notation simple, in our empirical application, we allow $\lambda$ to vary across supplier-retailer pairs. The Nash-in-Nash bargaining solution is the vector of wholesale prices for all products such that $w_{du}$ maximizes $NP_{du}$ for all upstream-downstream pairs $du$, given the results of the negotiations between other upstream-downstream pairs.

Following Horn and Wolinsky (1988) and Crawford and Yurukoglu (2012), we assume rival firms do not observe a bargaining breakdown, which means that rival firms do not adjust input or retail prices if negotiations between a specific upstream-downstream pair fail.[14] However, we do allow market shares to adjust in case of disagreement. Specifically, we assume disagreement payoffs for each $du$ combination are given by

$$d_{du}^U = \sum_{k \in \Omega^U \setminus \{k \in du\}} m_k^U s_k^{-du} \quad \text{and} \quad d_{du}^D = \sum_{k \in \Omega^D \setminus \{k \in du\}} m_k^D s_k^{-du}.$$

[14] Crawford and Yurukoglu (2012) point out that an alternative model in which other firms renegotiate based on disagreeing pairs dropping out is computationally much more challenging, and therefore estimate the simpler model in which breakdowns are unobservable by other firms.

In these expressions, $s_k^{-du}$ is defined as the (counterfactual) market share for product $k$ when products of $du$ are not offered, i.e.,

$$s_k^{-du} = \frac{\exp(\delta_k)}{1 + \sum_{l \in \mathcal{J}_g \setminus \{l \in du\}} \exp(\delta_l)}. \tag{12}$$

So the disagreement payoff for the pair $du$ consists of the profits for $d$ from products not supplied by $u$ and profits for $u$ for products sold by other retailers that are not available at retailer $d$, considering that the demand for products $-du$ may have increased as a result of the products $du$ not being sold.

The bargaining first-order condition is found by setting the derivative of equation (11) with respect to $w_{du}$ equal to zero for *all* products that belong to the set of products offered by each $du$ combination. Let $j$ be such a product. The first-order condition for product $j$ is

$$\lambda \left(\pi^U - d_{du}^U\right)^{\lambda-1} \left(\pi^D - d_{du}^D\right)^{1-\lambda} \frac{\partial \pi^U}{\partial w_j} + (1-\lambda) \left(\pi^U - d_{du}^U\right)^{\lambda} \left(\pi^D - d_{du}^D\right)^{-\lambda} \frac{\partial \pi^D}{\partial w_j} = 0. \tag{13}$$

Since the Nash bargaining model defines an equilibrium payment for the set of products sold (and not just for an individual product $j$), in this first-order condition $\pi^U$ and $\pi^D$ are the *total* profits of the upstream and downstream firm. Equation (13) can be simplified to

$$\lambda \left(\pi^D - d_{du}^D\right) \frac{\partial \pi^U}{\partial w_j} + (1-\lambda) \left(\pi^U - d_{du}^U\right) \frac{\partial \pi^D}{\partial w_j} = 0. \tag{14}$$

The partial derivatives $\partial\pi^U/\partial w_j$ and $\partial\pi^D/\partial w_j$ are given by

$$\frac{\partial \pi^U}{\partial w_j} = \sum_{k \in \Omega^U} \frac{d\pi_k^U}{dw_j} \quad \text{and} \quad \frac{\partial \pi^D}{\partial w_j} = \sum_{k \in \Omega^D} \frac{d\pi_k^D}{dw_j},$$

where $d\pi_k^U/dw_j$ and $d\pi_k^D/dw_j$ are the *total* derivatives of $\pi_k^U$ and $\pi_k^D$ with respect to $w_j$. These total derivatives include the direct effect of $w_j$ on the profits as well as an indirect effect that comes through changes in equilibrium prices $p^*(w)$ and are derived in Appendix B.[15] Condition (14) together with condition (9) yield the equilibrium wholesale input prices and retail prices.

[15] An alternative approach, which is used in Draganska, Klapper, and Villas-Boas (2010) and Ho and Lee (2017), assumes retail prices and input prices are simultaneously determined, which allows one to treat retail prices as fixed. In addition to treating the retail prices as fixed (which does not mean that retail prices are independent of equilibrium retail prices), this literature also assumes that the derivative of the disagreement payoff with respect to input prices is zero. While we depart from this literature by assuming input prices are determined taking into account that retail prices may change in response (i.e., we allow for a non-zero derivative of retail prices with respect to input prices), we do keep the assumption that there are no disagreement payoff derivatives with respect to input prices. This implies that even if a firm is involved in multiple contract negotiations, it will treat each separately. As pointed out by Sheu and Taragin (2021), this assumption is important for maintaining tractability.

### 3.3 Agency Model

In the agency model, retail prices are set by the upstream suppliers, while the retailers obtain a royalty $r_j$. The variable profits of the retailer and upstream firm from selling product $j$ are given by

$$\pi_j^D(p) = \left(r_j p_j - c_j^D\right) s_j(p) \quad \text{and} \quad \pi_j^U(p) = \left((1-r_j)p_j - c_j^U\right) s_j(p).$$

**Upstream Market**

In the agency model, the upstream supplier determines the retail price $p_j$. Overall profits of the supplier that sells products in the set $\Omega^U$ are given by

$$\pi^U = \sum_{j \in \Omega^U} \left((1-r_j)p_j - c_j^U\right) s_j(p).$$

As in the wholesale model, we assume a pure-strategy Nash equilibrium in retail prices. The first-order condition for product $j$ is

$$(1-r_j)s_j + \sum_{k \in \Omega^U} m_k^U \frac{\partial s_k}{\partial p_j} = 0, \tag{15}$$

where $m_k^U = (1-r_j)p_j - c_j^U$ is the upstream margin on product $k$ and the derivative of the market share of product $k$ with respect to $p_j$ is given by equation (10).

**Downstream Market**

The Nash bargaining solution is a vector of royalties that maximizes the Nash product,

$$NP_{du}(r_{du}; r_{-du}) = \left(\pi^U - d_{du}^U\right)^{\lambda} \left(\pi^D - d_{du}^D\right)^{1-\lambda}$$

for each upstream-downstream pair $du$, where $r_{du}$ and $r_{-du}$ are vectors of royalties for the pairs $du$ and $-du$, respectively. The bargaining first-order condition is found by setting the derivative of $NP_{du}$ with respect to $r_{du}$ equal to zero for all products that belong to the set of products offered by each $du$ combination. The bargaining first-order condition for one such product—product $j$—is found by setting the derivative of the Nash product with respect to $r_j$ equal to zero and can be simplified to

$$\lambda \left(\pi^D - d_{du}^D\right) \frac{\partial \pi^U}{\partial r_j} + (1-\lambda) \left(\pi^U - d_{du}^U\right) \frac{\partial \pi^D}{\partial r_j} = 0. \tag{16}$$

Similar to the wholesale model, $\pi^U$ and $\pi^D$ are not just the profits for product $j$, but the total profits of the firms. The partial derivatives $\partial \pi^U / \partial r_j$ and $\partial \pi^D / \partial r_j$ are given by

$$\frac{\partial \pi^U}{\partial r_j} = \sum_{k \in \Omega^U} \frac{d\pi_k^U}{dr_j} \quad \text{and} \quad \frac{\partial \pi^D}{\partial r_j} = \sum_{k \in \Omega^D} \frac{d\pi_k^D}{dr_j},$$

where $d\pi_k^U/dr_j$ and $d\pi_k^D/dr_j$ are the *total* derivatives of $\pi_k^U$ and $\pi_k^D$ with respect to $r_j$. These total derivatives include the direct effect of $r_j$ on the profits and an indirect effect that comes through changes in equilibrium prices $p^*(r)$ and are derived in Appendix B. Condition (16) together with condition (15) yields the equilibrium agency royalties and retail prices.

*Upstream-Downstream–Specific Royalties.* The analysis above assumes that a separate royalty is set for every product, whereas we assume one royalty for each upstream-downstream pair when structurally estimating the model. Modifying the analysis to allow for a setting in which each upstream firm and retailer choose a single royalty for all of the upstream firm's products carried by the retailer is relatively straightforward. In bargaining over the profit-maximizing royalty to set, retailer $d$ and upstream firm $u$ recognize that a change in royalty $r_j$ changes the royalties for the other products from upstream firm $u$ that are carried by retailer $d$ by the same amount. The first-order condition that reflects this behavior sets the sum of the derivatives in equation (16) across the products sold by the pair $du$ equal to zero and evaluates this sum at a common royalty, $r^{du}$. That is,

$$\sum_{j \in du} \frac{\partial NP_{du}}{\partial r_j}\bigg|_{r_j = r^{du}\ \forall\ j \in du,\ \forall du} = 0, \quad \text{for all } du. \tag{17}$$

The components of the left-hand side of equation (17) are the same as the components of equation (16).

### 3.4 Timing Assumptions

In the wholesale model, we assume firms first negotiate input contracts, followed by a second stage in which retailers set retail prices, taking negotiated input prices as given. We assume interim observability, which means that the second stage takes place after all negotiations are complete and input prices are observed (see also McAfee and Schwartz, 1994; Rey and Vergé, 2004; Gaudin, 2018). Following most of the literature (including Horn and Wolinsky, 1988), we assume bargaining breakdowns are *not* observed when retailers set prices. As pointed out by Iozzi and Valletti (2014), whether breakdowns are observed or unobserved matters for calculating disagreement payoffs. With our assumption of unobserved breakdowns, when there is a disagreement, retailers cannot adjust their retail prices in response. This means that for the calculation of the disagreement payoffs, we can assume that the retail prices are still as if all firms are active, so only market shares have to be adjusted to capture that consumers face fewer firms to choose from (see equation (12)).[16] For the agency model, we also assume interim observability and unobserved bargaining breakdowns. Note that in the agency model, the order is reversed, so firms first bargain over agency royalties, followed by a second stage in which publishers set retail prices.

[16] Gaudin (2018) points out that interim observability does not imply breakdown observability, as interim observability relates to the offer, while breakdown observability relates to an acceptance decision (see footnote 43 of Gaudin, 2018).

# 4 Vertical Contracts in the E-Book Industry

In this section, we focus on vertical contracts in the e-book industry. We first provide a description of important changes in the contracts between upstream book publishers and downstream book retailers. We then use a dataset on e-book retail prices in the period 2014-2015 to show how retail prices changed at Amazon and Barnes & Noble as a result of the switch from wholesale to agency contracts between publishers and bookstores. This transition to agency occurred after a period of intense bilateral bargaining between retailers and publishers.

## 4.1 Background

Initially, e-books were sold using wholesale contracts. Publishers would set a list price for the e-book and would sell the book to a retailer for roughly half the list price. The retailer then would set a retail price at which to sell the product to the consumers. This vertical contract changed in 2010 with the introduction of the iPad when Apple, together with five of the (then) Big Six publishers, developed the agency model to sell e-books at the iPad's new iBookstore. These publishers welcomed Apple's entrance to the e-book industry to provide a counterweight to Amazon's dominance and saw it as an opportunity to increase retail prices. Publishers believed that low e-book prices, especially Amazon's pricing of $9.99 for new releases, cannibalized hardcover sales and eroded consumers' perception of a book's value. As an MFN clause required the publishers to match retail prices at the iBookstore to the lowest price retailer, publishers compelled Amazon to adopt the agency model. Furthermore, the agency contracts included a mapping between list prices of newly released hardcover titles and the agency retail prices for the corresponding e-books, where this mapping was virtually identical across publishers.[17] The switch from wholesale to agency contracts led to an immediate increase in retail prices.

In 2012, the US Department of Justice sued Apple and the publishers for conspiring to raise the prices of e-books. Three of the publishers settled right away, and the other two followed in early 2013. As part of the settlement agreement, the publishers could not set retail prices for a period of two years.[18] Moreover, the retail price MFN clauses that were seen as fundamental for making the switch to the agency model were banned for a period of five years.[19] The U.S. district court

[17] The two basic price tiers were $12.99 for hardcover prices between $25 and $27.50 and $14.99 for hardcover prices between $27.51 and $30.

[18] Note that termination dates of the bans were intentionally staggered to minimize the likelihood of collusive action at the time new contracts had to be negotiated.

[19] In 2017, Amazon agreed to stop enforcing e-book MFN clauses in Europe as part of a settlement with the European Commission. Although there was a similar lawsuit in 2012 in Europe as in the United States, with similar settlements (a two-year ban on agency and five-year ban on pricing MFNs), this does not necessarily imply that Amazon was using *retail price* MFN clauses in their agreements with the publishers prior to 2017 in the United States. Even though Amazon was not part of the 2012 lawsuits, the publishers that were part of the lawsuit were banned from using pricing MFNs for a period of five years, which effectively meant that Amazon could also not use price MFNs in their agreements with these publishers during this period. However, since the settlements do not cover publishers that were not part of the lawsuit, Amazon could have potentially used MFNs in contracts with other publishers. Moreover, the 2017 settlement agreement with the European Commission was about the use of MFNs in general, which includes other restrictive ebook contract clauses, such as the requirements to disclose to Amazon the

argued that the two-year ban on agency and the five-year ban on retail price MFNs was necessary to reset the bilateral bargaining relationship between retailers and publishers. Apple did not settle but eventually lost the case after further appeals. As part of the federal court's injunction, which went into effect in October 2013, Apple could net enter agency agreements with the publishers that were part of the lawsuit, with expiration dates ranging from 24 months for agreements with Hachette to 48 months for agreements with Macmillan.[20] De los Santos and Wildenbeest (2017) show that the transition from agency to wholesale contracts following the ban resulted in an 18 percent decrease in retail prices at Amazon and 8 percent at Barnes & Noble.

In the period leading to the expiration of the two-year ban on agency contracts, publishers and retailers engaged in a relatively lengthy period of negotiations over the conditions under which the publishers would regain control of retail prices. The negotiations between Amazon and Hachette became well-known publicly as they included various pressure tactics. Amazon reduced the inventory, delayed delivery, increased e-book prices, and removed the pre-order button for Hachette titles. Hachette started a public campaign to pressure Amazon, which included the involvement and support of some of their bestselling writers. Despite the lengthy bargaining period, by the end of 2015, all of the major publishers had returned to new agency contracts with Amazon with publisher-set prices.

Table 1: New contract announcement and switch dates for Amazon

| | Start of the agency ban | New agency agreement announcement | Amazon switch to new agency |
|---|---|---|---|
| Simon & Schuster | Dec 17, 2012 | Oct 20, 2014 | Jan 01, 2015 |
| Hachette | Dec 04, 2012 | Nov 13, 2014 | Feb 01, 2015 |
| Macmillan | Apr 04, 2013 | Dec 18, 2014 | Jan 05, 2015 |
| Harper Collins | Sep 10, 2012 | Apr 13, 2015 | Apr 15, 2015 |
| Penguin Random House | Sep 01, 2013 | Jun 18, 2015 | Sep 01, 2015 |

*Sources*: The agency agreement announcement dates, as well as approximate switch dates, were widely reported by several media outlets (including a series of articles by Jeffrey Trachtenberg in the Wall Street Journal). Actual switch dates are verified using screenshots from Amazon, from which it can be inferred whether the price was set by the publisher or by Amazon. The dates of the start of the agency ban, which correspond to the switch to the wholesale model under the terms of the settlements, are taken from De los Santos and Wildenbeest (2017).

The first column in Table 1 displays the effective date of the start of the ban on agency contracts observed in the period after the settlement with the DOJ for each of the now Big Five publishers (De los Santos and Wildenbeest, 2017).[21] The second column of Table 1 displays the dates when

terms of contracts with other retailers.

[20]According to the final judgment and order entering permanent injunction (see https://www.justice.gov/atr/case-document/file/486651/download), "Apple shall not enter into or maintain any agreement with a Publisher Defendant that restricts, limits, or impedes Apple's ability to set, alter, or reduce the Retail Price of any E-book or to offer price discounts or any other form of promotions to encourage consumers to purchase one or more E-books."

[21]Because of a merger between Penguin and Random House in July 2013, the Big Six was renamed the Big Five. Although Random House was not a conspirator defendant in the DOJ lawsuits, it adopted the terms of the settlement after the merger, which was prior to the sample period for this paper.

it was reported in the media that  Amazon and each of the publishers had reached a new bilateral agency agreement. The third column displays the dates when the new agency agreements took effect, and the switch to the agency can be identified in the data. The dates on the table show that even though each publisher announced an agreement with Amazon prior to the end of the two-year ban, the actual implementation dates of the new agreements varied between January and September of 2015, which means that most agreements did not go into effect immediately.

Note that while the media has reported extensively on Amazon's dealings with each of the Big Five publishers, we were unable to find reports on new agency agreements between Barnes & Noble and the publishers. Moreover, unlike Amazon, Barnes & Noble does not mention on a book's product page whether or not the price was set by the publisher. Nevertheless, the two-year ban on agency went into effect at the same time for e-books sold at both Amazon and Barnes & Noble, which meant that contracts had to be renewed around the same time for both retailers. Moreover, new selling terms for Harper Collins e-books went into effect on the same date for *all* retailers.[22] We therefore make the assumption that for each publisher, the switch at Barnes & Noble happened at the same date as at Amazon. Also note that we exclude Apple from the analysis below since it was banned from using agency agreements for a much longer period than the other retailers and, therefore, did not switch back to agency agreements during our sample period.

## 4.2 Data Description

Our dataset contains daily prices (obtained using a web scraper) for the period between November 12, 2014 (seven weeks before the first Big Five publisher switched) and October 21, 2015 (seven weeks after the last Big Five publisher switched) for a large number of e-book titles. All titles are new and former New York Times bestseller books. Books that appear in the New York Times bestseller lists are added to the sample from the moment of their appearance on the list.[23] For a specific title, we observe its retail price and sales rank at both Amazon and Barnes & Noble. Moreover, we observe book characteristics such as publisher and ratings at Amazon. We aggregate the data to weekly observations.[24] Table 2 summarizes the variables we use for our analysis. A comparison of retail prices across the two retailers shows that depending on the publisher, retail prices were about 11 to 20 percent lower at Amazon than at Barnes & Noble when wholesale contracts were used but were more similar during the agency period.

A limitation of our dataset is that all of the books in our sample started out as New York Times bestseller titles, which means the sample is not necessarily representative of all relevant titles of a publisher. However, we started collecting data in 2011, which means that many of the titles in

[22] According to Publishers Lunch (https://lunch.publishersmarketplace.com/2015/04/harper-readies-return-to-full-agency), "Multiple retailers report that Harper has informed them their selling terms will change as of Tuesday, April 14. (The change is actually effective at midnight Pacific time rather than Eastern. Amazon would be among those companies that naturally end their business day on Pacific time.) Harper is requiring retailers to implement all price changes within 24 hours. Going forward, Harper will require that their e-books be sold at the publisher's listed consumer price, without any discounts." The article also notes that "Harper's notice to retailers is an 'interim' measure, in advance of more permanent new agency contracts," which means that even though other retailers could

Table 2: Summary statistics

| | Harper Collins | | Hachette | | Simon & Schuster | | Macmillan | | Penguin Random House | | Other publishers | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Price e-book (wholesale)* | | | | | | | | | | | | |
| Amazon | 9.17 | (3.46) | 8.75 | (2.44) | 9.86 | (2.93) | 8.65 | (2.45) | 9.06 | (2.61) | 8.70 | (3.29) |
| Barnes & Noble | 11.42 | (4.23) | 9.94 | (2.81) | 11.81 | (2.96) | 10.30 | (2.50) | 11.03 | (2.73) | 9.79 | (3.75) |
| *Price e-book (agency)* | | | | | | | | | | | | |
| Amazon | 10.82 | (3.44) | 9.79 | (2.67) | 11.57 | (2.92) | 9.94 | (2.84) | 12.07 | (2.81) | — | |
| Barnes & Noble | 10.94 | (3.33) | 10.17 | (2.68) | 11.64 | (2.69) | 10.01 | (2.79) | 12.21 | (2.64) | — | |
| *Book characteristics* | | | | | | | | | | | | |
| Rating | 4.30 | (0.37) | 4.24 | (0.40) | 4.30 | (0.39) | 4.21 | (0.40) | 4.25 | (0.39) | 4.39 | (0.32) |
| Titles | 366 | | 290 | | 392 | | 243 | | 1,237 | | 829 | |
| Observations | 19,460 | | 18,599 | | 24,122 | | 15,243 | | 78,576 | | 44,201 | |

*Notes*: The table presents the means of each variable, with standard deviations in parentheses. The data is aggregated to weekly observations and exclude titles with a lowest observed price of less than $2.99. Other publishers consists of non Big Five publishers with books sold at both Amazon and Barnes & Noble.

our sample were no longer best-selling titles during the 2014-2015 period, which is the focus of our analysis.

## 4.3 The Effect of the Switch to Agency on Retail Prices

For the analysis in this section, we use a similar difference-in-differences (DID) approach as in De los Santos and Wildenbeest (2017). But where De los Santos and Wildenbeest study the transition from agency contracts to wholesale contracts that followed the Justice Department's lawsuit against the major publishers and Apple in 2012, we focus on the transition from wholesale to agency that occurred after the two-year ban on agency had expired in the period 2014-2015. An important difference is that during the first period, several of the key players in the industry were found to be colluding. Another important difference is that MFN clauses were not used during the second agency period and, therefore, do not play a role in explaining the higher agency prices, as argued by Johnson (2017).

As was shown in Table 1, new contracts were announced between Amazon and the major publishers at different points in time, resulting in the staggering of the actual switching dates at Amazon. We exploit this cross-publisher variation in the timing of the switch in a difference-in-

no longer offer discounts, they could still negotiate new terms regarding agency royalties.

[23]We modified the collection method for technical reasons on July 21, 2015. Because of this, the number of books we could track was reduced and was restricted to mostly popular books, as defined by the sales rank.

[24]We exclude titles with a lowest observed price of less than $2.99 and only include e-books that are sold at both retailers.

Table 3: Results difference-in-differences analysis

| | Amazon | | | | Barnes & Noble | | | |
|---|---|---|---|---|---|---|---|---|
| | (A) | | (B) | | (C) | | (D) | |
| *Difference-in-differences estimator* | | | | | | | | |
| Agency × Harper Collins | 0.114 | (0.015) | 0.114 | (0.015) | -0.058 | (0.011) | -0.059 | (0.011) |
| Agency × Hachette | 0.076 | (0.010) | 0.076 | (0.010) | 0.009 | (0.010) | 0.009 | (0.010) |
| Agency × Simon & Schuster | 0.151 | (0.013) | 0.151 | (0.013) | -0.016 | (0.007) | -0.016 | (0.007) |
| Agency × Macmillan | 0.086 | (0.019) | 0.086 | (0.018) | -0.074 | (0.016) | -0.074 | (0.016) |
| Agency × Penguin Random House | 0.238 | (0.014) | 0.238 | (0.014) | 0.057 | (0.008) | 0.057 | (0.008) |
| *Other controls* | | | | | | | | |
| Rating | | | 0.024 | (0.014) | | | -0.036 | (0.014) |
| Constant | 2.161 | (0.002) | 2.059 | (0.059) | 2.332 | (0.001) | 2.487 | (0.058) |
| Agency impact (aggregate effect) | 0.122 | (0.007) | 0.122 | (0.007) | -0.022 | (0.005) | -0.022 | (0.005) |
| R-squared | 0.852 | | 0.852 | | 0.879 | | 0.879 | |
| Number of observations | 101,253 | | 101,253 | | 98,948 | | 98,948 | |

*Notes*: Dependent variable is log(*price*). All specifications include book and week fixed effects. Standard errors (clustered by book) in parentheses.

differences setup. Specifically, the baseline specification we estimate is

$$\log(price_{jt}) = \sum_p \gamma_p \cdot (agency_{jt} \times publisher_{pj}) + \beta \cdot X_{jt} + \nu_j + \nu_t + \varepsilon_{jt}, \tag{18}$$

where $price_{jt}$ is the e-book price of title $j$ at time $t$, $agency_{jt}$ is an indicator for whether at time $t$ title $j$ was sold using an agency contract, $publisher_{pj}$ is an indicator for whether the title is published by Big Five publisher $p$, $X_{jt}$ are time-varying book characteristics, and $\nu_j$ and $\nu_t$ are book and time (week) fixed effects. The difference-in-differences estimator is captured by $\gamma_p$ and gives the publisher-specific price effect of the switch to the agency model.

Table 3 gives the main results for the difference-in-differences analysis. We estimate equation (18) separately for Amazon and Barnes & Noble. Specification (A) gives the estimates for Amazon when using only book and week fixed effects. This specification corresponds to the extended two-way fixed effects model of Wooldridge (2021) in which we allow for heterogeneity at the cohort level only. The results show that the effect is not the same across publishers: the percentage increase in e-book prices following the switch ranges from 8 percent for Hachette to 27 percent for Penguin Random House. Aggregating the publisher treatment effects to obtain a weighted average across publishers gives an estimate of 0.122, which implies that average prices went up by approximately 13 percent due to the switch from wholesale to agency. Controlling for time-varying book characteristics, as in specification (B), does not change any of the estimated effects. The two remaining specifications give the estimated effects for Barnes & Noble. Prices for Macmillan, Harper Collins, and Simon & Schuster titles decreased following the switch to agency, while prices for books published by Penguin Random House increased by approximately 6 percent. Across publishers, the aggregated agency impact coefficient (-0.022) indicates that average prices decreased by approximately 2 percent following the switch.

The results from the difference-in-differences analysis point to two important observations. First, the effect of the switch to agency agreements was different for Amazon than for Barnes & Noble. Second, there is heterogeneity in the magnitude of the effect across publishers. These results are consistent with our theoretical and empirical framework discussed in Sections 2 and 3 for a situation in which different retailers and publishers have different relative bargaining power parameters and, therefore, respond differently to a move from wholesale contracts to agency contracts.

# 5 Estimation of the Bargaining Model

## 5.1 Data

We use a subset of the data used in the previous section to estimate the structural model—for the estimation of the wholesale model, we use the first seven weeks of the sample, while we use the last seven weeks of the sample for the estimation of the agency model. Table 4 provides summary statistics of the main variables by publisher. As before, we use weekly observations. We use the 100 most popular titles in our sample by overall sales, using the restriction that for a title to be included, it needs to be published by a Big Five publisher, and we need to have observations for both Amazon and Barnes & Noble throughout the entire sample.[25] In total, we have 14 weeks of data, which corresponds to a total of 2,800 weekly observations (1,400 for the wholesale period and 1,400 for the agency period). The largest Big Five publisher, Penguin Random House, represents most of the observations in our sample. Macmillan is the smallest, with 6 titles. A comparison of the average prices under the two selling regimes indicates that even though average prices were \$2.56 higher at Barnes & Noble than at Amazon during the wholesale period, average prices under the agency model are very similar across the retailers despite the five-year ban on the use of retail price MFN clauses during this period.

For the estimation of the structural model, we need quantity data. As we lack quantity data for each book title, we use the approach suggested by Chevalier and Goolsbee (2003) and Brynjolfsson, Hu, and Smith (2003) to infer sales from the observed sales rank data. In particular, we first estimate the relation between (daily) sales and (hourly) sales rank for Amazon by regressing $\log(\text{Sales}_a)$ on a constant and $\log(\text{Rank}_a)$, where we have used to subscript $a$ to indicate that this data is for Amazon only.[26] To run this regression, we need both sales rank data (which is observed) and sales data (which is not observed). To get around this, we used data from an online sales rank calculator,

[25] Unfortunately, we do not have sales rank data for Apple, so we cannot include Apple when estimating the model.

[26] Following Chevalier and Goolsbee (2003) and Brynjolfsson, Hu, and Smith (2003), we assume that book sales quantities follow a Pareto distribution, i.e., the probability that an observation $\tau$ exceeds a level of Sales is

$$\Pr(\tau > \text{Sales}) = \frac{\text{Rank}}{\text{Total number of books}} = \left(\frac{k}{\text{Sales}}\right)^{\theta},$$

where $k$ and $\theta$ are the scale and shape parameters of the Pareto distribution. Solving for Sales and taking logs gives $\log(\text{Sales}) = \gamma_0 + \gamma_1 \log(\text{Rank})$, where $\gamma_0 = \log(k) + \frac{1}{\theta}(\text{Total number of books})$ and $\gamma_1 = -\frac{1}{\theta}$.

Table 4: Summary statistics

| | Harper Collins | | Hachette | | Simon & Schuster | | Macmillan | | Penguin Random House | |
|---|---|---|---|---|---|---|---|---|---|---|
| *Price e-book (wholesale)* | | | | | | | | | | |
| Amazon | 9.98 | (3.86) | 7.68 | (2.40) | 6.97 | (3.05) | 7.48 | (3.39) | 7.67 | (2.40) |
| Barnes & Noble | 11.38 | (3.39) | 9.51 | (2.82) | 11.32 | (1.41) | 11.43 | (2.54) | 10.14 | (1.96) |
| *Price e-book (agency)* | | | | | | | | | | |
| Amazon | 9.97 | (1.29) | 9.49 | (2.12) | 10.84 | (1.32) | 11.03 | (3.16) | 10.83 | (1.95) |
| Barnes & Noble | 10.03 | (1.22) | 9.49 | (2.11) | 11.09 | (0.98) | 11.03 | (3.16) | 10.83 | (1.95) |
| *Weekly sales* | | | | | | | | | | |
| Amazon | 2,733 | (5,313) | 3,930 | (18,910) | 3,876 | (26,439) | 714 | (734) | 3,523 | (17,027) |
| Barnes & Noble | 933 | (2,233) | 736 | (3,038) | 597 | (2,933) | 146 | (120) | 468 | (1,314) |
| *Book characteristics* | | | | | | | | | | |
| Rating | 4.28 | (0.25) | 4.20 | (0.36) | 4.39 | (0.24) | 4.40 | (0.20) | 4.30 | (0.31) |
| Titles | 7 | | 17 | | 9 | | 6 | | 61 | |
| Observations | 196 | | 476 | | 252 | | 168 | | 1,708 | |

*Notes*: The table presents the means of each variable, with standard deviations in parentheses.

which, for a particular Amazon sales rank, gives the expected number of copies sold per day.[27] We collected sales data using the sales rank calculator for four weeks in July 2014 and four weeks in September 2015 for 177 different titles (3,720 observations in total). The estimated equation we got using this data is

$$\widehat{\log(\text{Sales}_a)} = \underset{(0.015)}{10.647} - \underset{(0.002)}{0.855} \ \log(\text{Rank}_a),$$

with $R^2 = 0.970$. The predicted daily sales for Amazon books in our main sample is then obtained using $\widehat{\text{Sales}_a} = \exp\left[10.647 - 0.855 \log(\text{Rank}_a)\right]$, where we use the observed sales rank for each Amazon observation in our sample. To obtain Barnes & Noble sales data, we use the same estimated equation but (i) use sales ranks from Barnes & Noble and (ii) assume that for a given sales rank, daily Barnes & Noble sales are a quarter of Amazon sales.[28] Since we use weekly data for our analysis, the last step is to aggregate daily sales to weekly sales by calculating average sales across the days in a particular week and multiplying by seven.

## 5.2 Estimation Approach

Our estimation approach is to jointly estimate demand and supply and to use covariance restrictions to deal with endogeneity concerns (MacKay and Miller, 2024). The unobserved characteristic $\xi_j$ in the utility function (7) captures unobserved quality, which is likely to be correlated with a book's price. Our main specification below includes book and store fixed effects, so the book- and

[27]See https://kindlepreneur.com/amazon-kdp-sales-rank-calculator. We collected this data in 2016 for a subset of the sample—note that sales numbers for a given sales rank have changed slightly since then.

[28]Predicted sales for Barnes and Noble are therefore obtained as $\widehat{\text{Sales}_b} = 0.25 \cdot \exp\left[10.647 - 0.855 \log(\text{Rank}_b)\right]$, where we use the subscript $b$ to indicate Barnes & Nobles data. Note that because we use store fixed effects in the demand equation, we get very similar estimates when assuming higher aggregate sales at Barnes & Noble relative to Amazon (since the difference will be absorbed by the store fixed effects).

store-specific variation in unobserved quality that does not vary over time is captured by these fixed effects. However, these fixed effects will not pick up variation in prices due to differences in unobserved quality over time. For instance, a favorable review in Oprah's Book Club may lead to a sudden increase in demand and retail prices. The traditional approach to resolve price endogeneity is to use supply-side instruments and estimate the demand side of the model using instrumental variables. However, the BLP-type instruments that are typically used when estimating demand (see Berry, Levinsohn, and Pakes, 1995) are difficult to apply in this context since e-book attributes do not explain much of the variance in sales and demand. Hausmann-type instruments are not suitable either since there is no regional price variation in this market. Instead, we follow the approach suggested by MacKay and Miller (2024), which is to restrict the covariance between unobserved demand and cost shocks to zero. Intuitively, the supply-side model imposes restrictions on how prices respond to demand shocks, and by restricting how the demand and supply unobservables move together, it is possible to obtain causal estimates of the endogenous price parameter without needing supply-side instruments. Although an assumption of zero correlation between the unobserved demand and cost shocks may seem ad hoc, we include fixed effects in both the demand and cost function to make the zero-covariance restriction more credible. For instance, a potential concern here is that books with greater unobserved quality may also have higher marginal costs—the book fixed effects will absorb the quality component from the demand and cost shocks, making the zero-correlation assumption more plausible. Moreover, we use both own- and cross-covariance restrictions for estimation, and as we will show below, our estimates are robust to using cross-covariance restrictions only.

The parameters to be estimated are the parameters of the demand and marginal cost functions, as well as the bargaining parameters. Throughout the analysis, we assume the bargaining parameters do not change throughout the sample, i.e., we estimate one bargaining parameter for each publisher-retailer combination (which does not depend on the type of vertical contract). In addition, we assume that the demand parameters, as well as the marginal cost parameters, remain the same across the two periods, which means that the identification of the bargaining parameters is largely driven by the change in prices we observe as a result of switching from the wholesale model to the agency model.

Start with the demand side of the model. Since we are assuming the model has a logit structure, we can express demand for product $j$ in period $t$ as

$$\log(s_{jt}) - \log(s_{0t}) - \alpha \log(p_{jt}) = X_{jt}\beta + \xi_{jt}, \tag{19}$$

where $\xi_{jt}$ can be decomposed using product and time fixed effects, i.e., $\xi_{jt} = \xi_j + \xi_t + \Delta\xi_{jt}$. Market shares $s_{jt}$ are calculated as $\text{sales}_{jt}/M$, where $M$ is the market size.[29] Given $\alpha$, the demand side residuals $\Delta\xi_{jt}$ can be obtained as the residuals of a regression of the left-hand side of this expression

[29]We assume a total market size of 16 mln, which corresponds to 5 percent of the total US population in 2015 (320 mln) considering buying a book in a given week (so once every twenty weeks).

on $X_{jt}$ as well as various fixed effects.

Next, consider the supply side of the model. Besides payments to the publishers, any other marginal costs of the retailers are likely to be negligible, so we set the retailers' marginal cost to zero.[30] The combined upstream and downstream markup of product $j$ equals the difference between price and marginal cost, which means upstream marginal cost $c_{jt}$ equals $c_{jt} = p_{jt} - m^D_{jt} - m^U_{jt}$, where, depending on whether agency or wholesale agreements were used in period $t$, we use the first-order conditions for the wholesale or agency period derived in Section 3 to solve for $m^D_{jt}$ and $m^U_{jt}$ as a function of the parameters (see Appendix C for details).

To obtain the supply side residuals $\eta$, we assume the upstream marginal cost for product $j$ in market $t$ is given by

$$\log(c_{jt}) = Z_{jt}\gamma + \eta_{jt}, \tag{20}$$

where $\eta_{jt}$ can be decomposed as $\eta_{jt} = \eta_j + \eta_t + \Delta\eta_{jt}$. This means that the supply side residuals $\Delta\eta_{jt}$ can be obtained as the residuals of a fixed effects regression of $\log(c_{jt})$ on $Z_{jt}$.

Equations (19) and (20) give us the demand side residuals $\Delta\xi_{jt}$ and supply side residuals $\Delta\eta_{jt}$ given the data and the parameters of the model. Following MacKay and Miller (2024), we use the orthogonality condition $E_t[\Delta\xi_{jt} \cdot \Delta\eta_{jt}] = 0$ for all $j, k$ for identification, where the expectation is over markets. The corresponding empirical moments that are used to estimate the parameters of the model $\sigma$ (which includes $\alpha, \beta, \gamma, \lambda$) by GMM are then

$$\hat{\sigma} = \arg\min_{\sigma} \left[ \frac{1}{J^2} \sum_{j,k} \left( \frac{1}{T} \sum_t \Delta\xi_{jt}(\sigma) \cdot \Delta\eta_{jt}(\sigma) \right)^2 \right]. \tag{21}$$

Appendix D discusses the results of a Monte Carlo exercise we use to investigate identification and to study the small sample performance of our estimation procedure.

## 5.3 Parameter Estimates

Table 5 gives the parameter estimates for various specifications of the bargaining model. Column (A) of Table 5 gives estimates of the demand parameters and the bargaining parameters for our main specification. Demand shifters we include are the log of price, the five-star rating of the title on Amazon, and book, store, and week fixed effects. As marginal cost shifters, we include book fixed effects. The price coefficient is estimated precisely and corresponds to an average own-price elasticity of around −1.9, whereas rating positively affects the marginal utility of an e-book.

All of the estimated bargaining power parameters are less than half, which, given our assumption that the bargaining weights are not affected by the selling method, suggests the retailers have more bargaining power than the publishers. The bargaining parameters for Amazon are generally lower than those for Barnes & Noble, which is consistent with the results of the difference-in-difference analysis in Section 4, which indicated a bigger switch-related price effect for Amazon than for

[30] Alternatively, a retailer's marginal cost can be estimated alongside the other parameters.

Table 5: Parameter estimates of the bargaining model

| Variable | (A) Main specification Coeff. | Std. Err. | (B) Retailer-specific price parameter Coeff. | Std. Err. | (C) Take-it or leave-it contracts Coeff. | Std. Err. | (D) Cross covariance restrictions only Coeff. | Std. Err. |
|---|---|---|---|---|---|---|---|---|
| *Demand parameters* | | | | | | | | |
| log(price) | -1.904 | (0.113) | | | -2.292 | (0.191) | -1.915 | (0.114) |
| Amazon | | | -1.832 | (0.115) | | | | |
| B&N | | | -1.666 | (0.084) | | | | |
| rating | 1.835 | (0.703) | 1.843 | (0.698) | 1.835 | (0.724) | 1.835 | (0.704) |
| *Bargaining parameters Amazon* | | | | | | | | |
| Harper Collins | 0.346 | (0.097) | 0.333 | (0.091) | | | 0.347 | (0.098) |
| Hachette | 0.244 | (0.040) | 0.238 | (0.037) | | | 0.244 | (0.040) |
| Simon & Schuster | 0.076 | (0.076) | 0.081 | (0.073) | | | 0.075 | (0.077) |
| Macmillan | 0.129 | (0.073) | 0.131 | (0.069) | | | 0.128 | (0.074) |
| Penguin Random House | 0.178 | (0.027) | 0.177 | (0.027) | | | 0.177 | (0.027) |
| *Average* | 0.195 | | 0.192 | | | | 0.194 | |
| *Bargaining parameters Barnes & Noble* | | | | | | | | |
| Harper Collins | 0.452 | (0.085) | 0.429 | (0.069) | | | 0.453 | (0.086) |
| Hachette | 0.383 | (0.031) | 0.374 | (0.025) | | | 0.384 | (0.032) |
| Simon & Schuster | 0.397 | (0.017) | 0.385 | (0.015) | | | 0.398 | (0.017) |
| Macmillan | 0.427 | (0.043) | 0.409 | (0.036) | | | 0.429 | (0.044) |
| Penguin Random House | 0.355 | (0.013) | 0.353 | (0.012) | | | 0.355 | (0.014) |
| *Average* | 0.403 | | 0.390 | | | | 0.404 | |
| Objective function | 0.009 | | 0.008 | | 0.019 | | 0.009 | |

*Notes*: Bootstrapped standard errors shown in parentheses (clustered by book title). Demand specification includes store, book, and week fixed effects. Marginal cost specification includes book fixed effects. Bargaining parameters are fixed to 1 for the wholesale model and 0 for the agency model in specification (C). Number of observations is 2,800.

Barnes & Noble, and hence suggests relatively more bargaining power for Amazon than for Barnes & Noble. However, there is substantial variation in the estimated bargaining parameters across publishers, which to some extent can be explained by the magnitude of the price effects we found in Section 4. Especially the estimated bargaining parameters for Barnes & Noble show a clear relation with the results of the difference-in-differences analysis: for both Harper Collins and Macmillan, we found a negative price effect of the switch to agency, which indicates these publishers have relatively more bargaining power, exactly as their above-average bargaining weight estimates show. The relation with the reduced-form findings is less clear for Amazon, although we do find bargaining power for Simon & Schuster and Penguin Random House—the publishers for which we found the biggest price effects—to be below average.

Table 6 gives the estimated royalty parameters during the agency period for specification (A) of Table 5. The average royalty share across retailers and publishers is 0.373, which is higher than the 30 percent that was typically used during the first agency period (between 2010 and 2012). Agency royalties are higher at Amazon than at Barnes & Noble, which is in line with Amazon's more favorable bargaining power estimates. Publishers with above-average bargaining power tend to have lower agency royalties. For instance, Harper Collins has the highest bargaining parameter estimates of all publishers and is also estimated to have the lowest agency royalty rates.

Table 7 reports the implied margins for the bargaining model estimates reported in column (A)

Table 6: Royalty parameter estimates

| | Amazon | | Barnes & Noble | | Average |
|---|---|---|---|---|---|
| Harper Collins | 0.353 | (0.058) | 0.288 | (0.052) | 0.321 |
| Hachette | 0.402 | (0.026) | 0.325 | (0.030) | 0.364 |
| Simon & Schuster | 0.492 | (0.036) | 0.318 | (0.029) | 0.405 |
| Macmillan | 0.462 | (0.040) | 0.302 | (0.036) | 0.382 |
| Penguin Random House | 0.443 | (0.024) | 0.340 | (0.027) | 0.392 |
| *Average* | 0.431 | | 0.314 | | 0.373 |

*Notes*: Estimates are for specification (A) in Table 5. Bootstrapped standard errors are shown in parentheses (clustered by book title).

of Table 5. The table reports figures for both the wholesale and agency models and shows that the publishers' margins went up for all of the publishers when switching to agency contracts. Amazon's average downstream margin also went up when switching to agency contracts, but Barnes & Noble's margins went down due to the switch.

Table 7: Prices and margins

| | Panel A. Wholesale period | | | | | Panel B. Agency period | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Retail price | Down-stream margin | Whole-sale price | Up-stream margin | Mar-ginal cost | Retail price | Down-stream margin | Whole-sale price | Up-stream margin | Mar-ginal cost |
| *Retailers* | | | | | | | | | | |
| Amazon | 7.74 | 4.18 | 3.57 | 0.65 | 2.92 | 10.55 | 4.61 | 5.94 | 3.14 | 2.80 |
| Barnes & Noble | 10.30 | 5.44 | 4.87 | 1.44 | 3.42 | 10.58 | 3.49 | 7.09 | 3.75 | 3.34 |
| *Publishers* | | | | | | | | | | |
| Harper Collins | 10.68 | 5.68 | 5.00 | 1.56 | 3.44 | 10.00 | 3.21 | 6.79 | 3.57 | 3.22 |
| Hachette | 8.59 | 4.58 | 4.01 | 1.07 | 2.94 | 9.49 | 3.45 | 6.04 | 3.18 | 2.86 |
| Simon & Schuster | 9.06 | 4.82 | 4.23 | 0.95 | 3.28 | 10.96 | 4.43 | 6.54 | 3.43 | 3.10 |
| Macmillan | 9.45 | 5.03 | 4.42 | 1.09 | 3.33 | 11.03 | 4.21 | 6.82 | 3.58 | 3.24 |
| Penguin Random House | 8.91 | 4.75 | 4.16 | 0.99 | 3.17 | 10.83 | 4.24 | 6.59 | 3.50 | 3.09 |

*Notes*: Estimates are for specification (A) in Table 5.

The three remaining columns of Table 5 give estimates for alternative models. In column (B) of the table, we allow for a more flexible demand system that allows for different price coefficients for the two retailers. Our main specification has a single price parameter, which means that if Amazon and Barnes & Noble cater to consumers who differ in their price sensitivity, the difference in price sensitivity could be picked up by the bargaining parameters.[31] As shown by the price parameter estimates in column (B) of Table 5, Barnes & Noble customers do appear to be less price sensitive on average than Amazon customers, although the difference is small. The bargaining parameters are not much affected by allowing for this additional layer of heterogeneity, although Barnes & Noble is now estimated to have slightly more bargaining power on average than in our main specification.

In column (C) of Table 5, we estimate the model assuming the publishers make take-it or leave-

[31] Retailer-specific price parameters can be identified from retailer-specific variation in prices and quantities within either the agency or wholesale period.

it offers in the wholesale model and the retailers make take-it or leave-it offers in the agency model. The estimated demand parameters for this specification indicate demand is more elastic, whereas the effect of rating is the same as in our main specification. A comparison of the objective function values for the two specifications suggests the bargaining model outperforms the take-it or leave-it model. However, the two models are non-nested—the bargaining model assumes the bargaining parameters are constant across the two types of vertical contracts, while with take-it or leave-it contracts, the publishers have all the bargaining power in the wholesale model ($\lambda = 1$) and retailers have all the bargaining power in the agency model ($\lambda = 0$). To formally test which model gives the best fit to the data, we use the non-nested test proposed by Rivers and Vuong (2002). The test statistic is $-191.54$, which means we can strongly reject the take-it or leave-it model against the bargaining model.[32]

In our main specification, we use both own-product covariance restrictions as well as cross-product covariance restrictions, i.e., $\mathbb{E}_t[\Delta\xi_{jt}\Delta\eta_{kt}] = 0$ for all $j, k$, where expectations are over markets $t$ (see Section 4.1 of MacKay and Miller, 2024). This gives us $J \times J$ restrictions, where $J$ of these restrictions reflect own-product covariance restrictions. As a robustness check, we have estimated the model using only cross-product covariance restrictions, i.e., $\mathbb{E}_t[\Delta\xi_{jt}\Delta\eta_{kt}] = 0, \quad \forall j \neq k$. The results are shown in column (D) of Table 5 and are almost identical to the results for the main specification. This is perhaps not very surprising since only $J$ of the $J \times J$ covariance restrictions used to estimate the main specification reflect own-product covariance restrictions.

**Additional Robustness**

In column (A) of Table 8, we estimate demand and supply separately. To estimate the demand side, we use two-stage least squares with lagged prices as a price instrument. This instrument has been used in other markets where it is difficult to use traditional instruments, such as the market for console video games (Nair, 2007; Shiller, 2013) as well as online marketplaces (Jin, Lu, Zhou, and Fang, 2023). The estimated price coefficient decreases in magnitude compared to our main specification. Also shown in the table are the estimated supply-side parameters, which are estimated in a separate step by minimizing the sum of squared residuals of the marginal cost equation, taking the demand parameters as given. The estimated bargaining parameters are again close to those for the main model, which suggests that the estimation of the supply side parameters of the model is robust to using a more traditional IV-based approach to estimate the model.

To get a better sense of how the uncertainty related to the price parameters affects the supply side estimates, in column (B) of Table 8 we take a different approach and calibrate the price coeffi-

[32] The Rivers and Vuong (2002) statistic is calculated as $T_N = (\sqrt{N}/\hat{\sigma}_N)(\hat{Q}_1 - \hat{Q}_2)$, where $N$ is the number of observations, $\hat{Q}_1$ and $\hat{Q}_2$ are the objective function values of the bargaining model and the take-it or leave-it model, respectively, and $\hat{\sigma}_N$ is the estimated standard deviation of the difference between $\hat{Q}_1$ and $\hat{Q}_2$ (estimated using 100 bootstrap replications). The Rivers and Vuong test statistic has to be evaluated against a standard normal distribution, which, given the test-statistic of $-191.54$, results in a $p$ value of 0.000, so we can strongly reject the take-it or leave-it model against the bargaining model.

Table 8: Parameter estimates alternative supply side model and estimation approaches

| Variable | (A) Demand and supply separately | | (B) Price parameter calibrated | | (C) Sales obtained using BHS | | (D) Excluding top titles | |
|---|---|---|---|---|---|---|---|---|
| | Coeff. | Std. Err. | Coeff. | Std. Err. | Coeff. | Std. Err. | Coeff. | Std. Err. |
| *Demand parameters* | | | | | | | | |
| log(price) | -1.308 | (0.165) | -2.200 | | -1.866 | (0.110) | -1.496 | (0.041) |
| rating | 2.237 | (0.732) | | | 1.869 | (0.713) | 2.021 | (0.442) |
| *Bargaining parameters Amazon* | | | | | | | | |
| Harper Collins | 0.249 | (0.052) | 0.348 | (0.121) | 0.347 | (0.095) | 0.298 | (0.065) |
| Hachette | 0.198 | (0.036) | 0.223 | (0.048) | 0.249 | (0.038) | 0.286 | (0.021) |
| Simon & Schuster | 0.091 | (0.041) | 0.003 | (0.092) | 0.086 | (0.074) | 0.185 | (0.046) |
| Macmillan | 0.121 | (0.047) | 0.076 | (0.087) | 0.138 | (0.071) | 0.195 | (0.042) |
| Penguin Random House | 0.170 | (0.033) | 0.137 | (0.029) | 0.183 | (0.025) | 0.228 | (0.011) |
| *Average* | 0.166 | | 0.157 | | 0.201 | | 0.238 | |
| *Bargaining parameters Barnes & Noble* | | | | | | | | |
| Harper Collins | 0.344 | (0.039) | 0.489 | (0.102) | 0.449 | (0.083) | 0.375 | (0.060) |
| Hachette | 0.310 | (0.017) | 0.405 | (0.042) | 0.382 | (0.030) | 0.346 | (0.021) |
| Simon & Schuster | 0.325 | (0.009) | 0.436 | (0.021) | 0.395 | (0.017) | 0.372 | (0.017) |
| Macmillan | 0.338 | (0.021) | 0.469 | (0.055) | 0.424 | (0.042) | 0.375 | (0.029) |
| Penguin Random House | 0.302 | (0.009) | 0.370 | (0.016) | 0.354 | (0.013) | 0.337 | (0.008) |
| *Average* | 0.324 | | 0.434 | | 0.401 | | 0.361 | |
| Objective function | 0.067 | | 0.042 | | 0.009 | | 0.006 | |

*Notes*: Bootstrapped standard errors are shown in parentheses (clustered by book title), except for demand parameters in column (A), which are TSLS standard errors. Lagged prices are used to instrument for price in specification (A). Demand specifications include book, store, and week fixed effects. Marginal cost specification includes book fixed effects. Number of observations is 2,800.

cient. We then estimate the supply-side model only by minimizing the sum of squared (upstream) marginal cost residuals. We fix the price parameter to $-2.2$, which corresponds to Amazon's internal estimate of the average price elasticity for e-books.[33] As shown in column (B) of the table, more elastic demand leads to slightly lower bargaining weight estimates on average for Amazon but slightly higher average bargaining weight estimates for Barnes & Noble, which implies more bargaining power for Amazon and less for Barnes & Noble in comparison to the main specification. Nevertheless, the differences with the estimates for the main specification are relatively small, which suggests the supply-side estimates are relatively robust to variation in the price parameter despite the different estimation approach (i.e., minimizing the sum of squared marginal cost residuals instead of targeting zero cross-covariance between demand and supply side residuals).

To address the concern that our estimates are sensitive to the way in which we have obtained sales data, in column (C) of Table 8 we use the estimates from Brynjolfsson, Hu, and Smith (2003) to translate sales rank into sales, i.e., predicted sales for Amazon are given by $\widehat{\text{Sales}_a} = \exp\left[10.526 - 0.871 \log(\text{Rank}_a)\right]$. As can be seen from the table, estimates are very similar to those of the main specification. Another potential concern is that the number of titles we use to estimate

[33] According to a message from the Amazon Books Team to the reader published at readersunited.com in 2014, "for every copy an e-book would sell at \$14.99, it would sell 1.74 copies if priced at \$9.99," which implies an own-price elasticity of $\%\Delta Q/\%\Delta P = 74/(100 \times (-5/14.99)) = -2.2$.

the structural model is limited and that the sales corresponding to the 100 titles included in the sample might not be representative of the overall sales share of each publisher. A comparison of the structural sample to the sample used for the reduced form analysis (which contains 2,528 unique Big Five titles) shows that due to several successful bestsellers published by Penguin Random House as well as Hachette, these two publishers are overrepresented in terms of sales (i.e., units sold), whereas books by Harper Collins and Macmillan are underrepresented. To see whether this affects the estimates of the bargaining parameters, in the last column of Table 8 we have excluded several of the top bestseller titles.[34] Comparing these results to those for the main specification shows that the estimated price coefficient is less negative, which can be explained by the observation that some of the removed bestselling titles also had low prices. The publisher-retailer bargaining parameters do change somewhat, with most bargaining parameters going up at Amazon (suggesting more bargaining power to the publishers) and going down at Barnes & Noble. However, the average bargaining parameters across publishers and retailers is 0.3, identical to the main specification, suggesting that the model's finding that Amazon and, to a lesser extent, Barnes & Noble have most of the bargaining power is robust to this change in the sample.

## 5.4 Counterfactual Analysis of the Most Favored Nations Clause

The settlements between the DOJ and the Big Five publishers in 2012 explicitly banned the use of retail price MFN clauses for a period of five years. The MFN clauses of the agency agreements required that the retail price of a specific e-book title set by a publisher be the same at all retailers. In this section, we study what happens to agency prices when retail price MFN clauses are reinstated, which, starting in 2017, is again a possibility. According to DOJ, the MFN clauses that were used during the initial switch to agency contracts in 2010 were essential for making the entire industry shift towards agency agreements, with the switch from wholesale to agency leading to higher consumer prices. Even though the largest publishers returned to the agency model and MFN clauses were not instrumental in making the switch to this second period of agency pricing, this does not mean that MFN clauses are unlikely to have a further impact on pricing once permitted again. The reason for this is that MFN guarantees a retailer that a book's price will not exceed that of competing retailers when raising its agency royalty. This encourages retailers to push for higher royalties, which results in higher retail prices (see also Johnson, 2017).

We use the estimates from specification (A) of Table 5 to simulate equilibrium prices and royalties when MFN agreements are used. Since a specific e-book title should now have the same price at both Amazon and Barnes & Noble, the retail price for title $t$ is determined using the

[34] In particular, we took out the top two bestselling Harper Collins titles, the top three bestselling Hachette titles, the top Simon & Schuster title, and the top eleven bestselling Penguin Random House titles, while keeping all Macmillan titles. To get back to 100 titles, we added the next 17 bestselling titles.

Table 9: Prices, royalties, margins, and profits MFN

| | No MFN | | | | MFN | | | |
|---|---|---|---|---|---|---|---|---|
| | Price | Royalty | Margin | Profits | Price | Royalty | Margin | Profits |
| *Retailers* | | | | | | | | |
| Amazon | 10.59 | 0.436 | 4.63 | 588,722 | 11.40 | 0.479 | 5.14 | 565,351 |
| Barnes & Noble | 10.61 | 0.329 | 3.50 | 84,581 | 11.40 | 0.402 | 5.59 | 119,257 |
| *Publishers* | | | | | | | | |
| Harper Collins | 9.85 | 0.321 | 3.51 | 21,916 | 10.82 | 0.400 | 3.32 | 18,032 |
| Hachette | 9.64 | 0.364 | 3.22 | 36,312 | 10.47 | 0.435 | 3.00 | 30,869 |
| Simon & Schuster | 11.10 | 0.405 | 3.48 | 17,062 | 12.67 | 0.437 | 4.00 | 14,251 |
| Macmillan | 11.32 | 0.382 | 3.68 | 11,692 | 12.86 | 0.435 | 3.95 | 9,505 |
| Penguin Random House | 10.81 | 0.392 | 3.48 | 400,624 | 11.40 | 0.497 | 2.64 | 381,091 |

*Notes*: Estimates are based on the bargaining model estimates reported in specification (A) of Table 5. Figures in the Margin columns reflect downstream margins for the retailers and upstream margins for the publishers.

following first-order condition:

$$\sum_{j \in t} \frac{\partial \pi^U}{\partial p_j}\bigg|_{p_j = p_t \; \forall \; j \in t} = 0.$$

Since bargaining is over royalties, the bargaining first-order condition is only affected by the indirect effect that comes through changes in equilibrium prices for the different titles.[35] The implications of using MFN on prices, royalties, margins, and profits are shown in Table 9. The table shows that royalties increase across the board, with Barnes & Noble seeing the biggest changes among the retailers and Hachette, Simon & Schuster, and Macmillan among the publishers. Even though retail prices go up as well, by an average of 8 percent across titles, this price increase is not enough to prevent margins from going down for all but one of the publishers. Moreover, there is a lot of variation in price changes across the publishers, ranging from an average price increase of 5 percent for Penguin Random House titles to 15 percent for Macmillan titles. Table 9 also shows that publishers' profits decrease, which is driven by the higher share of revenue going to the retailers combined with higher retail prices. Overall retail profits are up when MFN clauses are used, although only Barnes & Noble benefits from this increase. Moreover, combined industry profits are down, so even though Barnes & Noble would benefit substantially from the reinstatement of MFN clauses, this might not be enough for MFN agreements to make a comeback.

# 6 Conclusions

In this paper, we have studied the effects of the transition from wholesale contracts to agency contracts in the e-book market from 2014 to 2015. Using a difference-in-differences analysis, we

[35] Dubois, Gandhi, and Vasserman (2022) study MFN clauses in a Nash-in-Nash bargaining environment in the context of reference pricing in the pharmaceutical industry. An important difference with our setting is that in Dubois, Gandhi, and Vasserman (2022) the MFN clauses are with respect to the prices over which is bargained, whereas in our setting, the bargaining is with respect to agency royalties, and the MFN clauses only affect the retail prices that are set after agency royalties have been agreed upon.

have shown that prices increased by 13 percent following the switch at Amazon but went down 2 percent at Barnes & Noble. We have theoretically shown that if an upstream and downstream firm are bargaining over input prices, retail prices will be higher or lower under agency depending on the firms' relative bargaining power.

Our structural model extends this theoretical model to allow for competition among publishers and retailers, multi-product firms, and logit demand. We have shown how to estimate this model using sales rank data, prices, and book characteristics. Estimates of the bargaining model have shown that the retailers have most of the bargaining power, although there are large differences in estimated bargaining weights between retailer-publisher pairs. Moreover, the bargaining model better fits the data than a model in which input prices are determined using take-it or leave-it contracts. The results from a counterfactual analysis in which we reinstate MFN clauses lead to changes in consumer prices of about 8 percent. Nevertheless, the counterfactual analysis also shows that the adoption of MFN would lower the profits of the publishers and Amazon, which might be a contributing factor to why MFN contracts so far have not made a return.

What complicates our analysis of the market for e-books is that the objective function of the publishers and retailers has not always been clear. Our structural model assumes static profit maximization within a single market, which means complementaries with other products and dynamic considerations are not directly taken into account. For instance, Amazon not only sells e-books but also the hardware that goes with it, which may affect pricing or royalty decisions (see Gaudin and White, 2014). Dynamic competition could be important too, especially since consumers may face switching costs when moving between the retailers' different e-book platforms (see Johnson, 2020). Furthermore, we know from the 2012 lawsuit that the publishers were mostly concerned about how low e-book prices affected the market for hardcover books and supported the move to agency despite earning less from agency contracts, in the short term, than they were from wholesale contracts. Another limitation of our study is that litigation of the initial agency contracts has likely affected subsequent developments in this industry, so our results may not necessarily generalize to other contexts in which contracts are not litigated. Despite these limitations, our study shows the importance of the interaction of bargaining power and contract types (agency or wholesale) in determining retail prices.

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# A Proofs and Derivations Bilateral Monopoly Bargaining Model

## A.1 Retail Price Optimality Condition Wholesale Model

Because $p^*(w)$ is monotonically increasing in $w$, it is possible to use the first order condition (1) to eliminate $w$ from these profit expressions and express the Nash product as a function of the retail price $p$ (as Johnson (2017) observed for the take-it or leave-it case). It is then possible (and simpler) to characterize the bargaining solution by maximizing the Nash product with respect to the retail price $p$. To this end, we substitute equation (1) into the profit expressions to express profits in terms of the retail price: $\pi^U = \left(p - \phi(p) - c^U - c^D\right) Q(p)$ and $\pi^D = \phi(p)Q(p)$. Substituting these expressions and their derivatives into equation (2) gives

$$\begin{aligned} &\lambda\phi(p)Q(p)\left[(1-\phi'(p))Q(p) + (p-\phi(p)-c^U-c^D)Q'(p)\right] \\ &+(1-\lambda)\,(p-\phi(p)-c^U-c^D)Q(p)\left[\phi'(p)Q(p)+\phi(p)Q'(p)\right] = 0. \end{aligned} \tag{A1}$$

Dividing both sides of equation (A1) by $Q'(p)$ and rearranging gives an expression for the retail price in the wholesale model as a function of $\phi(p)$, $\phi'(p)$, and $\lambda$:

$$p = c^U + c^D + \phi(p)\left(\frac{\lambda + 1 - \phi'(p)}{\lambda + (1-\lambda)(1-\phi'(p))}\right).$$

## A.2 Retail Price Optimality Condition Agency Model

We can rewrite the first-order condition for price in equation (5) as

$$r = 1 - \frac{c^U}{p - \phi(p)}. \tag{A2}$$

It is again helpful to substitute the first order condition (A2) into the profits in (4) to express profits in terms of the retail price. After some algebra, this gives an upstream profit of

$$\pi^U = \frac{c^U}{p-\phi(p)}\phi(p)Q(p). \tag{A3}$$

Downstream profit can be written as the difference between joint profit and upstream profit:

$$\begin{aligned} \pi^D &= \left(p - c^U - c^D\right)Q(p) - \pi^U \\ &= \left(p - c^U - c^D\right)Q(p) - \frac{c^U}{p-\phi(p)}\phi(p)Q(p). \end{aligned} \tag{A4}$$

The derivative of the upstream profit (A3) with respect to $p$ is

$$\pi^{U\prime} = \frac{c^U\left[\phi'(p)Q(p)+\phi(p)Q'(p)\right](p-\phi(p)) - c^U\phi(p)Q(p)(1-\phi'(p))}{(p-\phi(p))^2}, \tag{A5}$$

and the derivative of the downstream profit (A4) is

$$\pi^{D'} = Q(p) + (p - c^U - c^D)Q'(p) - \pi^{U'}. \tag{A6}$$

Substituting the expressions in (A3), (A4), (A5), and (A6) into the bargaining first-order condition in (2), where the primes now indicate derivatives with respect to $r$, gives

$$\begin{aligned} \lambda \left[ \left( p - \phi(p) \frac{c^U}{p - \phi(p)} - c^U - c^D \right) Q(p) \right] \pi^{U'} + (1 - \lambda) \left( \frac{c^U}{p - \phi(p)} \phi(p) Q(p) \right) \\ \times \left[ Q(p) + (p - c^U - c^D)Q'(p) - \pi^{U'} \right] = 0. \end{aligned} \tag{A7}$$

Observe that

$$\pi^{U'}/Q'(p) = \phi(p) \left[ c^U \frac{p(1 - \phi'(p))}{(p - \phi(p))^2} \right].$$

Dividing both sides of the bargaining first-order condition (A7) by $Q'(p)$ and rearranging expresses the retail price in the agency model as a function of $\phi(p)$, $\phi'(p)$, and $\lambda$:

$$p = c^U + c^D + \phi(p) \left( \frac{(1 - \lambda)(p - \phi(p))^2 + c^U p(1 - \phi'(p))}{(p - \phi(p))\big(p(1 - \lambda\phi'(p)) - \phi(p)(1 - \lambda)\big)} \right).$$

### A.3 Proof of Proposition 1

**Proof.** We show that the wholesale model leads to a strictly higher price than the agency model when the upstream firm has all of the bargaining power and a strictly lower price when the opposite is true. The proposition then follows from the continuity of the equilibrium prices with respect to $\lambda$.

Suppose first that the upstream firm has all the bargaining power, i.e., $\lambda = 1$. Using equation (3), the first order condition in the wholesale model is

$$p^w - c^U - c^D = \phi(p^w) \left(2 - \phi'(p^w)\right) \tag{A8}$$

where the subscript '$w$' denotes the equilibrium price in the wholesale model. Note that this condition corresponds to the first-order condition in the take-it or leave-it case analyzed by Johnson (2017). Using equation (6), the first-order condition for the agency model is

$$p^a - c^U - c^D = \phi(p^a) \left( \frac{c^U}{p^a - \phi(p^a)} \right) \tag{A9}$$

where the subscript '$a$' denotes the agency price. We show by contradiction that the agency price must be lower than the wholesale price.

Suppose not, i.e., suppose $p^a \geq p^w$. Because the slope of the right-hand side of equation (A8) is less than 1 by assumption, there is a unique solution to equation (A8). Further, because $p^a \geq p^w$, it must be true that $p^a - c^U - c^D \geq \phi(p^a)\,(2 - \phi'(p^a)))$. Combining this with equation (A9) yields

$$\phi(p^a)\left(\frac{c^U}{p^a - \phi(p^a)}\right) \geq \phi(p^a)\left(2 - \phi'(p^a))\right),$$

Using $1 - r = c^U/(p^a - \phi'(p^a))$, this gives $1 - r \geq 2 - \phi'(p^a)$, which is a contradiction because $1 - r \leq 1$ and $2 - \phi'(p^a) > 1$. This establishes that $p^a < p^w$ when the upstream firm has all the bargaining power.

Next, consider the case where the downstream firm has all the bargaining power, i.e., $\lambda = 0$. The first-order conditions for this case are

$$p^w - c^U - c^D = \phi(p^w) \tag{A10}$$

and

$$p^a - c^U - c^D = \phi(p^a)\left(1 + c^U \frac{p^a(1 - \phi'(p^a))}{(p^a - \phi(p^a))^2}\right). \tag{A11}$$

Note that the condition for $p^a$ corresponds to the agency take-it or leave-it case analyzed by Johnson (2017). Proceeding again by contradiction, suppose $p^a \leq p^w$. Because the right-hand side of equation (A10) has slope less than 1, there is a unique solution for $p^w$, and the supposition that $p^a \leq p^w$ implies $p^a - c^U - c^D \leq \phi(p^a)$. Combining this with equation (A11) yields

$$\phi(p^a)\left(1 + c^U \frac{p^a(1 - \phi'(p^a))}{(p^a - \phi(p^a))^2}\right) \leq \phi(p^a).$$

But since $\phi'(p^a) < 1$, all terms in parentheses on the left-hand side of this inequality are positive, which means that the term between brackets exceeds one, which yields a contradiction. Thus, $p^a > p^w$ when the downstream firm has all the bargaining power. ■

# B Price Derivatives

## Wholesale Model

From equation (10) (swapping $k$ and $j$) we have

$$\frac{\partial s_j}{\partial p_k} = \begin{cases} \alpha s_j\,(1 - s_j)\,/p_j & \text{if } k = j; \\ -\alpha s_k s_j / p_k & \text{if } k \neq j. \end{cases}$$

The total derivative $d\pi_k^U/dw_j$ is given by

$$\frac{d\pi_k^U}{dw_j} = \frac{\partial \pi_k^U}{\partial w_j} + \sum_{k=1}^{N} \frac{\partial \pi_j^U}{\partial p_k}\frac{\partial p_k^*}{\partial w_j}, \quad \text{where} \quad \frac{\partial \pi_k^U}{\partial w_j} = \begin{cases} s_k & \text{if } k = j, \\ 0 & \text{if } k \neq j. \end{cases} \tag{A12}$$

The derivative $\partial \pi_j^U / \partial p_k$ is given by

$$\frac{\partial \pi_j^U}{\partial p_k} = \begin{cases} m_j^U \alpha s_j (1 - s_j) / p_j & \text{if } k = j, \\ -m_j^U \alpha s_k s_j / p_k & \text{if } k \neq j. \end{cases}$$

Similarly, the total derivative $d\pi_k^D / dw_j$ is given by

$$\frac{\partial \pi_j^D}{\partial w_j} = \frac{\partial \pi_k^D}{\partial w_j} + \sum_{l=1}^{N} \frac{\partial \pi_j^D}{\partial p_l} \frac{\partial p_l^*}{\partial w_j}, \quad \text{where} \quad \frac{\partial \pi_k^D}{\partial w_j} = \begin{cases} -s_k & \text{if } k = j, \\ 0 & \text{if } k \neq j. \end{cases} \tag{A13}$$

The derivative $\partial \pi_j^D / \partial p_k$ is given by

$$\frac{\partial \pi_j^D}{\partial p_k} = \begin{cases} s_j + m_j^D \alpha s_j (1 - s_j) / p_j & \text{if } k = j, \\ -m_j^D \alpha s_k s_j / p_k & \text{if } k \neq j. \end{cases}$$

The price derivatives $\partial p_l^* / \partial w_j$ are derived by totally differentiating the retail price first-order conditions in equation (9). The solution is

$$p_{ww}^* = [\pi_{pp}^D]^{-1} [-\pi_{pw}^D].$$

The $(k,l)$th element of $\pi_{pp}^D$ is given by

$$\pi_{pp}^D = T^D(k,l) \frac{\partial^2 \pi_j^D}{\partial p_k \partial p_l}.$$

Straightforward calculations yield the following expression for the derivatives on the right-hand side of this equation:

$$\frac{\partial^2 \pi_j^D}{\partial p_k \partial p_l} = \begin{cases} 2\frac{\partial s_j}{\partial p_j} + m_j^D \frac{\partial^2 s_j}{\partial p_j \partial p_j}, & \text{if } j = k = l, \\ \frac{\partial s_j}{\partial p_l} + m_j^D \frac{\partial^2 s_j}{\partial p_j \partial p_l}, & \text{if } j = k \neq l, \\ m_j^D \frac{\partial^2 s_j}{\partial p_k \partial p_k}, & \text{if } j \neq k = l, \\ \frac{\partial s_j}{\partial p_k} + m_j^D \frac{\partial^2 s_j}{\partial p_k \partial p_j}, & \text{if } j \neq k,\ l = j, \\ m_j^D \frac{\partial^2 s_j}{\partial p_k \partial p_l}, & \text{if } j \neq k,\ j \neq l,\ k \neq l. \end{cases}$$

The own-price and cross-price derivatives are given in equation (10). The second derivatives are given by

$$\frac{\partial^2 s_j}{\partial p_k \partial p_l} = \begin{cases} \alpha (1 - 2s_j) \frac{\partial s_j}{\partial p_j} / p_j - \frac{\partial s_j}{\partial p_j} / p_j & \text{if } j = k = l, \\ \alpha (1 - 2s_j) \frac{\partial s_j}{\partial p_l} / p_j & \text{if } j = k \neq l, \\ -\alpha \left( s_j \frac{\partial s_k}{\partial p_k} + s_k \frac{\partial s_j}{\partial p_k} \right) / p_k - \frac{\partial s_j}{\partial p_k} / p_k & \text{if } j \neq k = l, \\ -\alpha \left( s_j \frac{\partial s_k}{\partial p_j} + s_k \frac{\partial s_j}{\partial p_j} \right) / p_k & \text{if } j \neq k,\ l = j, \\ -\alpha \left( s_j \frac{\partial s_k}{\partial p_l} + s_k \frac{\partial s_j}{\partial p_l} \right) / p_k & \text{if } j \neq k,\ j \neq l,\ k \neq l. \end{cases}$$

The $(k,l)$th element of $\pi^D_{pw}$ is given by

$$\pi^D_{pw} = T^D(k,l)\frac{\partial^2 \pi^D_j}{\partial p_k \partial w_l}.$$

Straightforward calculations yield the following expression for the derivatives on the right-hand side of this equation:

$$\frac{\partial^2 \pi^D_j}{\partial p_k \partial w_l} = \begin{cases} -\alpha s_j\left(1-s_j\right)/p_j & \text{if } j=k=l, \\ \alpha s_k s_j/p_k & \text{if } j\neq k,\ j=l \\ 0 & \text{otherwise.} \end{cases}$$

## Agency Model

The total derivative $d\pi^U_k/dr_j$ is given by

$$\frac{d\pi^U_k}{dr_j} = \frac{\partial \pi^U_k}{\partial r_j} + \sum_{k=1}^{N}\frac{\partial \pi^U_j}{\partial p_k}\frac{\partial p^*_k}{\partial r_j}, \quad \text{where} \quad \frac{\partial \pi^U_k}{\partial r_j} = \begin{cases} -p_k s_k & \text{if } k=j, \\ 0 & \text{if } k\neq j. \end{cases}$$

The derivative $\partial\pi^U_j/\partial p_k$ is given by

$$\frac{\partial \pi^U_j}{\partial p_k} = \begin{cases} (1-r_j)s_j + m^U_j \alpha s_j\left(1-s_j\right)/p_j & \text{if } k=j, \\ -m^U_j \alpha s_k s_j/p_k & \text{if } k\neq j. \end{cases}$$

Similarly, the total derivative $d\pi^D_k/dr_j$ is given by

$$\frac{\partial \pi^D_j}{\partial r_j} = \frac{\partial \pi^D_k}{\partial r_j} + \sum_{l=1}^{N}\frac{\partial \pi^D_j}{\partial p_l}\frac{\partial p^*_l}{\partial r_j}, \quad \text{where} \quad \frac{\partial \pi^D_k}{\partial r_j} = \begin{cases} p_k s_k & \text{if } k=j, \\ 0 & \text{if } k\neq j. \end{cases} \tag{A14}$$

The derivative $\partial\pi^D_j/\partial p_k$ is given by

$$\frac{\partial \pi^D_j}{\partial p_k} = \begin{cases} r_j s_j + m^D_j \alpha s_j\left(1-s_j\right)/p_j & \text{if } k=j, \\ m^D_j \alpha s_k s_j/p_k & \text{if } k\neq j. \end{cases}$$

The price derivatives $\partial p^*_l/\partial r_j$ are derived by totally differentiating the retail price-first order conditions in equation (15). The solution is

$$p^*_{rr} = [\pi^U_{pp}]^{-1}[-\pi^U_{pr}].$$

The $(k,l)$th element of $\pi^U_{pp}$ is given by

$$\pi^U_{pp} = T^U(k,l)\frac{\partial^2 \pi^U_j}{\partial p_k \partial p_l}.$$

Straightforward calculations yield the following expression for the derivatives on the right-hand side of this equation:

$$\frac{\partial^2 \pi_j^U}{\partial p_k \partial p_l} = \begin{cases} 2(1-r_j)\frac{\partial s_j}{\partial p_j} + m_j^U \frac{\partial^2 s_j}{\partial p_j \partial p_j}, & \text{if } j = k = l, \\ (1-r_j)\frac{\partial s_j}{\partial p_l} + m_j^U \frac{\partial^2 s_j}{\partial p_j \partial p_l}, & \text{if } j = k \neq l, \\ m_j^U \frac{\partial^2 s_j}{\partial p_k \partial p_k}, & \text{if } j \neq k = l, \\ (1-r_j)\frac{\partial s_j}{\partial p_k} + m_j^U \frac{\partial^2 s_j}{\partial p_k \partial p_j}, & \text{if } j \neq k,\ l = j, \\ m_j^U \frac{\partial^2 s_j}{\partial p_k \partial p_l}, & \text{if } j \neq k,\ j \neq l,\ k \neq l. \end{cases}$$

The $(k,l)$th element of $\pi_{pr}^U$ is given by

$$\pi_{pr}^U = T^U(k,l)\frac{\partial^2 \pi_j^U}{\partial p_k \partial r_l}.$$

Straightforward calculations yield the following expression for the derivatives on the right-hand side of this equation:

$$\frac{\partial^2 \pi_j^U}{\partial p_k \partial r_l} = \begin{cases} -s_j[1+\alpha(1-s_j)] & \text{if } j = k = l, \\ \alpha s_j s_k & \text{if } j \neq k,\ j = l \\ 0 & \text{otherwise.} \end{cases}$$

# C Derivation Margins and Computational Details

## Wholesale Model

*Downstream Margins.* The vector of downstream margins $m^D$ can be written as

$$m^D = -\left(T^D \cdot \Delta\right)^{-1} s, \tag{A15}$$

where $T^D$ is an ownership matrix whose $(j,k)$th element is 1 if products $j$ and $k$ are sold by the same retailer and zero otherwise, and $\Delta$ is a matrix of market share derivatives with respect to price whose $(j,k)$th element is given by $\partial s_k / \partial p_j$ in equation (10).[36]

*Upstream Margins.* The bargaining first-order condition in equation (14) can be used to solve the upstream margins as a function of the downstream margins. First, rewrite equation (14) as

$$E_j^D\left(\pi^U - d^U\right)\frac{1-\lambda}{\lambda} + \frac{\partial \pi^U}{\partial w_j} = 0, \tag{A16}$$

where $E_j^D = \left(\pi^D - d^D\right)^{-1}\left(\partial \pi^D / \partial w_j\right)$. Using equation (A12) and taking into account the ownership

[36]When using matrix notation, we use $\cdot$ to indicate an entrywise (Hadamard) product.

structure, we can write $\partial\pi^U/\partial w_j$ as

$$\frac{\partial\pi^U}{\partial w_j} = s_j + \sum_{k\in\Omega^U} \left(m_k^U Z_{jk}^w\right),$$

which, using matrix notation, can be written as $s + (T^U Z^w)m^U$. Here, $T^U$ is an ownership matrix whose $(j,k)$th element is 1 if products $j$ and $k$ are titles of the same publisher and zero otherwise, and $Z^w$ is a matrix that captures how market shares change through changes in equilibrium prices, and whose $(j,k)$th element is given by

$$Z_{jk}^w = \alpha s_k \left(1 - s_k\right)/p_k \frac{\partial p_k^*}{\partial w_j} - \sum_{l\neq k} \alpha s_l s_k / p_l \frac{\partial p_l^*}{\partial w_j},$$

Taking into account the ownership structure and using $\pi^U - d^U = (T^U \cdot S)m^U$, we can write the bargaining first-order condition in equation (A16) as

$$s + \left(T^U \cdot Z^w + E^D \left(T^U \cdot S\right) \frac{1-\lambda}{\lambda}\right) m^U = 0, \tag{A17}$$

where $S$ is a matrix with market shares on the diagonal and the differences in market shares when product $j$ is not offered as off-diagonal elements, i.e.,

$$S = \begin{bmatrix} s_1 & -\Delta s_2^{-1} & \dots & -\Delta s_N^{-1} \\ -\Delta s_1^{-2} & s_2 & \dots & -\Delta s_N^{-2} \\ \vdots & \vdots & \ddots & \vdots \\ -\Delta s_1^{-N} & -\Delta s_2^{-N} & \dots & s_N \end{bmatrix}.$$

In this expression $\Delta s_k^{-j}$ is defined as the additional market share for product $k$ when product $j$ (and all other products that are part of the downstream-upstream combination $du$) is not offered, i.e., $\Delta s_k^{-j} = s_k^{-du} - s_k$, with $s_k^{-du}$ defined as in equation (12).[37]

Solving equation (A17) for $m^U$ gives

$$m^U = -\left(T^U \cdot Z^w + E^D \left(T^U \cdot S\right) \frac{1-\lambda}{\lambda}\right)^{-1} s. \tag{A18}$$

To derive an expression for $E^D$, first note that we can write equation (A13) as

$$\frac{\partial\pi^D}{\partial w_j} = -s_j + \sum_{k\in\Omega^D} \left(B_{jk}^D + m_k^D Z_{jk}^w\right),$$

[37]The notation used for $S$ follows Draganska, Klapper, and Villas-Boas (2010). Note that if product $j$ and $k$ are part of the same downstream-upstream combination $du$, then if $j$ is not offered, $k$ is not offered as well, resulting in $\Delta s_k^{-j} = -s_k$. Also note that using matrix $S$, the difference between profits and disagreement profits can be written as $\pi^U - d^U = (T^U \cdot S)m^U$ for the upstream firm and as $\pi^D - d^D = (T^D \cdot S)m^D$ for the downstream firm.

where $B^{Dw}_{jk} = -s_k(\partial p^*_k/\partial w_j)$. In matrix notation this is $-s + T^D \cdot B^{Dw} + (T^D \cdot Z^w)m^D$. Moreover, since $\pi^D - d^D = (T^D \cdot S)m^D$, we get

$$E^D = \left(\left(T^D \cdot S\right) m^D\right)^{-1} \left(-s + T^D \cdot B^{Dw} + \left(T^D \cdot Z^w\right) m^D\right).$$

## Agency Model

*Downstream Margins.* The downstream margin under agency is directly related to the royalty $r$ and, assuming zero marginal cost for the retailers is given by

$$m^D = rp. \tag{A19}$$

*Upstream Margins.* Since the upstream firm sets retail prices, we can solve the pricing first-order condition in equation (15) for the vector of upstream margins $m^U$, which gives using matrix notation

$$m^U = -\left(T^U \cdot \Delta\right)^{-1} (1-r)s. \tag{A20}$$

*Computational Details.* Equations (A20) and (A19) show that to obtain the upstream and downstream margins in the agency model, we need a vector of agency royalties $r$ in addition to the price parameter $\alpha$. The agency royalties are not observed, but since they are determined through bargaining, they can be obtained by solving the bargaining first-order condition in equation (16) for $r$, given bargaining weights $\lambda$ and price parameter $\alpha$.

Due to the inherent complexity of the bargaining first-order condition in the agency model, solving this first-order condition for $r$ has to be done numerically. Because of this, it is computationally much faster to start from a vector of royalties (one for each retailer-publisher pair) and to use the bargaining first-order condition to obtain the vector of bargaining weights $\lambda$ (again, one for each retailer-publisher pair) as a function of the agency royalties and the other parameters of the model for which the bargaining first-order condition holds. First, rewrite equation (16) as

$$E^U_j \left(\pi^D - d^D\right) \frac{\lambda}{1-\lambda} + \frac{\partial \pi^D}{\partial r_j} = 0, \tag{A21}$$

where $E^U_j = \left(\pi^U - d^U\right)^{-1} (\partial \pi^U/\partial r_j)$. Using equation (A14) and taking into account the ownership structure, we can write $\partial \pi^D/\partial r_j$ as

$$\frac{\partial \pi^D}{\partial r_j} = A_j + \sum_{k \in \Omega^D} \left(B^D_{jk} + m^D_k Z^r_{jk}\right),$$

where $A_j = p_j s_j$ and $B^D_{jk} = r_k s_k(\partial p^*_k/\partial r_j)$. In matrix notation this is

$$A + T^D \cdot B^D + (T^D \cdot Z^r)m^D.$$

Taking into account the ownership structure and using $\pi^D - d^D = (T^D \cdot S)m^D$, we can write the bargaining first-order condition in equation (A21) as

$$A + T^D \cdot B^D + \left( T^D \cdot Z^r + E^U (T^D \cdot S) \frac{\lambda}{1-\lambda} \right) m^D = 0.$$

Solving for $L = (1-\lambda)/\lambda$ gives

$$L = -(A + T^D \cdot B^D + (T^D \cdot Z^r)m^D)^{-1}(E^U(T^D \cdot S)m^D). \tag{A22}$$

where $E^U$ is a vector whose $j$th element is given by $E^U_j = \left(\pi^U - d^U\right)^{-1}(\partial \pi^U / \partial r_j)$, $B^D$ is a matrix whose $(j,k)$th element is given by $r_k s_k (\partial p^*_k / \partial r_j)$, and $Z^r$ is a matrix that captures how market shares change through changes in equilibrium prices, and whose $(j,k)$th element is given by

$$Z^r_{jk} = \alpha s_k \left(1 - s_k\right)/p_k \frac{\partial p^*_k}{\partial r_j} - \sum_{l \neq k} \alpha s_l s_k / p_l \frac{\partial p^*_l}{\partial r_j}.$$

By reorganizing the bargaining first-order condition for the agency model this way, we end up with a closed-form expression for the bargaining parameters as a function of the price parameter $\alpha$ as well as the agency royalties $r$, as in equation (A22). Then, when estimating the model, instead of starting from an initial vector of bargaining parameters $\lambda$ and solving for $r$, one can start from an initial vector of agency royalties $r$ and solve for $\lambda$, which significantly speeds up estimation.[38] Since we are assuming the bargaining weights do not depend on the selling method, we can then use equation (A22) to substitute for $(1-\lambda)/\lambda$ in equation (A18) to obtain upstream margins in the wholesale model.

# D Small Sample Performance

To investigate identification as well as small sample performance of our estimation procedure, we run a Monte Carlo exercise. The setup of the experiment is as follows. We simulate two retailers who each sell two products, where the two products are provided by two different upstream firms, so there are four differentiated products in total. We let the firms compete for a number of periods, where in half the periods, retail and input prices are set according to the wholesale model and in half the periods, retail and input prices are set using the agency model. We assume disagreement payoffs are zero when bargaining. We normalize time fixed effects $(\xi_t, \eta_t)$ to zero. We assume product $j$'s marginal cost during period $t$ is given by $\log(c_{jt}) = 1 + \Delta\eta_{jt}$. In our first specification, we allow for a single price coefficient and let consumer $i$'s indirect utility for product $j$ in period $t$ be given by $u_{ijt} = 10 - 4\log(p_{jt}) + \Delta\xi_{jt} + \varepsilon_{ijt}$. We use the same indirect utility function for our

[38] It is important to stress that starting from a vector of $\lambda$'s and using the bargaining first-order condition to numerically solve for $r$ (given the other parameters) is identical to proceeding the other way around, but takes much longer since the bargaining first-order condition has to be solved numerically.

second specification, but instead of a single price parameter of $-4$, we allow for retailer-specific price coefficients of $-4.2$ and $-3.8$, respectively. We generate data assuming both demand and supply shocks are uniform, with $\Delta\xi \sim U(0, 0.5)$ and $\Delta\eta \sim U(0, 0.5)$. Table A1 reports the mean and standard deviation of the estimated parameters, where for each specification, we allow for either 10 or 50 periods.

Table A1: Monte Carlo simulations

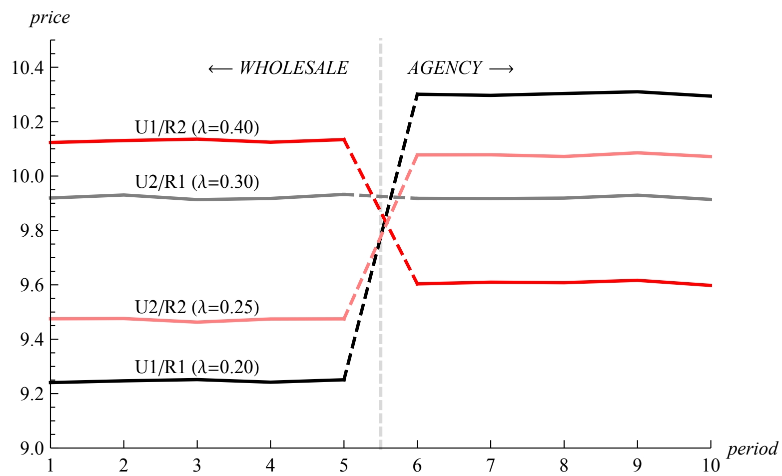
| | | One price coefficient | | | | Retailer-specific price coefficients | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 10 markets | | 50 markets | | 10 markets | | 50 markets | |
| Variable | True | Coeff. | Std. Dev. | Coeff. | Std. Dev. | Coeff. | Std. Dev. | Coeff. | Std. Dev. |
| *PANEL A. DEMAND MODEL ONLY (OLS)* | | | | | | | | | |
| log(price) | -4.000 | -3.539 | (0.333) | -3.551 | (0.141) | | | | |
| Retailer 1 (R1) | -4.200 | | | | | -3.846 | (0.297) | -3.841 | (0.132) |
| Retailer 2 (R2) | -3.800 | | | | | -3.474 | (0.272) | -3.470 | (0.121) |
| *PANEL B. DEMAND AND SUPPLY MODEL* | | | | | | | | | |
| *Demand parameters* | | | | | | | | | |
| log(price) | -4.000 | -4.300 | (0.468) | -4.026 | (0.206) | | | | |
| Retailer 1 (R1) | -4.200 | | | | | -4.302 | (0.500) | -4.085 | (0.210) |
| Retailer 2 (R2) | -3.800 | | | | | -3.904 | (0.343) | -3.740 | (0.149) |
| *Bargaining parameters Retailer 1 (R1)* | | | | | | | | | |
| Upstream 1 (U1) | 0.200 | 0.198 | (0.075) | 0.189 | (0.067) | 0.179 | (0.083) | 0.181 | (0.057) |
| Upstream 2 (U2) | 0.300 | 0.305 | (0.110) | 0.288 | (0.095) | 0.288 | (0.141) | 0.279 | (0.096) |
| *Bargaining parameters Retailer 2 (R2)* | | | | | | | | | |
| Upstream 1 (U1) | 0.400 | 0.410 | (0.110) | 0.391 | (0.105) | 0.427 | (0.113) | 0.413 | (0.065) |
| Upstream 2 (U2) | 0.250 | 0.253 | (0.128) | 0.237 | (0.089) | 0.247 | (0.102) | 0.243 | (0.087) |
| Observations | | 40 | | 200 | | 40 | | 200 | |

*Notes*: Results are based on 10,000 simulations. Utility is given by $u_{ijt} = 10 + \alpha_r \log(p_{jt}) + \Delta\xi_{jt} + \varepsilon_{ijt}$, where $\alpha_r$ is either $-4$ or $-4.2$ and $-3.8$. Marginal cost is given by $\log(c_{jt}) = 1 + \Delta\eta_{jt}$. Data is generated assuming $\Delta\xi \sim U(0, 0.5)$ and $\Delta\eta \sim U(0, 0.5)$.

Panel A of Table A1 shows price coefficient estimates when only the demand side is estimated, using OLS—failing to deal with price endogeneity results in the price parameter being underestimated, even when 50 periods are used and irrespective of whether the price coefficient is retailer-specific. Panel B shows that by jointly estimating supply and demand using the cross-covariance restrictions approach, the bias in the price parameter estimates disappears. The average price parameters are relatively close to the true parameter values even when the number of periods is small, and the standard deviation of the estimates decreases in the number of observations used. Furthermore, for both cases, the nonlinear bargaining parameters are very close to the true parameter values even when data from only ten periods is used, and the estimates become more precise when the number of periods increases. As argued before, the identification of the bargaining parameters follows from observed changes in prices when switching selling methods, and the Monte Carlo results show that using data from both pricing regimes allows one to successfully pin down the bargaining parameters while simultaneously dealing with price endogeneity, even in relatively small samples.

The identification argument can also be seen from Figure A1, which shows simulated prices for each upstream-retailer pair for the 10-period case (averaged across the 10,000 simulations) and a single price parameter. The figure shows that for upstream-retailer pairs with a relatively low bargaining parameter (U1/R1 and U2/R2), prices increase when switching to agency, whereas prices remain constant (U2/R1) or go down (U1/R2) for the upstream-retailer pairs that face higher values of their bargaining parameter $\lambda$.

Figure A1: Simulated prices for each upstream-retailer pair




*Notes:* Simulated prices for each upstream-retailer pair for the 10-period case with a single price parameter (averaged across 10,000 simulations). Utility is given by $u_{ijt} = 10 + \alpha_r \log(p_{jt}) + \Delta\xi_{jt} + \varepsilon_{ijt}$, where $\alpha_r$ is either $-4$ or $-4.2$ and $-3.8$. Marginal cost is given by $\log(c_{jt}) = 1 + \Delta\eta_{jt}$. Data is generated assuming $\Delta\xi \sim U(0, 0.5)$ and $\Delta\eta \sim U(0, 0.5)$. Bargaining parameters are given in the first column of Table A1.