

# Secondary Markets and Firm Profits: Evidence from College Textbooks\*

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## Abstract

Secondary markets create competition between new and used goods, but also raise the value of new goods by facilitating resale. Depending on the relative strength of these forces, firms may gain or lose from closing the secondary market. We investigate these ideas empirically in the context of college textbooks. Using the estimates of a structural model of student and publisher behavior, we find that closing the secondary market would substantially increase publisher profits. We then explore how the impact of the secondary market depends on consumer preferences and other market features like the mechanism determining used prices.

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# 1 Introduction

For many durable goods, there is an active secondary market in which used goods compete for sales with new goods. Firms take varying approaches in response to this kind of competition. In some cases, firms take actions to impede the functioning of the secondary market. In the context of this paper, college textbook publishers may have an incentive to aggressively push E-Textbooks – where digital rights management technology can potentially prevent resale – in order to close the secondary market directly. Another recent example besides E-Textbooks is Microsoft’s latest gaming system, Xbox One, for which Microsoft considered placing restrictions on the ability of consumers to buy and sell used games.<sup>1</sup> In other cases, firms take actions to *lessen* frictions in the secondary market. Perhaps the most salient instance of an active secondary market – automobiles – is a good example.<sup>2</sup> Certified pre-owned programs and transferable factory warranties across owners are ubiquitous, both of which facilitate secondary market transactions.<sup>3</sup>

What explains such heterogeneous responses by firms to the secondary markets for their products? When purchasing a durable good, consumers are buying a sequence of utility flows from the use of the product. One component of that sequence may be resale. If the secondary market is closed, the value from resale falls to zero, which puts downward pressure on price. In this sense, secondary markets provide a benefit to firms: the more a product can be resold for tomorrow, the more consumers may be willing to pay for it today. At the same time, used goods compete with new goods for sales, harming firms. Closing the secondary market entails the termination of both effects, and which effect dominates may depend on the specifics of the industry under examination.

In the strategy literature, value-based strategy (e.g., Brandenburger and Stuart (1996); MacDonald and Ryall (2004); Chatain (2011)) provides another natural interpretation. In the language of value-based strategy, an active secondary market *creates value* for the firm by increasing buyer willingness to pay, as buyers may value the ability to resell. At the same time, however, an active secondary market may reduce the firm’s *added value* and thereby impede the firm’s ability to *capture value*. Without a secondary market, the firm is the

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<sup>1</sup>Arora, N. (2013, June 19). Microsoft Gives In To Gamers On Xbox One Used Games, Connection Requirement. *Forbes.com*.

<sup>2</sup>According to the automotive company Edmunds, 69 percent of all vehicles sold in 2016 were used. Edmunds *Used Vehicle Market Report* February 2017; *Sales Insights* December 2016.

<sup>3</sup>All of the top eight vehicle producers in the world (according to 2016 total production) have both certified pre-owned programs and transferable warranties. Source: OICA World Motor Vehicle Production report and company websites.

entire source of buyer willingness to pay. With a secondary market, the firm still provides the initial product, but value can then continue to be created even if the firm shuts down.<sup>4</sup>

One clear question from the firm’s perspective is which path to take: is it advisable to help or hinder the functioning of the secondary market? Answering this question requires quantifying the countervailing forces that the secondary market entails. We take up this task for the case of college textbooks, where students have the choice to buy new or used versions of required textbooks. The ability to resell used books increases student willingness to pay: the more books can be resold for, the more students may be willing to pay for them. On the other hand, students may buy used books instead of new books, and textbook publishers do not receive the proceeds of used book sales. Thus, it is ultimately an empirical question whether publishers benefit from the secondary market or are harmed by it. From a policy perspective, the functioning of secondary markets affects welfare, making advances in empirical modeling relevant to regulators who may be examining such actions.<sup>5</sup>

Building on prior empirical findings in the industry (Chevalier and Goolsbee (2009)), we develop a structural model of how students make purchasing decisions and how publishers make pricing and revising decisions. The model captures substitution between new and used books, the ability of publishers to charge for resale value, and how publishers fight competition with the secondary market via revisions. After estimating the model’s parameters using data on textbook sales and publisher behavior, we then conduct counterfactual analyses that quantify the impact of the secondary market on publisher profits. In our main counterfactual, we find that publishers would substantially benefit from closing the secondary market. New book prices fall (since publishers can no longer charge for resale value), but publishers sell more books and spend less on revisions. Overall, we estimate that publisher profits would increase by 42.6 percent. In short, from the perspective of publisher profits, it appears that competition with used books dominates any benefits provided by resale value. This result is consistent with textbook publisher claims that the used textbook market harms profits,<sup>6</sup> as well as the recent development of E-Textbooks for which publishers can more effectively prevent resale.

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<sup>4</sup>Consider, for example, the DeLorean Motor Company. DeLorean cars continue to be transacted today despite the company going bankrupt and ceasing production in 1982.

<sup>5</sup>Cases concerning the resale of digital goods have already begun to make their way into the courts. For example, the startup ReDigi, who provides a platform that allows consumers to buy and sell previously purchased digital music, was recently ruled to have violated copyright law. Sisario, B. (2013, April 1). A Setback for Resellers of Digital Products. *New York Times*.

<sup>6</sup>In its 2012 annual report, textbook publisher Cengage notes that they “face competition from the used textbook market” and that an increasingly efficient secondary market “may materially adversely affect our business.” Cengage Learning Holding II, L.P., *Annual Report for the Fiscal Year ended June 30, 2012*.

To further illustrate how the secondary market can affect outcomes, we conduct additional counterfactual analyses varying the parameters of the model. First, we show that publishers would benefit from the presence of the secondary market if (i) new and used books were less substitutable and (ii) resale value was more important to students. These results have clear implications for how firms can be expected to respond to secondary market competition. For instance, as opposed to interfering with the secondary market, it may instead be optimal for a firm to adjust its product characteristics in a way that reduces the substitutability of new and used goods.

Second, we explore the role of the mechanism determining used prices. During the period of our data, university bookstores had extremely rigid pricing rules for used books, with used books priced at essentially a constant fraction – 75 percent – of new books. This rigid used book pricing stands in stark contrast to the much freer competition currently occurring on Amazon.com and other online platforms. To analyze the impact of this competition on market outcomes, we change the mechanism determining used prices to be a market clearing mechanism and examine the model’s predictions. Consistent with data from Amazon and other online platforms, we find that used prices lower than the rigid 75 percent rule at university bookstores are needed to clear the market. The results also indicate that publisher profits are lower with market clearing than under the rigid used book pricing mechanism, which suggests that publisher incentives to interfere with the secondary market were likely strengthened by the growth of firms like Amazon.<sup>7</sup>

## 1.1 Related Literature

The theoretical literature on the interaction between durable goods producers and secondary markets is extensive, with the impact of secondary markets examined under a wide variety of assumptions about consumer preference heterogeneity, the nature of product depreciation, commitment, etc.<sup>8</sup> The model we examine in this paper reflects one of the main trade-offs described in Hendel and Lizzeri (1999) (and others): permitting resale increases buyer willingness to pay and may facilitate the segmentation of new and used buyers, but also introduces competition between new and used goods.

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<sup>7</sup>This implication is consistent with reports suggesting growing financial difficulties for textbook publishers. Mitchell, J. (2014, August 27). A Tough Lesson for College Textbook Publishers. *Wall Street Journal*. Church, S and Jinks, B. (2013, July 2). Cengage Learning Files for Chapter 11 Bankruptcy. *Bloomberg*.

<sup>8</sup>Among others, relevant papers include Swan (1970); Miller (1974); Bulow (1982, 1986); Rust (1986); Waldman (1993); Anderson and Ginsburgh (1994); Hendel and Lizzeri (1999); Oraiopoulos et al. (2012); and Cui et al. (2014).

The empirical literature is considerably smaller but growing. In both Lazarev (2013) (airline tickets) and Leslie and Sorensen (2014) (concert tickets), a key question when it comes to the effects of secondary markets is the efficiency of the allocation of seats. Both find that resale increases allocative efficiency, but that there are potentially offsetting effects as well. For instance, Leslie and Sorensen (2014) find that resale induces costly rent-seeking to obtain tickets in the primary market, which partially offsets the allocative efficiency gains of resale. In the strategy literature, Bennett et al. (2015) hypothesize situations in which firms will either benefit or be harmed by secondary markets – and thus how firms can be expected to strategically respond – and then test those hypotheses using data from the US concert ticket industry.

A major difference between our setting and those of Lazarev (2013), Leslie and Sorensen (2014), and Bennett et al. (2015) is that tickets, unlike textbooks, are in some sense non-durable. With tickets, there is a fixed time at which the good becomes worthless (the time of the flight/event), whereas the time at which a textbook loses value – when the book is revised – is a choice variable of the publisher. In addition, in contrast to tickets, textbooks purchased on the primary and secondary markets are less likely to be perfectly substitutable.

The papers most closely related to our work are Shiller (2013) (video games) and Chen et al. (2013) (automobiles), who also examine structural models to estimate the impact of secondary markets. In their baseline specifications, both find that closing the secondary market would substantially increase firm profits, by 50+ percent. These findings are similar to our own results, which indicate that publisher profits would increase by 42.6 percent after closing the secondary market.

Our contribution to this literature is four-fold. First, the models studied in this paper, Shiller (2013), and Chen et al. (2013) are all tailored to the specifics of the industry under examination. While such an approach facilitates more reliable measurement, the generalizability of the findings is less certain. The fact that all three papers indicate that firms would profit from closing the secondary market suggests that, in real-world markets, the negative effects of competition with used goods may tend to outweigh the benefits provided by resale value. Second, our specific context allows us to straightforwardly model publishers' strategic revision choices, as opposed to assuming fully exogenous product depreciation. Third, we explore the impact of the mechanism determining used prices, which affects both (i) resale value and (ii) how strongly used goods compete for sales. Given the rise of internet commerce, the way in which used prices are determined in many markets may be meaningfully different than in the past. Fourth, while structural estimation is prevalent in the economics

literature, it is less so in the strategy literature (Grennan (2014) is a notable exception). We view this paper as an example of the potential usefulness of structural methods in empirically examining bedrock concepts in strategy like value creation and value capture.

The rest of the paper proceeds as follows. Section 2 describes the data and provides descriptive statistics to motivate the structural model. Section 3 (demand) and section 4 (supply) develop the model and present the parameter estimates. Section 5 conducts the counterfactual analyses. Section 6 concludes.

## 2 Data

Before proceeding to the full structural model, we begin by providing background on our main data source, along with descriptive evidence about publisher and student behavior.

### 2.1 Textbook Sales Data

Our data covers economics textbook sales from about 1,800 university bookstores in the US over the 11 year (22 semester) period from 1997 to 2007. The universities covered account for around 60 percent of total college enrollment, and include everything from community colleges to Ivy League universities. The data is currently produced by Nielsen and is the same data used in Iizuka (2007) and Chevalier and Goolsbee (2009) (each with different sub-samples of the full data, which covers additional subjects and years).

The data contains the aggregate (aggregating across universities) unit sales and total revenue – both new and used – for each unique combination of International Standard Book Number (ISBN)-year-semester, along with basic characteristics of the ISBN like the title, author, and edition. The data also contains information about the ISBNs that are assigned to students at the universities tracked, including a variable containing estimated class enrollment. Several ISBNs correspond to the same “book” (combination of title and author), both within and across semesters, so we manually combine these ISBNs on the basis of the reported title and author. We then collapse the data to the book-year-semester level, converting all monetary values to CPI-adjusted 2007 dollars. For example, a row in the final dataset shows that in the fall semester of 2001, 17 percent of the estimated enrollment for classes utilizing Greg Mankiw’s *Principles of Macroeconomics* bought a new copy of the book at an average price of \$115, while 28 percent of the estimated enrollment bought a used copy at an average price of \$84.

**Table 1: Final Sample Descriptive Statistics**

	Mean	Median	Standard Deviation
New Sticker Price	\$124.11	\$115.96	\$18.47
Used Sticker Price	\$91.34	\$85.36	\$14.24
New Share	0.286	0.280	0.049
Used Share	0.238	0.238	0.040
Age at Revision	5.7	6.0	0.9
Enrollment	11,491	9,095	9,989
Page Length	631	576	165
Semesters	15.5	17	3.9
Editions	3.4	3.0	0.9

Notes: Prices are in CPI-adjusted 2007 dollars. Shares are calculated using the estimated enrollment in classes utilizing the book as the market size. Book age is defined as the number of semesters since the book was last revised.

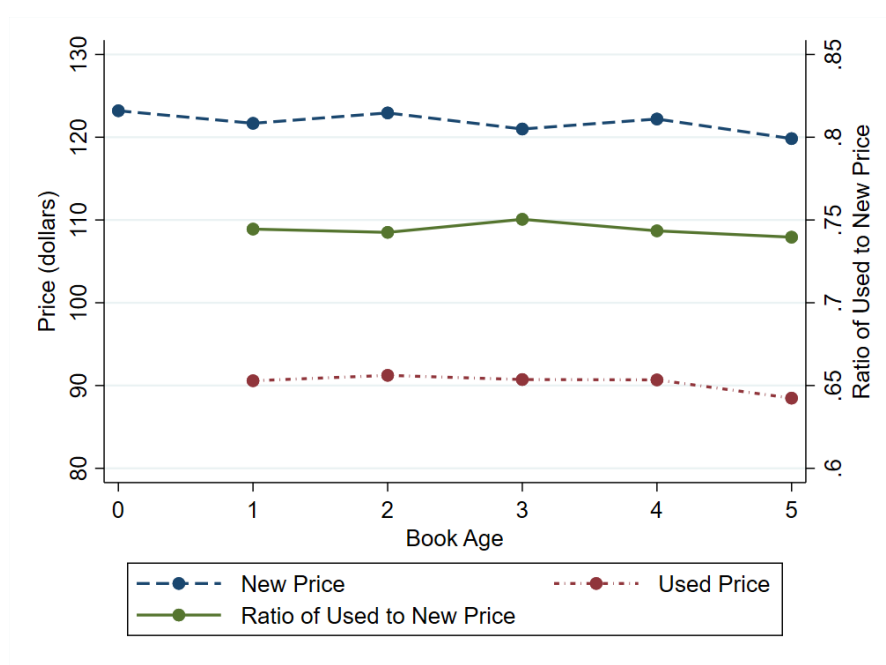
The data covers more than 5,000 books in total, but sales are extremely concentrated. The top 1 percent of books account for 52 percent of total new book revenue, while the bottom 90 percent of books account for only 11 percent of revenue. High-selling books are the focus of the paper: low-selling textbooks, study guides, and books like Adam Smith’s *The Wealth of Nations* are all excluded from the final sample. We also focus on introductory books, as these books tend to be revised more frequently in a manner consistent with the structural model. The enrollment data includes a description of the course, e.g. “Microeconomics: Principles,” which we use to classify books as intro or non-intro according to whether the majority of enrollment for the book is for an intro or non-intro course. The full list of 53 introductory books in the final sample and the precise sample restrictions we use are given in section 7.1 in the appendix. Table 1 provides basic summary statistics about the books in the final sample: the following subsections provide more detailed descriptive information.<sup>9</sup>

<sup>9</sup>One limitation of the data is that it does not contain information about textbook sales beyond university bookstores. To check for evidence of the growing importance of alternative sales channels (like Amazon.com) over the period of the data, we have estimated models examining shares over time. If the data was increasingly missing sales through other channels, shares would likely decrease markedly over time. A regression of (log) combined new plus used share on semesters since the beginning of the data, (log) new sticker price, and age fixed effects yields a (statistically insignificant) coefficient estimate that implies a roughly six percent reduction in share over the 11 year period of the data. This result suggests that university bookstores still sold the majority of volume for our sample even as companies like Amazon began to grow.

## 2.2 Price Patterns

There are several idiosyncracies in the market for textbooks during the period of our data concerning pricing. First, both new and used sticker prices do not substantially vary over the life of an edition. Second, used prices appear to be set at essentially a constant 75 percent of new book prices. According to Chevalier and Goolsbee (2009), bookstore operators are often constrained by contract with the university to price used books for no more than 75 percent of the new book price.<sup>10</sup>

To illustrate these characteristics of prices in our sample, Figure 1 plots (i) the average new and used price for books in the final sample by book age (i.e., semesters since the last revision) and (ii) the average ratio of the used price to the new price. As shown in the figure, both new and used prices are essentially flat in book age. A test of the null hypothesis that the averages are the same for each age yields a p-value of 0.95 for new prices and 0.89 for used prices, thus failing to reject constant prices. The ratio of the used price to the new price is also flat in book age, hovering just under 0.75. A regression of used price on new price (without a constant) yields a coefficient estimate of 0.743 (and an R-squared of 0.998).



**Figure 1: New and Used Prices by Book Age** Newly revised books correspond to an age of zero, at which point used books are not available. Age five combines all ages greater than or equal to five.

<sup>10</sup>Bookstore operators are also often constrained to buy back current edition books for no less than 50 percent of the new book price, a fact which we utilize when modeling resale.



## 2.3 Revision Patterns

As shown above, sticker prices are more or less constant within an edition. However, *effective* prices that take resale value into account vary. At the beginning of an edition when a publisher is unlikely to revise the book, students who purchase the book can likely resell it the following semester. If revision is imminent, on the other hand, there is a strong possibility that the purchased book will become worthless for the purpose of resale in the subsequent semester, since the bookstore has no use for old edition books that are no longer assigned.

Figure 2 plots the timing of revisions for books in the final sample. Books are essentially never revised at early ages, whereas all books are revised within eight semesters (four years). The most common revision timing is six semesters (three years). Chevalier and Goolsbee (2009) study whether student purchasing behavior is responsive to impending revisions, finding that “the data strongly support the hypothesis that students are forward-looking with low short-run discount rates and that they behave as if they have rational expectations of publishers’ revision behavior.” We rely on this finding in the structural model, in which students correctly anticipate revisions and take expected resale prices into account when making purchasing decisions.

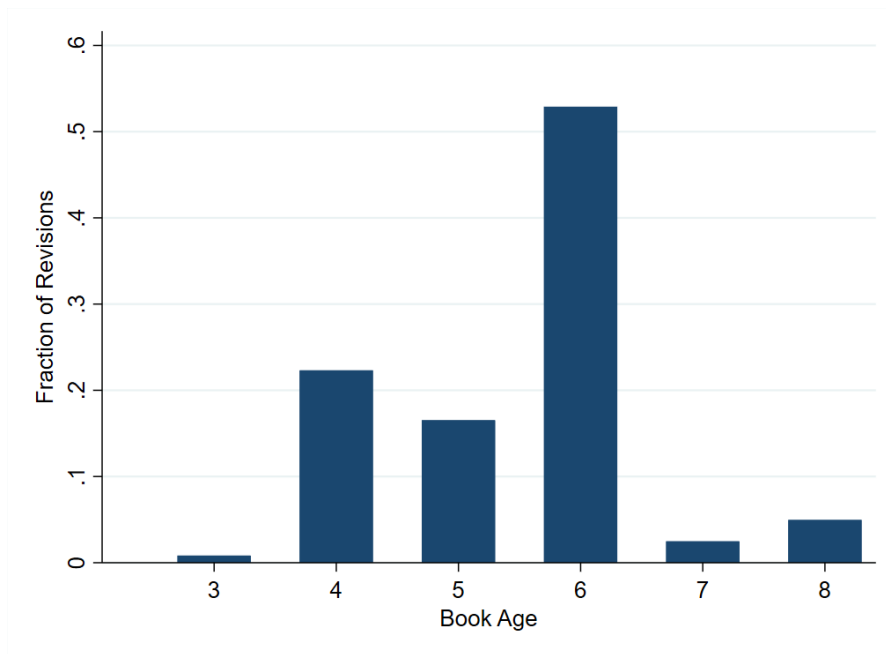
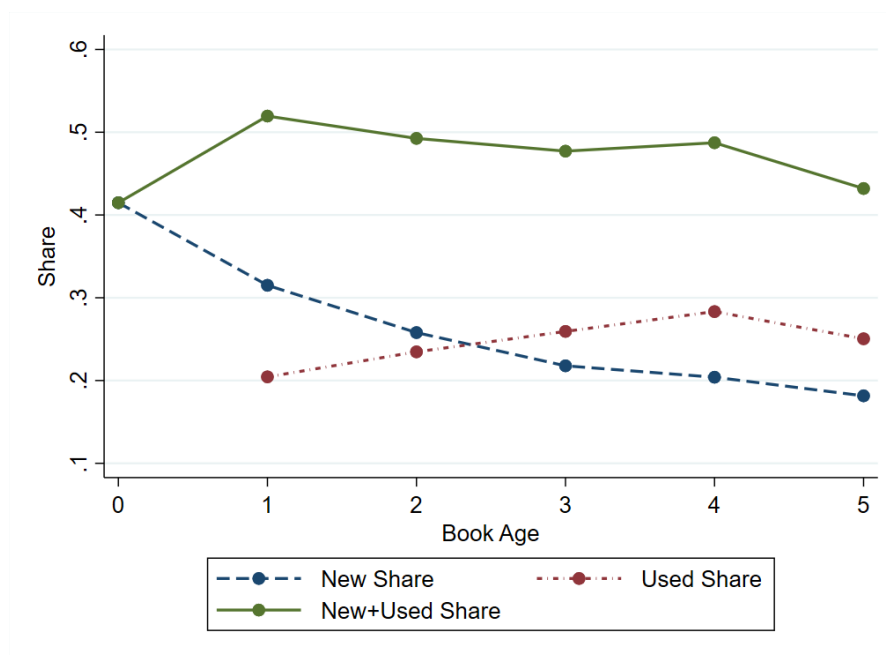


Figure 2: Histogram of Revision Timing

## 2.4 Share Patterns

Figure 3 plots average shares – i.e., the percentage of estimated enrollment buying the new or used copy of the book – by book age. When used books become available at age one, they take 20 percent of the market. At the same time, the new book share falls by about half that amount: 10 percentage points. This pattern suggests that some used book purchases are driven by substitution from new to used, while other used book purchases are driven by substitution from the outside good to used. Average used shares increase from age one to age four, which may reflect increased availability of used books at university bookstores. The combined new plus used share is relatively flat from age one to age four, but falls substantially at age five. As most revisions occur at age six (Figure 1), this pattern is consistent with students being forward-looking and sensitive to imminent revisions.<sup>11</sup>



**Figure 3: New, Used, and Combined Shares by Book Age** Newly revised books correspond to an age of zero, at which point used books are not available. Age five combines all ages greater than or equal to five.

<sup>11</sup>The pattern is also potentially consistent with an increase in unobserved student-to-student transactions, but unfortunately we do not have any data that speaks to this possibility.

### 3 Demand

We now develop a structural model of student purchase behavior. The focus of the model is the competition between new books, their used versions, and the outside good. In addition to non-purchase, the outside good also contains other options that we do not observe in the data, like student-to-student transactions and piracy.

We assume that competition between textbooks of the same subject is weak, allowing us to abstract away from professors' textbook choice decisions. Competition between textbooks might be weak due to professors largely making textbook decisions invariant of publishers' pricing and revising policies, or if professors face large switching costs. In either case, the effect of professor choice on the within-textbook competitive dynamics we model would arguably be limited. More practically, adding an additional layer of decision making on the demand side would substantially complicate the model and threaten the feasibility of estimating it.

#### 3.1 Model

After being assigned a textbook in semester  $t$ , students choose between the outside option and buying the new or used version of the current edition of that book.<sup>12</sup> The utilities of student  $i$  in semester  $t$  from choosing new ( $n$ ), used ( $u$ ), or the outside good ( $\emptyset$ ) are:

$$\begin{aligned} u_{int} &= \alpha_0 - \beta \cdot \tilde{p}_{int} + \xi_{nt} + \epsilon_{int} \\ u_{iut} &= \gamma_0 + \gamma_1 \cdot x_t - \beta \cdot \tilde{p}_{iut} + \xi_{ut} + \epsilon_{iut} \\ u_{i\emptyset t} &= 0 + \epsilon_{i\emptyset t}. \end{aligned} \tag{1}$$

$x_t$  is book age (i.e., semesters since last revision). We allow the utility of the used book to change with age (according to  $\gamma_1$ ) in order to rationalize the observed pattern in the data that used shares increase with age. A similar parameter for new books is not needed to match the observed share patterns, so we exclude it for the sake of parsimony and to clarify the identification of the model's parameters.<sup>13</sup>  $\xi_{nt}$  and  $\xi_{ut}$  are demand shocks which

<sup>12</sup>Purchases of an old edition, which the publisher no longer produces, are contained in the outside option.

<sup>13</sup>By excluding such a parameter, we rule out quality deterioration as an explanation for declining new sales as books age. We believe this restriction is largely reasonable for student demand. To the extent that the primary use of a textbook is fulfilling class obligations, it is unclear why students would care about the examples, etc. being a few years out-of-date. Up-to-date content may be more relevant for professors' textbook choices, but again we abstract away from those choices in order to facilitate the computation of the model.

we assume to be mean zero and i.i.d. over time. Students' idiosyncratic tastes are captured by  $\epsilon_{it} \equiv (\epsilon_{int}, \epsilon_{iut}, \epsilon_{i\emptyset t})$ . For instance, a student who dislikes highlighted or underlined text may have a small value of  $\epsilon_{iut}$ .

$\tilde{p}_{ijt}$  is the *effective price* of option  $j$  (new  $n$  or used  $u$ ) that includes the utility (in dollars) of resale and/or future use of the book. The effective price varies by student because different students may assign different values to continued use of the book beyond the current semester. Suppressing semester  $t$  for brevity from here on, the effective price  $\tilde{p}_{ij}$  can be decomposed as:

$$\tilde{p}_{ij} = p_j - \delta_s \cdot v_i, \quad (2)$$

where  $p_j$  is the sticker price of the book,  $\delta_s$  is students' semester discount factor (assumed to be constant across students), and  $v_i$  is the value of the book to student  $i$  beyond the current semester. The price of the new book  $p_n$  is chosen by the publisher, while the price of the used book  $p_u$  is mechanically determined by:

$$p_u = \lambda \cdot p_n. \quad (3)$$

That is, the used price is a constant fraction of the new price. We adopt this mechanical specification of used price formation given the institutional background and price patterns outlined in section 2.2. That evidence indicates that  $\lambda \approx 0.75$ , and hence we fix  $\lambda = 0.75$  when estimating the model. (We examine the impact of changing the mechanism determining used prices to be market clearing in section 5.2.)

The value of the book to student  $i$  beyond the current semester,  $v_i$ , is the combination of two potential sources of value: (i) resale and (ii) continued use of the book. If the publisher revises the book – rendering the old edition worthless for the purpose of resale – students receive the value from continued use of the book,  $r_i$ . If the publisher does not revise the book, students have the option either to keep the book and receive  $r_i$ , or resell the book and receive  $(1 - \kappa) \cdot p_u$ , where  $\kappa \in [0, 1]$  reflects the bookstore's markup on used books. During the period of our data, bookstores bought used books for 50 percent of the new price and sold them for 75 percent of the new price (see section 2.2). Students therefore receive  $50/75=2/3$  of the used price, and hence  $\kappa \approx 1/3$ . We fix  $\kappa = 1/3$  when estimating the model.

Drawing on Chevalier and Goolsbee (2009), we assume that students correctly anticipate when the publisher will revise the book. Denote the age at which revision will occur by  $T$ .

$v_i$  can then be written as:

$$v_i = \begin{cases} r_i, & x + 1 = T \\ \max \left[ (1 - \kappa) \cdot p_u, r_i \right], & x + 1 < T. \end{cases} \quad (4)$$

If the book will be revised next semester, the future value of the book to student  $i$  is the value of continued use ( $r_i$ ). If the book will not be revised next semester, on the other hand, the future value of the book to student  $i$  is either the resale value ( $(1 - \kappa) \cdot p_u$ ) or the value of continued use ( $r_i$ ), whichever is greater.<sup>14</sup> The max operator reflects student optimizing behavior when faced with the choice between reselling the book and receiving  $(1 - \kappa) \cdot p_u$  or keeping it and receiving  $r_i$ .  $r_i$  can therefore also be interpreted as student  $i$ 's reservation value: the minimum resale value required for student  $i$  to be willing to resell.

Consider the impact of  $v_i$  on student choice behavior. For example, if a student places a high value on continued use of the book and does not discount the future much (i.e.,  $\delta_s \cdot v_i$  is large), then the effective price of a book will be far below the sticker price, as the loss of utility from paying the sticker price today is offset by the value of future use. Alternatively, if students are myopic ( $\delta_s = 0$ ), then the effective price of a book is identical to the sticker price, since myopic students assign no value to future options when making purchase decisions.

In the model, students differ from one another along two dimensions: (i) their idiosyncratic tastes  $\epsilon_i \equiv (\epsilon_{in}, \epsilon_{iu}, \epsilon_{i\emptyset})$ , and (ii) their reservation values  $r_i$ . To facilitate computation of the model, we assume that  $\epsilon_i$  and  $r_i$  are independent.<sup>15</sup> Given this assumption, the share of students choosing option  $j$  (new  $n$ , used  $u$ , or the outside option  $\emptyset$ ) is given by:

$$s_j(x, p_n) = \int \left( \int \mathbf{1} [j = \operatorname{argmax}_{k \in C(x)} u_{ik}] g_\epsilon(\epsilon_i) d\epsilon_i \right) g_r(r_i) dr_i, \quad (5)$$

where the choice set  $C(x)$  is  $\{n, \emptyset\}$  if age  $x$  is equal to zero (in which case used books are not available) and  $\{n, u, \emptyset\}$  otherwise. For notational convenience, we write shares  $s_j(x, p_n)$  as depending only on age  $x$  and new price  $p_n$ .  $\mathbf{1}[\cdot]$  is an indicator function that takes a value of one if the expression on the inside of the brackets is true – i.e., if option  $j$  delivers the

<sup>14</sup>Given the evidence in section 2.2, we assume that the new price  $p_n$  does not change within a book's edition. Therefore, students do not need to form an expectation over future prices in order to compute equation (4), since absent revision the new and used price next semester will be the same as the current semester.

<sup>15</sup>Given independence and the assumption of logit tastes, the integration over  $\epsilon_i$  can be computed in closed form. In addition, nothing in our data directly speaks to the correlation between  $\epsilon_i$  and  $r_i$ , though in reality at least some correlation may be present. For instance, students who assign a high value to continued use of the book may also be more likely to have a strong preference for a new book.

highest utility – and zero otherwise.  $g_\epsilon$  is the distribution of idiosyncratic tastes  $\epsilon_i$  and  $g_r$  is the distribution of reservation values  $r_i$ .

We assume that tastes  $\epsilon_i$  are generalized extreme value distributed such that demand is nested logit, with the new and used books nested according to nesting parameter  $\rho$ .  $\rho = 0$  corresponds to simple logit demand – i.e., no correlation between  $\epsilon_{in}$  and  $\epsilon_{iu}$  – whereas  $\rho = 1$  corresponds to perfect correlation. Nested logit demand allows for more flexible substitution patterns than simple logit demand, which is important because the impact of the secondary market on publisher profits may depend on the substitutability of new and used books. We assume that reservation values  $r_i$  are log-normally distributed with location parameter  $\mu_r$  and scale parameter  $\sigma_r$ .

## 3.2 Estimation

In this section, we outline the procedure we use to obtain estimates of the model’s parameters and then report the results.

### Parameters calibrated outside of the model

As discussed above, we fix  $\lambda = 0.75$  and  $\kappa = 1/3$  when estimating the model. We also fix the parameters determining the distribution of student reservation values:  $\mu_r$  and  $\sigma_r$ . Since our textbook data does not include any information that directly pertains to reservation values or resale decisions, we utilize an alternative source to inform these parameters. Specifically, we utilize survey data collected from several thousand students at the University of North Carolina between 2011 and 2013, as further documented in Spence (2015).<sup>16</sup> As part of the survey, students who purchased textbooks were asked: “Even if you plan on keeping your book at the end of the semester, what is the lowest amount you would be willing to sell your book for, once you are finished taking this course?” After scaling the survey responses to be measured in CPI-adjusted 2007 dollars and restricting the data to books priced in the range of our final sample, we estimate  $\mu_r$  and  $\sigma_r$  by maximum likelihood using the reported answers to this question. For students reporting \$0, which is not in the support of a log-normal distribution, we replace \$0 with the minimum reported value above zero, which is one cent. Measuring reservation values in tens of dollars, the resulting estimates are  $\hat{\mu}_r = 1.178$  and  $\hat{\sigma}_r = 1.085$ . Given these estimates, the median reservation value is about \$32.50, with 85 percent of students valuing continued use of the book at less than \$100. While we suspect

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<sup>16</sup>We thank Forrest Spence for providing us with this data.

that heterogeneity across books in the distribution of reservation values may be present, unfortunately we do not have sufficient data to link surveyed books to books in our sample, and hence we assume that these parameters do not vary by book. To numerically integrate over the distribution of reservation values, we use 1,000 random draws from the distribution.

It is also worth noting the difference between the time period of our textbook sales data (1997 to 2007) and the survey data (2011 to 2013). It is possible that students' reservation values have meaningfully changed over time. For instance, recent students may have more information about resale values than past students. While we assume that the survey responses accurately capture reservation values for our time period, we have also estimated the counterfactuals with upward and downward adjustments to  $\hat{\mu}_r$  and  $\hat{\sigma}_r$ . In the cases we have examined, higher reservation values increase publisher profits, but do not appear to affect whether closing the secondary market is profitable or not.

### Remaining parameters

In contrast to many consumer products, we believe it is largely reasonable to assume that the demand-side parameters in the textbook context do not vary substantially from product to product (i.e., book to book). For many students, the primary use of a textbook is for completing assignments, studying for tests, etc. In that case, the author or content of the book may not have much bearing if any on student value. We therefore assume that the remaining demand parameters  $\theta^D \equiv (\alpha_0, \gamma_0, \gamma_1, \beta, \delta_s, \rho)$  are the same across the books in our final sample.

To estimate the parameters with our aggregate data on textbook purchases, we follow the method of moments estimation procedure developed by Berry et al. (1995). For each candidate value of the demand parameters, we find the values of the demand shocks  $\xi_n$  and  $\xi_u$  that equate the model-predicted and observed shares for each observation. Denote the full vector of these values, which are functions of the demand parameters, by  $\xi(\theta^D)$ . We then estimate  $\theta^D$  by exploiting assumed orthogonality conditions between  $\xi(\theta^D)$  and a set of instruments. In particular, we solve:

$$\min_{\theta^D} \xi(\theta^D)' ZWZ' \xi(\theta^D), \quad (6)$$

where  $Z$  is a matrix of instruments and  $W$  is a positive definite weight matrix. For instruments, we use indicator variables for each unique combination of book type (new or used) and book age through age five, plus the page length of each book. This corresponds to

12 instruments in total: six new book-age indicator variables (ages zero to five), five used book-age indicator variables (ages one to five), and page length. Ages greater than five, which account for less than 2 percent of observations, are grouped with the age five indicator variable. For the weight matrix, we utilize  $W = (Z'Z)^{-1}$ , which is the efficient weight matrix assuming homoskedastic errors (Nevo (2000b)).

## Identification

The idea behind the book type-age indicator variable instruments is to allow detailed aspects of the observed share patterns to inform the parameters. The base utility parameters  $\alpha_0$  and  $\gamma_0$  strongly influence the overall level of new and used shares.  $\gamma_1$ , which controls the evolution of the utility of used books over time, can be identified by how used shares change with book age. The identification of the nesting parameter  $\rho$  and the student discount factor  $\delta_s$  is somewhat more nuanced. When used books become available at age one,  $\rho$  heavily influences the extent to which the used book takes share from the new book vs. the outside good.  $\rho$  can therefore be identified by the magnitude of the new plus used share increase once used books become available, with the magnitude of the combined share increase decreasing in  $\rho$ .<sup>17</sup>  $\delta_s$  can be identified by the responsiveness of demand to impending revisions. As a benchmark, suppose that students are myopic ( $\delta_s = 0$ ), such that effective prices are identical to sticker prices. In that case, shares will not respond to impending revisions. On the other hand, if students are forward-looking with  $\delta_s > 0$ , shares will fall in semesters in which the book will be revised the following semester (at age five in particular).

A common concern when estimating demand models of this form is the possible endogeneity of prices: i.e., correlation between the demand shocks  $\xi_n$  and  $\xi_u$  and price  $p_n$ . To address this concern, we instrument for the price of each book with the page length of that book. We collect the page length for the most recent edition of each book in the sample, and therefore the instrument varies only across books. The length of a book affects the cost of printing and shipping it, and therefore can be viewed as a marginal cost shifter. Indeed, the correlation between new prices and page length is extremely strong: about 0.91. The remaining requirement is that page length is uncorrelated with the demand shocks  $\xi_n$  and  $\xi_u$ . The intuitive justification for this exogeneity assumption is that it is not clear why students in an introductory economics class would have different underlying demand for the required textbook if it was 800 pages compared to 600 pages (i.e., except for the effect via price).

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<sup>17</sup>The assumption that the non-price utility of the new book does not change with age is important for this argument. Otherwise, a small new plus used share increase between age zero and age one might be able to be explained by falling new book utility.



This assumption would be violated if, for instance, longer textbooks contained more class materials that students value. While we cannot rule out violations of this form, overall we believe it is reasonable to assume that page length is exogenous to student preferences. We also report the parameter estimates assuming that prices are exogenous.

### 3.3 Results

The demand parameter estimates are reported in Table 2. The estimates assuming that prices are exogenous correspond to specification (1), while the estimates instrumenting for prices with book page length correspond to specification (2).

**Table 2: Demand Parameter Estimates**

		Specification: (1)		Specification: (2)	
		Instrument for price? No		Page Length	
Description	Parameter	Estimate	Standard Error	Estimate	Standard Error
Base new book utility	$\alpha_0$	0.423	0.084	0.806	0.107
Base used book utility	$\gamma_0$	-0.120	0.094	-0.113	0.103
Used book age	$\gamma_1$	0.024	0.021	0.071	0.024
Price sensitivity	$\beta$	0.164	0.011	0.247	0.018
Student discount factor	$\delta_s$	1	–	1	–
New/used nesting	$\rho$	0.575	0.066	0.474	0.074
# of Books		53		53	
# of Editions		180		180	
# of Observations		824		824	

Notes: The parameters governing used prices, resale prices, and the distribution of student reservation values are fixed in estimation ( $\lambda = 0.75$ ,  $\kappa = 1/3$ ,  $\mu_r = 1.178$ , and  $\sigma_r = 1.085$ ). The student discount factor converged to the upper bound of one in both specifications.

For both specifications, the student discount factor converged to the upper bound of one. While consistent with Chevalier and Goolsbee (2009), who also estimate student discount factors statistically indistinguishable from one, it is perhaps surprising that college students would exhibit such forward-looking behavior. An interesting theory we have heard that can potentially help explain this result is that money for the initial textbook purchase may often be supplied by parents, whereas the proceeds from resale may be retained by students. In that case, student purchase behavior will be particularly sensitive to resale value.

To facilitate interpretation of the remaining parameters, we calculate the implied (i) shares and (ii) own and cross-price elasticities for a book with  $p_n = \$124.11$  and  $T = 6$

**Table 3: Estimated Shares and Elasticities**

<i>Panel A: Shares</i>			
Book Age	New	Used	New+Used
0	0.410	–	0.410
1	0.259	0.222	0.480
2	0.246	0.242	0.488
3	0.233	0.263	0.496
4	0.221	0.284	0.505
5	0.151	0.223	0.374

<i>Panel B: Elasticities</i>			
	New	Used	Outside
New	-3.71	1.75	–
Used	2.07	-2.60	–
Outside	0.58	0.49	–

Notes: All statistics are calculated for a book with  $p_n = \$124.11$ ,  $T = 6$ , and demand parameters equal to the point estimates for specification (2) in Table 2. The parameters governing used prices, resale prices, and the distribution of student reservation values are fixed at the values utilized in estimation. The elasticities are averages between age one and age five. The columns are price changes and the rows are quantity changes: e.g., a 1 percent increase in the price of the new book is estimated to yield a 3.71 percent decrease in the new book share and a 2.07 percent increase in the used book share.

(the mean values for books in the final sample, rounding  $T$  to the nearest integer) and demand parameters equal to the point estimates for specification (2). We prefer specification (2) because of the larger estimated price sensitivity, which is consistent with the possible endogeneity of prices. For the elasticity calculations, we sever the mechanical link between new prices and used prices (equation (3)) to isolate demand-side behavior. The results are reported in Table 3.

The estimated share patterns exhibit the same noteworthy characteristics that appear in the aggregate share data depicted in Figure 3. The new plus used share jumps up when used books become available at age one. The used share then continues to climb while the new plus used share remains relatively constant. At age five – the semester before revision – shares fall sharply due to the increase in effective prices.

The estimated cross-price elasticities indicate that substitution between new and used books is much stronger than substitution toward the outside good. Estimated diversion ratios (not reported in the table) are also illustrative of this point. Of the students substituting

away from the new book following a price increase, we estimate that 63 percent of them would switch to buying used. Proportional substitution based on shares implies a much lower diversion ratio of 32 percent. It is also worth noting that the true price elasticity faced by publishers is weaker than the -3.71 presented in Table 3. When a publisher increases the price of the new book, used prices increase mechanically in turn, which dampens the substitution to used books. The new book own price elasticity taking this linkage into account is estimated to be -1.54.

## 4 Supply

The purpose of explicitly modeling student purchase behavior is so that we can forecast how demand would change in response to a shift in the environment, such as closing the secondary market (i.e., banning resale). Besides the demand response, whether publishers would benefit from closing the secondary market depends on their cost structures, and also their own strategic responses to the change in environment. We therefore also implement a structural model of publisher pricing and revising decisions, and combine that model with observed publisher behavior to estimate publisher costs.

### 4.1 Model

We assume that each publisher has two choice variables: (i) the price of the new book  $p_n$  and (ii) the length of the revision cycle  $T$ . The publisher commits to both of these decisions: the price cannot be changed, nor can the revision cycle be adjusted. These assumptions are consistent with the known institutional details of the industry. As shown in section 2.2, new book prices are essentially flat within edition. Moreover, publishers often sign contracts with textbook authors that specify the timing of revisions (Chevalier and Goolsbee (2009)).

Each semester, the publisher earns the flow profits from sales of the book. In semesters where the book is revised, the publisher also incurs a fixed revising cost. We assume that publishers evaluate price and revision cycle choices by the average per-semester profits generated by those choices. Normalizing the number of students assigned the book to one, the publisher's optimization problem is thus:

$$\max_{p_n, T} \frac{\sum_{x=0}^{T-1} s_n(x, p_n) \cdot (p_n - c)}{T} - \frac{F}{T}, \quad (7)$$

where  $T$  is constrained to be an integer greater than or equal to one.<sup>18</sup>  $c$  is the marginal cost of the book and  $F$  is the fixed revising cost (normalized by the number of students). The first term in the maximand reflects profits from book sales, while the second term reflects revision spending. Shortening the revision cycle implies less frequent competition with used books, but also higher revision spending. For instance, if  $T = 1$ , the publisher will never face competition from used books, but the publisher will also incur the revising cost  $F$  every semester. The optimal revision cycle balances these effects.

## 4.2 Estimation

The parameters to be estimated on the supply side of the model are the marginal cost  $c$  and fixed revising cost  $F$  for each book. These parameters may vary across books due to differences in book length, fees paid to authors, etc. We estimate these parameters for the most recent edition of each book for which we observe the revision timing by finding the values of  $c$  and  $F$  such that the solution to the publisher’s optimization problem (7) is equal to the observed new book price and revision timing. This procedure is analogous to the recovery of marginal costs in the static case (e.g., Nevo (2000a); Nevo (2001)), with the addition of the revising decision and associated fixed revising cost. When solving the publisher’s optimization problem for each book, we set the demand parameters equal to the point estimates for specification (2) in Table 2.

The identification of the supply parameters is relatively straightforward. Intuitively, the optimal revision age is increasing in the fixed revising cost, so the  $F$  for each book can be identified by the age at which the book is revised. Similarly, the optimal price is increasing in marginal cost, so the  $c$  for each book can be identified by the price of the book. Since revision timing is integer-valued, this procedure yields an *interval* of fixed revising costs such that the model-predicted revision timing is equal to the observed revision timing. Marginal costs are point-identified.

## 4.3 Results

The supply parameter estimates are reported in Table 4. Mean estimated marginal costs are \$38.78, or about 5.7 cents per page. A report by the educational product firm Follett esti-

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<sup>18</sup>To simplify the computation of optimal publisher behavior, we compute shares deterministically by setting the demand shocks  $\xi_n$  and  $\xi_u$  equal to zero. Without this simplification, solving the publisher’s optimization problem requires (i) specifying the distribution of the demand shocks and (ii) integrating over the demand shocks for all semesters prior to revision, which is an integral over  $2T - 1$  dimensions.

**Table 4: Supply Parameter Estimates**

Parameter	Mean	Median	Standard Deviation
Marginal cost $c$	\$38.78	\$31.55	\$26.06
Marginal cost $c$ per page	\$0.057	\$0.056	\$0.028
Fixed revising cost $F$ lower bound	\$20.24	\$18.50	\$6.47
Fixed revising cost $F$ upper bound	\$26.45	\$24.64	\$8.33
Fixed revising cost $F$ midpoint	\$23.35	\$21.57	\$7.40

Notes: All values are in CPI-adjusted 2007 dollars. The fixed cost estimates are normalized by student enrollment.

mates that \$33.60 of a \$100 textbook’s price goes to printing and shipping.<sup>19</sup> The estimated marginal costs therefore appear to be similar to industry sources.

Turning to the estimated fixed revising costs, recall that the estimates are normalized by student enrollment. Books in the final sample have an average estimated enrollment of 11,491 (Table 1). The data captures roughly 60 percent of total college enrollment, so scaling enrollment up to the universities not included in the data yields a total enrollment estimate of  $11,491/0.6=19,152$ . Multiplying the mean estimated fixed revising cost midpoint by this estimate of enrollment generates revision costs of  $\$23.55*19,152\approx\$450,000$ . A report by the Association of American Publishers suggests that these numbers are in the ballpark of – though somewhat less than – industry claims: “Developing a new textbook and accompanying learning tools can cost more than \$1 million.”<sup>20</sup>

## 5 Counterfactual Analysis

In this section, we use the estimated structural model to simulate student and publisher behavior in alternative market environments. In section 5.1, we close the secondary market by banning resale. When the secondary market is closed, students can still buy new books but used books cannot be bought or sold. For publishers, closing the secondary market eliminates competition with used books, but also eliminates their ability to charge for resale value. Which force dominates, and on what parameters does the answer hinge?

In section 5.2, we convert the mechanism determining used prices to be market clearing.

<sup>19</sup>Follett Insight. *The Real Cost of Textbooks – and Affordable Options for Students*.

<sup>20</sup>Association of American Publishers, Inc. *Why PIRG is Wrong: Myths and Facts About College Textbooks*, 2006.

The main purpose of this exercise is to understand how publisher incentives to close the secondary market might have been affected by the rise of non-university bookstore intermediaries like Amazon.com, where sellers are not held to rigid pricing rules. Are publisher incentives to close the secondary market strengthened or weakened when used prices are determined by market clearing?

We calculate all estimates for a book with demand parameters equal to the point estimates for specification (2) in Table 2 and supply parameters equal to the means in Table 4. The parameters governing used prices, resale prices, and the distribution of student reservation values are fixed at the values utilized in estimation.<sup>21</sup>

## 5.1 Closing the Secondary Market

When the secondary market is closed, students no longer need to anticipate revisions: with no resale, the effective price of new books is always the sticker price less the student's discounted reservation value (i.e.,  $p_n - \delta_s \cdot r_i$ ). Closing the secondary market also eliminates the publisher's incentive to revise the book, as revision no longer has an impact on student demand. The publisher instead faces a standard static pricing problem, choosing price to maximize flow profits.

Table 5 reports estimates of the effect of closing the secondary market on a variety of market outcomes. A first thought is that closing the secondary market would allow the publisher to charge a higher price, because competition with used books disappears. In fact, however, the opposite occurs, with the new sticker price falling by 6.9 percent. When the secondary market is closed, the publisher can no longer charge students for resale value, which puts downward pressure on the new price. The new *effective* price, on the other hand, rises considerably. Without resale, many students face much higher effective prices because they are no longer able to recoup some of the purchase price via resale. 31.2 percent of students purchase the new book when the secondary market is closed, which is larger than the average new share when the secondary market is open (24.0 percent). At age zero, however, the new share is higher when the secondary market is open, because at that point there is no competition with used books *and* students can benefit from resale in the next semester (which increases student willingness to pay). The benefit of closing the secondary market comes at non-zero ages where competition with used books is particularly damaging.

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<sup>21</sup>The exact values of the parameters are as follows. Demand:  $\alpha_0 = 0.806$ ,  $\gamma_0 = -0.113$ ,  $\gamma_1 = 0.071$ ,  $\beta = 0.247$ ,  $\delta_s = 1$ ,  $\rho = 0.474$ . Supply:  $c = \$38.78$  and  $F = \$23.35$ . Other parameters:  $\lambda = 0.75$ ,  $\kappa = 1/3$ ,  $\mu_r = 1.178$ , and  $\sigma_r = 1.085$ . The demand shocks  $\xi_n$  and  $\xi_u$  are set to zero to facilitate the computation (see footnote 18).

**Table 5: Closing the Secondary Market**

	Open (Status Quo)	Closed (No Resale)	Percent Change
New Sticker Price	\$129.03	\$120.07	-6.9%
New Effective Price	\$46.21	\$61.10	32.2%
New Share	0.240	0.312	29.9%
Age=0	0.395	0.312	-21.0%
Age>0	0.209	0.312	49.1%
Used Sticker Price	\$96.77	–	–
Used Effective Price	\$14.91	–	–
Used Share	0.246	–	–
Age at Revision	6	–	–
Publisher Profits	\$17.77	\$25.34	42.6%
Flow Profits	\$21.66	\$25.34	17.0%
Revision Spending	\$3.89	\$0.00	-100.0%
Student Surplus	\$36.39	\$28.26	-22.4%
Bookstore Profits	\$6.61	\$0.00	-100.0%
Total Surplus	\$60.77	\$53.60	-11.8%

Notes: The estimates are calculated for a book with demand parameters equal to the point estimates for specification (2) in Table 2 and supply parameters equal to the means in Table 4. The parameters governing used prices, resale prices, and the distribution of student reservation values are fixed at the values utilized in estimation. See footnote 21 for the exact parameter values. All monetary values are in CPI-adjusted 2007 dollars. All statistics are averages across the distribution of student reservation values and book ages. Bookstore profits capture the markup on used books, assuming no other revenues or costs of operation. Publisher profit, student surplus, and bookstore profit estimates are per student. Total surplus is the sum of publisher profits, student surplus, and bookstore profits.

Overall, we estimate that publisher profits increase by 42.6 percent when the secondary market is closed. This result indicates that the detrimental effect from used book competition on publisher profits far exceeds any benefits that are generated by resale value. As discussed above, new sticker prices actually fall when the secondary market is closed. Rather than greater pricing power, the large increase in profits instead comes from (i) a higher quantity sold and (ii) less revision spending. The decrease in revision spending accounts for  $\$3.89/(\$25.34-\$17.77)=51$  percent of the increase in profits, with the increase in flow profits accounting for the remaining 49 percent.

The complete absence of revision spending when the secondary market is closed is arguably a somewhat extreme case. However, even if the publisher is held to revising every six semesters – as in the status quo case – we estimate that publisher profits would be \$25.34-

\$3.89=\$21.45, which is still 20.7 percent higher than publisher profits when the secondary market is open. In short, given the estimated parameter values, the results strongly suggest that publishers would benefit from closing the secondary market.

The rise of E-Textbooks, where digital rights management technology can more readily prevent resale, is consistent with the result that publishers would profit from closing the secondary market. In addition, even if publishers cannot directly close the secondary market, they can take actions that make resale less prevalent. For instance, publishers now often rent textbooks to students, which allows publishers to make sales that do not subsequently compete with new books in future semesters.<sup>22,23</sup>

It is also worth highlighting that total surplus falls by 11.8 percent when the secondary market is closed: the increase in publisher profits from closing the secondary market is less than the combined decrease in student surplus and bookstore profits. This result echoes the intuition from value-based strategy provided at the outset of the paper. While a smoothly functioning secondary market may create value, it is also capable of impeding firm value capture to an extent that the firm would prefer the secondary market to be closed entirely.

### **Can publishers benefit from the secondary market?**

While the results suggest that closing the secondary market would increase publisher profits at the estimated parameter values, for other parameter values the presence of the secondary market is beneficial to publishers. Recall the two main forces through which the secondary market affects publisher profits: competition between new and used books harms publishers, while resale value benefits publishers. By varying model parameters that capture these two forces, we can examine the subsequent quantitative impact on the profitability of closing the secondary market.

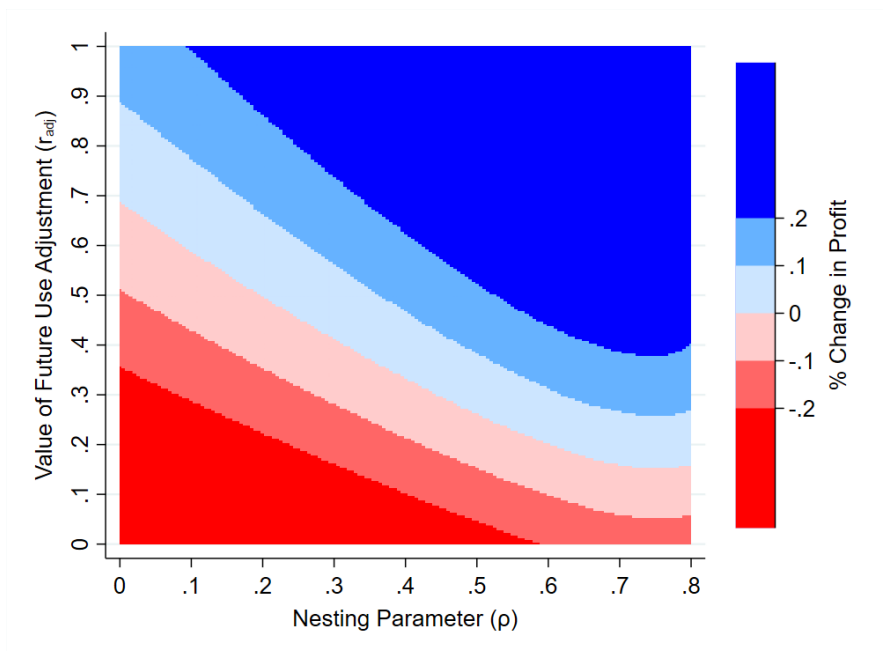
To examine the impact of competition between new and used books, we vary the nesting parameter  $\rho$ , which governs the correlation in students' idiosyncratic tastes for new and used books. For high values of this parameter, tastes are highly correlated, whereas for low values new and used books are less substitutable. To examine the impact of resale value, we introduce an additional parameter,  $r_{adj}$ , that scales the estimated student reservation values  $r_i$ . In particular, we let  $r'_i = r_{adj} \cdot r_i$  for all  $i$  and then solve the model for the adjusted

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<sup>22</sup>Lewin, T. (2009, August 13). Textbook Publisher to Rent to College Students. *New York Times*. Besides rental, customized textbooks containing additional professor-specific materials may also be more difficult for students to resell.

<sup>23</sup>In section 7.2 in the appendix, we examine an additional counterfactual in which we permit publishers to rent books in addition to selling them. We find that publishers benefit from having a rental option, as it allows publishers to attract students with low reservation values without decreasing the price of new books.





**Figure 4: The Profitability of Closing the Secondary Market by  $\rho$  and  $r_{adj}$**  The figure plots the impact of closing the secondary market on publisher profits for a grid of  $\rho$  and  $r_{adj}$ . Blue indicates that closing the secondary market is profitable, with darker colors signaling greater profitability. Red indicates that closing the secondary market is unprofitable, with darker colors signaling greater losses.

reservation values  $r'_i$ . To see how this adjustment affects behavior, recall the utility that students receive in the semester following purchase when the book is not revised, as given in equation (4):  $\max [(1 - \kappa) \cdot p_u, r_i]$ . That is, students can either resell the book and receive  $(1 - \kappa) \cdot p_u$  or keep it and receive  $r_i$ . Closing the secondary market eliminates the first argument of the max, and the impact of that change on student willingness to pay depends on how large the alternative  $r_i$  is. The smaller  $r_{adj}$  is, the less students value continued use of the book, and hence the more important the secondary market is in supporting student willingness to pay.

Figure 4 plots the change in publisher profits from closing the secondary market for different combinations of  $\rho$  and  $r_{adj}$ . These changes range from -45 percent in the lower left corner to +53 percent in the upper right corner. Publishers are more likely to be harmed by closing the secondary market when new and used books are less substitutable (i.e., lower values of  $\rho$ ) and when resale value is a greater determinant of student willingness to pay (i.e., lower values of  $r_{adj}$ ).

The large range of possible effects reported in Figure 4 suggests that firm interactions with the secondary market can have a major impact on profitability. One clear lesson is that the segmentation of new and used buyers is highly beneficial. If new and used goods

are not viewed as substitutable for a substantial fraction of buyers, the firm may choose to aid the smooth operation of the secondary market, as the firm can charge buyers for resale value without inducing substitution away from new goods. If new and used goods are highly substitutable, on the other hand, a smoothly functioning secondary market may prompt would-be new buyers to purchase used goods, thereby damaging profitability. While the segmentation of new and used buyers may in part be determined by exogenous consumer preferences, it is also a function of firm actions. For example, Acura offers buyers of its NSX supercar an “insider experience” with private factory tours and guided time on a race track.<sup>24</sup> A new NSX with this service is presumably less substitutable with a used NSX than a new NSX without the service. Online access codes with new textbook purchases that provide students with additional materials can be interpreted similarly.<sup>25</sup>

## 5.2 Market Clearing Used Prices

Given the observed patterns in the data, we have good reason to suspect that used prices for the period of our data were determined mechanically as roughly 75 percent of new prices. The market frictions that led to this price setting mechanism were clearly substantially lessened by the growth of online intermediaries like Amazon.com. With Amazon and firms like it, used prices are perhaps better modeled as being determined by market clearing: i.e., the used price that prevails is the price that equates the demand and supply of used books. In this section, we convert the mechanism determining used prices to be market clearing and then examine the subsequent predictions of the model. The discussion below is relatively informal: section 7.3 in the appendix provides a detailed explanation of how we compute market clearing used prices.

When used prices are determined by market clearing, students need to form expectations about future used prices (in addition to anticipating revisions). To find market clearing used prices, we search for used prices that satisfy rational expectations: i.e., used price expectations that generate demand such that subsequent market clearing used prices are equal to those expectations. Intuitively, more students will buy new and used books if they expect high used prices next semester, but that greater demand (which becomes supply next semester) will potentially push used prices next semester lower than what students expected. When solving the model, we impose that these asymmetries do not occur: in equilibrium,

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<sup>24</sup>Capparella, J. (2017, February 21). Acura NSX Buyers Can Get “Insider Experience” at Central Ohio Factory and Test Track. *Car and Driver*.

<sup>25</sup>Carrns, A. (2016, September 23). A New Cost at College: Digital Access Codes. *New York Times*. The article reports that one-third of courses include access codes among the required course materials.

the used prices that students anticipate when making purchase decisions are equal to the used prices that prevail in the following semester.

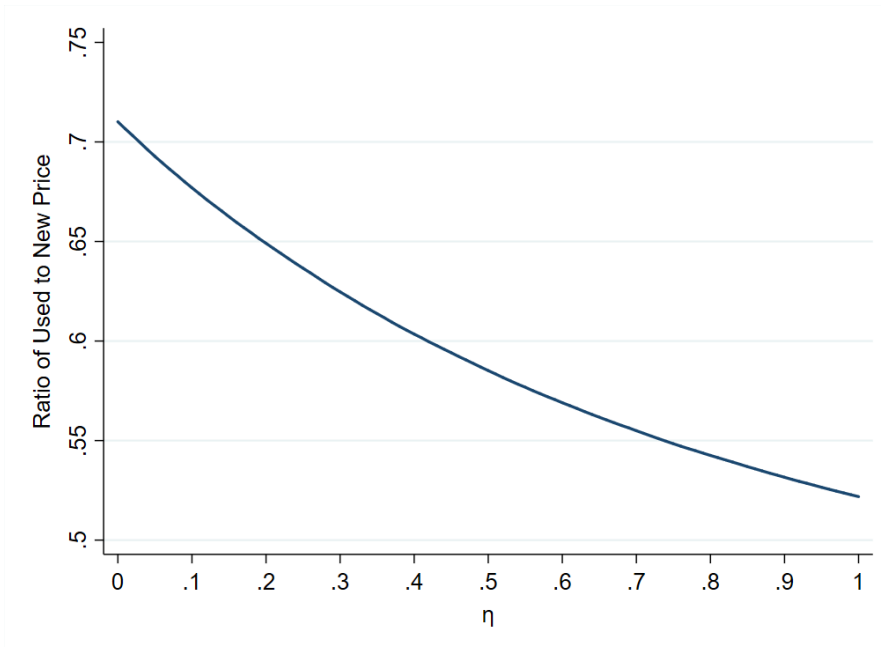
Another wrinkle in implementing market clearing used prices is the possible deterioration of student reservation values ( $r_i$ ) over time. For instance, a student may have a reservation value of \$50 one semester after taking the class but a much smaller reservation value two semesters after taking the class, which will affect the available supply of used books and hence the market clearing used price. Absent data to facilitate more detailed modeling of  $r_i$  beyond the semester immediately following purchase, we assume that a constant proportion  $\eta$  of the remaining potential supply of used books becomes available for sale, irrespective of the prevailing used price. At the extremes,  $\eta = 0$  corresponds to students making a once-and-for-all decision whether to resell in the semester immediately following purchase, while  $\eta = 1$  corresponds to all value from future textbook use being generated in the semester immediately following purchase, after which all students who did not initially resell become willing to resell. In short, higher values of  $\eta$  correspond to a faster supply of used books to the secondary market. See section 7.3 in the appendix for additional explanation.

A final note is that we hold  $\kappa$  and  $\gamma_1$  at the values reported in Table 2.  $\kappa$  captures the bookstore's markup on used books and  $\gamma_1$  can be interpreted as reflecting the availability of used books. The rise of firms like Amazon arguably impacts these parameters, but we hold them constant to isolate the impact of changing the mechanism determining used prices.

## Results

To begin, we examine the impact of market clearing on used prices. To isolate the effect of the market clearing mechanism, we start by holding publisher pricing and revising decisions at the status quo values reported in Table 5 ( $p_n = \$129.03$ ,  $T = 6$ ). Figure 5 reports the estimated ratio of the average market clearing used price to the new price as a function of  $\eta$ . As expected, used prices fall as used books are more quickly supplied to the secondary market (i.e., as  $\eta$  increases). The results suggest that used prices lower than 75 percent of the new price are needed to clear the market. This result is consistent with data from Amazon, where used textbooks typically sell for below 75 percent of the new price (Chevalier and Goolsbee (2009)). The result is also consistent with the data from Spence (2015), where online used prices are, on average, 58 percent of new prices.

How do these lower used prices affect publisher profits? Lower used prices damage publisher profitability in two immediate ways. First, lower used prices make used books a more attractive substitute for new books. Second, lower used prices reduce student willingness to



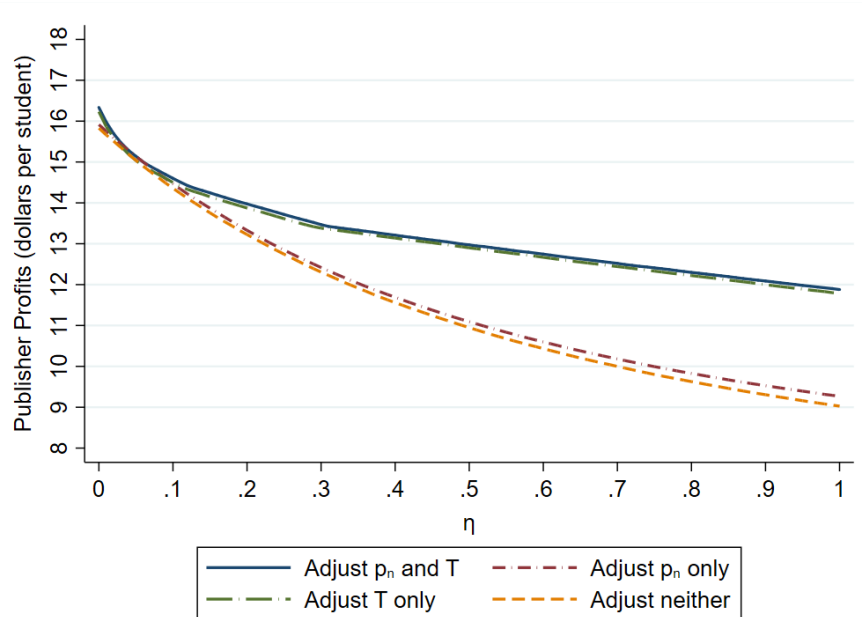
**Figure 5: Market Clearing and Used Prices**

pay for new books (by decreasing resale value).<sup>26</sup> Figure 6 confirms that the shift to market clearing used prices is damaging to publisher profits. In the figure, we report publisher profits (as a function of  $\eta$ ) allowing the publisher to respond to market clearing used prices by adjusting the new price, revision timing, neither, or both. In every case, publisher profits fall below the status quo profits reported in Table 5 (\$17.77 per student). Textbook publishers are widely thought to be under major financial pressure due to the growth of firms like Amazon, which is consistent with this result.<sup>27</sup> The result also suggests that the rise of firms like Amazon likely strengthened publisher incentives to close the secondary market.

Another striking aspect of Figure 6 is the impact of changes in revision timing compared to changes in the new price. Adjusting prices makes only an incremental difference in publisher profits, whereas adjusting revision timing is much more consequential. This result suggests that ignoring versioning decisions in durable goods markets or treating them as exogenous may fail to capture fundamental strategic considerations. The way in which publishers in the model respond to market clearing used prices is also interesting. As  $\eta$  goes to one (i.e., as used books are more quickly supplied to the secondary market), the optimal revision cycle shortens to three semesters. When used prices are determined by

<sup>26</sup>Lower used prices also decrease the resale value of *used* books, but with the strong countervailing force that used books are cheaper upfront.

<sup>27</sup>See footnote 7 for references.



**Figure 6: Market Clearing and Publisher Profits** “Adjust neither” corresponds to the case where the new price and revision timing are held at their status quo values reported in Table 5 ( $p_n = \$129.03$ ,  $T = 6$ ). “Adjust  $T$  only” allows the publisher to optimally change the revision timing (holding price constant). “Adjust  $p_n$  only” allows the publisher to optimally change the new price (holding revision timing constant). “Adjust  $p_n$  and  $T$ ” allows the publisher to optimally respond to market clearing used prices by adjusting both the new price and revision timing.

market clearing, new shares fall more precipitously in book age, leading to shorter optimal revision cycles. This result is consistent with observations by market participants. In-sample textbook author Robert Frank notes that “It used to be your new edition would come out. Then, the next year, it would sell half as many copies as the first year and then half again on the third year. Now it’s you sell copies – if you sell any at all in the first year – and it’s done.”<sup>28</sup>

In addition, while the shift to market clearing lowers used prices (Figure 5), the publisher interestingly responds to the stronger price competition by *increasing* the price of new books. Averaging over  $\eta$ , the average new price when the publisher can adjust both  $p_n$  and  $T$  is \$137.67. When only adjusting  $p_n$  (holding  $T$  fixed), the average new price is \$144.62. Both estimates exceed the \$129.03 status quo new price from Table 5. Intuitively, when prices of used books are determined by market clearing, current semester sales of new books carry a cost in future semesters: the more new books are sold now, the lower used prices will be in the future, which harms future publisher profits. The publisher may optimally respond by

<sup>28</sup>NPR, *Planet Money*, Episode 573: Why Textbook Prices Keep Climbing, 2016.

raising the price of new books, where intuitively the rationale is to hold down the supply of used books. The model prediction that stronger competition from the used market can generate higher new prices is consistent with recent industry trends. The component of the CPI that tracks new college textbooks was the sixth-fastest growing component from January 2008 to January 2015 out of more than 350 different components.<sup>29</sup>

## 6 Conclusion

The effect of secondary markets on firm profits is ambiguous. Secondary markets benefit firms by facilitating resale, thus increasing buyer willingness to pay, but harm firms by creating competition between new and used goods. We examine these issues in the context of college textbooks, where students may be willing to pay more for textbooks that they can easily resell, but used books compete with new books for sales. Determining whether the secondary market helps or harms publishers on balance requires quantifying the extent to which publishers can charge for resale value as well as the extent to which used books steal share from new books.

To do so, we develop and estimate a structural model of student and publisher behavior. At the estimated parameter values, the model suggests that closing the secondary market would substantially increase publisher profits. While closing the secondary market puts downward pressure on prices, new book sales increase and publishers spend less on revisions. In an additional counterfactual analysis, we find that publishers would benefit from the secondary market if (i) new and used books were less substitutable and (ii) resale value was more important to students. We also examine the impact of changing the mechanism determining used prices to be market clearing, as opposed to the rigid used book pricing mechanism that prevailed during the period of our data. Consistent with rising financial pressure on textbook publishers concurrent with Amazon.com's growth, the results suggest that publisher incentives to close the secondary market are strengthened once used prices are determined by market clearing.

These results have several implications for future market developments. First, publishers may be expected to take actions to limit the supply of used books, such as developing E-Textbooks for which digital rights management technology can effectively prevent resale. Second, besides interfering with the operation of the secondary market, publishers may instead take actions that reduce the substitutability of new and used books. For instance,

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<sup>29</sup>Bureau of Labor Statistics, Consumer Price Index reports, 2008-2015.

creating additional online materials that are only accessible with a new book purchase may reduce the substitutability of new and used books while still retaining a great deal of resale value. Third, while digital rights management technology may make disallowing resale possible, it may also make other restraints that stop short of fully banning resale possible. For example, Amazon received a patent in 2013 for a technology facilitating the resale of digital goods. The technology includes tools for sellers to control resale such as a maximum number of transfers, resale price minimums, and transfer fees.<sup>30</sup> Resale price minimums, for instance, may look very similar to the rigid pricing rules of university bookstores examined here. In our view, the strategic implications of such restraints in an increasingly digital world, e.g. in which goods do not physically depreciate, is an interesting topic for future research.

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<sup>30</sup>Streitfeld, D. (2013, March 7). Imagining a Swap Meet for E-Books and Music. *New York Times*.

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# 7 Appendix

## 7.1 Books in the Final Sample

Count	Author	Title	Count	Author	Title
1	Arnold	Economics	28	Mankiw	Principles of Macroeconomics
2	Arnold	Microeconomics	29	Mankiw	Principles of Microeconomics
3	Bade	Foundations of Economics	30	Mansfield	Economics USA
4	Bade	Foundations of Macroeconomics	31	McConnell	Macroeconomics
5	Bade	Foundations of Microeconomics	32	McConnell	Microeconomics
6	Baumol	Economics: Principles and Policy	33	McEachern	Macroeconomics: A Contemporary Introduction
7	Baumol	Macroeconomics: Principles and Policy	34	McEachern	Microeconomics: A Contemporary Introduction
8	Baumol	Microeconomics: Principles and Policy	35	Miller	Economics Today
9	Boyes	Economics	36	Miller	Economics Today: The Macro View
10	Carbaugh	Contemporary Economics	37	Miller	Economics Today: The Micro View
11	Case	Principles of Economics	38	O'Sullivan	Economics: Principles, Applications, and Tools
12	Case	Principles of Macroeconomics	39	O'Sullivan	Macroeconomics: Principles, Applications, and Tools
13	Case	Principles of Microeconomics	40	O'Sullivan	Microeconomics: Principles, Applications, and Tools
14	Colander	Economics	41	Parkin	Economics
15	Colander	Macroeconomics	42	Samuelson	Economics
16	Colander	Microeconomics	43	Samuelson	Macroeconomics
17	Frank	Principles of Economics	44	Samuelson	Microeconomics
18	Frank	Principles of Macroeconomics	45	Schiller	The Economy Today
19	Gottheil	Principles of Economics	46	Schiller	The Macro Economy Today
20	Gottheil	Principles of Macroeconomics	47	Schiller	The Micro Economy Today
21	Gottheil	Principles of Microeconomics	48	Sexton	Exploring Microeconomics
22	Gwartney	Macroeconomics: Private and Public Choice	49	Stiglitz	Principles of Macroeconomics
23	Gwartney	Microeconomics: Private and Public Choice	50	Stiglitz	Principles of Microeconomics
24	Hall	Economics: Principles and Applications	51	Taylor	Economics
25	Hall	Macroeconomics: Principles and Applications	52	Tucker	Macroeconomics for Today
26	Hall	Microeconomics: Principles and Applications	53	Tucker	Microeconomics for Today
27	Mankiw	Brief Principles of Macroeconomics			

Notes: For books with multiple authors, only a single author is listed in the table.

We utilize the following restrictions to identify this sample. The goal of the restrictions is to trim the data to a sample of books to which the structural model arguably applies and for which there is sufficient data to precisely measure outcomes like student purchase shares.

1. Require books to be assigned for introductory courses for the majority of estimated enrollment
2. Require books to have at least 10 semesters of data without gaps (data availability is spotty even for some high-selling books)
3. Require books to have at least 500 enrolled students in each semester
4. Require books to have an average new sticker price of at least \$100 (to exclude study guides)
5. Require books to have data for at least two editions (i.e., so we observe at least one revision)

## 7.2 Rental

We have also simulated outcomes adding a rental option for publishers. When rental is permitted, publishers also choose a rental price in addition to a selling price. We assume that marginal costs for rentals are 1/6th of marginal costs for sales (e.g., the same copy of a book can be rented six times before it needs to be replaced). We assume that the quality of rentals is the same as new books, but with zero value beyond the semester of use (i.e.,  $v_i = 0$ ). The results from this counterfactual are reported in Table 6 below. The first two columns of the table are copied from Table 5 for comparison. Publisher profits increase substantially when adding the rental option. With rental, publishers can more easily target students who have low reservation values. For instance, when the secondary market is open, the rental share is estimated to be largest at age five when the book will be revised the next semester. Adding rental does not appear to meaningfully affect publisher incentives to close the secondary market: in fact, the results indicate that publishers would prefer a closed secondary market without rental to an open secondary market with rental.

**Table 6: Closing the Secondary Market: Adding Rental**

	Open (Status Quo)	Closed (No Resale)	Open w/ Rental	Closed w/ Rental
New Sticker Price	\$129.03	\$120.07	\$137.87	\$130.60
New Effective Price	\$46.21	\$61.10	\$52.29	\$71.63
New Share	0.240	0.312	0.172	0.202
Age=0	0.395	0.312	0.270	0.202
Age>0	0.209	0.312	0.152	0.202
Rental Price	–	–	\$66.45	\$74.77
Rental Share	–	–	0.143	0.179
Used Sticker Price	\$96.77	–	\$103.40	–
Used Effective Price	\$14.91	–	\$18.89	–
Used Share	0.246	–	0.197	–
Age at Revision	6	–	6	–
Publisher Profits	\$17.77	\$25.34	\$21.69	\$30.71
Flow Profits	\$21.66	\$25.34	\$25.58	\$30.71
Revision Spending	\$3.89	\$0.00	\$3.89	\$0.00
Student Surplus	\$36.39	\$28.26	\$37.80	\$30.79
Bookstore Profits	\$6.61	\$0.00	\$5.67	\$0.00
Total Surplus	\$60.77	\$53.60	\$65.16	\$61.50

Notes: The first two columns of the table are copied from Table 5 in the main text. The notes to that table apply here as well, but are suppressed for brevity.

### 7.3 Market Clearing Used Prices

In this section, we explain how we compute market clearing used prices. To begin, it is convenient to define the share of students who purchase new or used books that plan on reselling in the next semester if the book is not revised. Denote the share of students buying book type  $j$  (new  $n$  or used  $u$ ) at age  $x$  who plan to resell at age  $x + 1$  by  $\hat{s}_j(x)$ :

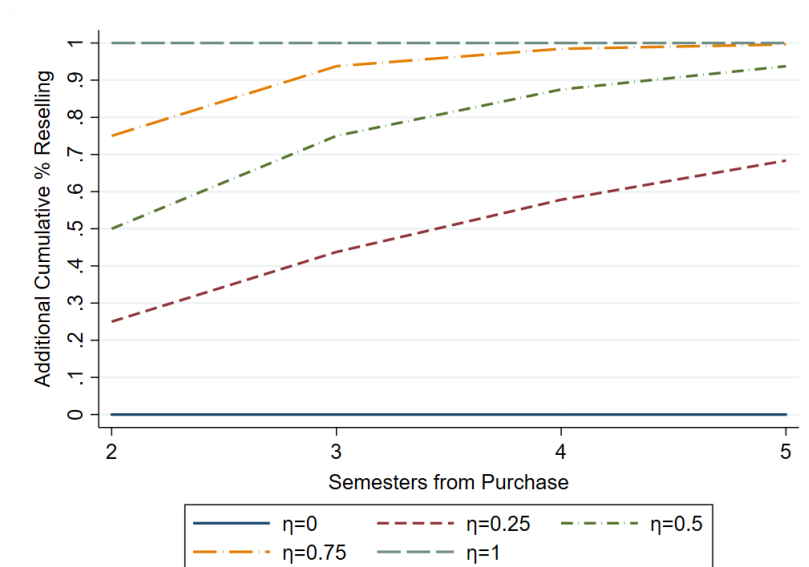
$$\hat{s}_j(x) = \int \mathbb{1}[(1 - \kappa) \cdot p_u(x + 1) \geq r_i] \left( \int \mathbb{1}[j = \operatorname{argmax}_{k \in C(x)} u_{ik}] g_\epsilon(\epsilon_i) d\epsilon_i \right) g_r(r_i) dr_i, \quad (8)$$

where  $p_u(x + 1)$  is the expected used price next semester. All other terms are as defined in the main text. For brevity, we suppress the dependence of shares on everything besides age  $x$ . This formula is extremely similar to the overall share equation (equation (5)), but adding the condition that the student plans to resell the book next semester. As when estimating the supply side of the model, we set the demand shocks  $\xi_n$  and  $\xi_u$  to zero. Setting these shocks equal to zero is helpful because it makes shares a deterministic function of age: otherwise, market clearing used prices need to be computed as a function of the demand shocks.

In semesters beyond the semester immediately following purchase, we assume that a constant proportion  $\eta$  of the remaining potential supply of used books becomes available for sale, irrespective of the prevailing used price. Figure 7 provides additional explanation. To examine the supply of used books given this assumption, first consider the new book purchases that become available for resale at each age, as shown in the table below. Each cell of the table denotes the quantity of books that were purchased new at the age given by the column and made available for resale at the age given by the row.

<u>Age at resale:</u>	<u>Age at purchase:</u>				
	$x = 0$	$x = 1$	$x = 2$	$\dots$	$x = T - 2$
$x = 1$	$\hat{s}_n(0)$	0	0	$\dots$	0
$x = 2$	$\eta[s_n(0) - \hat{s}_n(0)]$	$\hat{s}_n(1)$	0	$\dots$	0
$x = 3$	$\eta(1 - \eta)[s_n(0) - \hat{s}_n(0)]$	$\eta[s_n(1) - \hat{s}_n(1)]$	$\hat{s}_n(2)$	$\dots$	0
$\dots$	$\dots$	$\dots$	$\dots$	$\dots$	$\dots$
$x = T - 1$	$\eta(1 - \eta)^{T-3}[s_n(0) - \hat{s}_n(0)]$	$\eta(1 - \eta)^{T-4}[s_n(1) - \hat{s}_n(1)]$	$\eta(1 - \eta)^{T-5}[s_n(2) - \hat{s}_n(2)]$	$\dots$	$\hat{s}_n(T - 2)$

The cells of the table define a  $T - 1$  by  $T - 1$  matrix in which the sum of each row gives the supply of used books for each age that comes directly from new book purchases. As  $T \rightarrow \infty$ , the sum of each column approaches  $s_n(x)$ : i.e., all new book sales are eventually supplied to the secondary market. Denote this matrix by  $\Omega_n$ . A similar matrix can be constructed for used purchases,  $\Omega_u$ . The first column of  $\Omega_u$  is all zeros (because used books are not available



**Figure 7:  $\eta$  and the Supply of Used Books** The x-axis is semesters since purchase and the y-axis is the cumulative fraction of students who did not resell one semester from purchase who resell in future semesters. Resale one semester from purchase is determined as modeled in equation (4). Thereafter,  $\eta$  governs the additional supply of used books to the secondary market. For example, suppose that 50 percent of students bought a new book at age zero and that 40 percent of those students resold at age one, leaving  $(1-0.4)*0.5=30$  percent of students holding used books. For  $\eta = 0.5$ , half of those students will resell at age two, half of the remainder will resell at age three, etc.

at age zero), while the remaining columns are defined as with  $\Omega_n$  but for used purchases. The total supply of used books at each age – except for age zero when used books are not available – is then given by  $(\Omega_n + \Omega_u)\vec{1}$ , where  $\vec{1}$  is a column vector of  $T - 1$  ones.

To compute market clearing used prices, we solve the following non-linear system of  $T - 1$  equations that equate the demand and supply of used books:

$$\begin{bmatrix} s_u(1) \\ s_u(2) \\ \dots \\ s_u(T - 1) \end{bmatrix} = (\Omega_n + \Omega_u)\vec{1}. \quad (9)$$

Though the notation is suppressed,  $s_u(x)$ ,  $\Omega_n$ , and  $\Omega_u$  all depend on the vector of used prices.  $s_u(x)$  depends on the current used price and the used price next semester, except for age  $T - 1$  where  $s_u(T - 1)$  depends only on the current used price (since resale becomes impossible when the book is revised at age  $T$ ). The dependence of  $\Omega_n$  and  $\Omega_u$  on used prices is more complicated. For instance, the supply of used books at age five depends in part on the used price at age one, since that price affects sales both at age zero and age one, sales which eventually make their way onto the secondary market.