Institutional cross-holdings and generic entry in the pharmaceutical industry*

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Abstract

Brand-name pharmaceutical companies often file lawsuits against generic drug manufacturers that challenge the monopoly status of patent-protected drugs. Institutional cross-holdings, measured by the weight of the top generic shareholders' ownership in the brand-name company relative to their ownership in the generic manufacturer, are significantly positively associated with the likelihood that the two parties will enter into a settlement agreement in which the brand pays the generic to stay out of the market. Cross-holdings are also positively associated with the brand's daily abnormal returns around the settlement agreement. Entrants who settle with the brand-name company and receive a 180 day period of marking exclusivity are more likely to delay the sale of generic substitutes if they have higher cross-holdings with the brand-name firms. These delays preclude other generic firms from entering the market.

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Pay-for-delay deals are a bad prescription for America; when drug companies agree not to compete, consumers lose. Jon Leibowitz, Chairman of Federal Trade Commission (January 13, 2010)

1. Introduction

We show that institutional cross-holdings (that is, a group of institutional investors who hold large stakes in competitors) are associated with product market interactions between competitors. To do so, we analyze patent litigation lawsuits between brand-name pharmaceutical companies and generic drug manufacturers over the sample period of 1999–2015. The Hatch-Waxman Act of 1984 streamlined the entry of low cost drugs by allowing generic manufacturers to challenge the monopoly status of patent-protected drugs. Brand-name manufacturers can respond by filing patent-infringement lawsuits against a generic challenger. We show that institutional cross-holdings (i.e., the relative ownership that the generic firm's top shareholders have in the brand-name manufacturer compared to ownership in the generic manufacturer are associated with the likelihood that the two parties enter into a settlement agreement in which the brand manufacturer often pays the generic manufacturer to stay out of the market.[1]

In recent years, there has been an increased focus on the question of whether the common institutional ownership of natural competitors has anticompetitive effects in the product markets. This question challenges the Fisher Separation Theorem, which stipulates that, regardless of their preferences, shareholders unanimously support own-firm value maximization. Hart (1979) and DeAngelo (1981) argue that shareholder unanimity only holds under a set of restrictive assumptions. For example, Hart (1979) points out that unanimity does

[1]Elhauge (2016) uses the term "horizontal shareholding" to describe the situation in which a common set of investors own significant shares in corporations that are already horizontal competitors in a product market. We use the terms "cross-holdings" and "cross-ownership" to describe the extent to which institutional shareholders of the entrant hold shares in the incumbent. Our measure is similar in spirit to the measures used by Matvos and Ostrovsky (2008) and Harford, Jenter, and Li (2011).

not hold when shareholders hold shares of other firms. Indeed, a theoretical literature in industrial organization shows that well-diversified shareholders maximize aggregate portfolio profits, because the benefits to one firm from competing aggressively can be at the expense of other portfolio firms (e.g., Rotemberg, 1984; Reynolds and Snapp, 1986; Farrell and Shapiro, 1990; Gordon, 1990; Admati, Pfleiderer, and Zechner, 1994; Hansen and Lott, 1996; O'Brien and Salop, 2000; Gilo, Moshe, and Spiegel, 2006; Azar, 2012, 2017).[2]

Azar, Schmalz, and Tecu (2017) develop a modified Herfindahl-Hirschman index (MHHI) that takes into account common institutional ownership in the U.S. airline industry. They find that market concentration is ten times larger than what is "presumed likely to enhance market power" by antitrust authorities. They further show that ticket prices are about 3–12% higher on the average airline route than would be the case under separate ownership. In related study, Azar, Raina, and Schmalz (2016) find a similar effect of common ownership in the U.S. banking industry.

These academic papers received attention from both academics and regulators. For example, in his testimony before the Senate Judiciary Subcommittee on Antitrust, Bill Baer, a former Assistant Attorney General for Antitrust, stated that antitrust authorities in the U.S. have opened investigations based on the claims in these academic papers. In a recent Statement of Objection for a proposed merger, the European Commission presented an MHHI analysis that accounts for the effects of common ownership.[3]

However, one concern with MHHI is that it is an endogenous measure of concentration that depends on both common ownership and product market shares. In a recent paper, O'Brien and Waehrer (2017) develop a simple analytical example to show a potential spurious correlation between price and MHHI, even if common ownership has no casual impact on price. Azar et al. (2017) address this issue by using BlackRock's acquisition of Barclays BGI,

[2]See Schmalz (2018) for the literature review.

[3]An op-ed in The New York Times discusses common ownership of companies in concentrated markets. ("A Monopoly Donald Trump Can Pop," Eric Posner, Fiona Scott Morton, and Glen Weyl, New York Times, The Opinion Pages, December 7, 2016). The authors wrote a proposal to the Department of Justice and the Federal Trade Commission (FTC), arguing that antitrust authorities should take the lead by enforcing the Clayton Act against institutional investors.

which represents a shock to the structure of institutional ownership of airline companies. They document a positive impact of the implied changes in common ownership during the pre-merger period on subsequent changes in ticket prices.[4]

We examine this issue from a different perspective: if common owners care about joint profits of the industry, do they block product market entrants? To address the question, we analyze a sample of patent infringement lawsuits filed by brand-name drug manufacturers against generic manufacturers who filed Paragraph IV applications with the Food and Drug Administration (FDA). A successful Paragraph IV challenge allows generic manufacturers to produce bioequivalent drugs before the expiration of patents covering the branded product at issue. Such a pre-entry setting allows us to establish a more straightforward link between product market outcomes and institutional ownership without the confounding effects arising from market concentration. More specifically, we rely on the incumbent-entrant relationship to regress institutional cross-holdings on a variety of metrics indicating entry outcomes. This approach is in a similar vein as Matvos and Ostrovsky (2008) and Harford et al. (2011).

Our empirical design is also appealing for two additional reasons. First, instead of inferring collusion from product prices, we observe the colluding behavior per se in those patent litigation lawsuits. The wide use of "pay-for-delay" settlements in which a brand-name pharmaceutical company (incumbent) and generic drug manufacturers (would-be entrants) settle a Paragraph IV patent challenge has widely been considered as anticompetitive.[5] Second, we identify the mode of would-be competition between incumbent and entrants. The FDA requires generic manufacturers to establish bioequivalence for pharmaceutically equivalent

[4]One possible limitation of their approach is that the pre-merger market shares might predict subsequent changes in prices. In a multi-period model with consumer switching costs, for example, higher market concentration today can predict higher prices tomorrow (Klemperer, 1987; Chevalier and Scharfstein, 1996; Dasgupta and Titman, 1998).

[5]Branstetter, Chatterjee, and Higgins (2011) and Helland and Seabury (2016) find that such settlements delay generic entry, increase drug prices, and decrease quantity. Based on patent settlement agreements filed with the FTC between January 1, 2004 and September 30, 2009, an FTC staff study shows agreements with compensation from the brand to the generic on average prohibit generic entry for nearly 17 months longer than agreements without payments.

drug products, allowing us to examine how common ownership affects prices through the lens of product market entries.[6]

Our sample consists of 1,339 distinct Paragraph IV challenges. The sample period starts from pending cases as of November 1, 2003, and ends with cases closed as of August 2016. We document two stylized facts for this sample. First, the mean settlement rate at the patent level is 72.3% and it varies substantially across federal district courts. Second, common institutional ownership exists in about 22% of Paragraph IV challenges. Conditional on common institutional ownership, the top ten generic shareholders, on average, hold 9.5% of shares of the brands, and this percentage increases to 17.4% for the top 30 generic shareholders.

Our panel regression results suggest that the likelihood that the two parties enter into a settlement agreement increases in the extent that institutional investors in the generic firm hold shares in the brand-name firm. The economic magnitude of the effect of cross-holdings is that a one standard deviation increase in top generic shareholders' weight on the brand increases the probability of settlement by about five percentage points. In these specifications, we control for drug sales and fixed effects at the incumbent-, entrant-, court-, and time-levels. In addition, to prevent zero values of cross-holdings from driving the results, we use three indicator variables for whether either one of the two parties or both are private firms. We also for ranks based on the level of cross-holdings to show that the results are not driven by nonlinearities.

Nonetheless, our baseline results could be driven by portfolio allocation choices of active institutional investors. For example, generic shareholders could hold more shares in the brand-name firm if they anticipate that entries are unlikely to be successful.[7] To examine whether "passive" ownership impacts the likelihood of settlement, we next rely on variation in index fund ownership to measure institutional cross-holdings. Two factors explain changes

[6] In a post-entry game setting, Azar et al. (2017) recognize competitors based a network relationship among airlines providing differentiated services within the same route. One possible interpretation of their results is that, in high MHHI routes, airlines aggressively compete on quality.

[7] In a recent study, Gutierrez and Philippon (2017) shows that the rise of industry concentration and common ownership is correlated with firms' reluctance to invest despite high profits.

in index fund ownership: (1) households' investment of their savings in the funds and (2) the value of funds' aggregate holdings. Neither of the two factors depends on the litigation outcome of each patent. These results are similar to the baseline findings.

One concern with using ownership of index funds is that the variation does not solely come from aggregate fund growth. It can also arise from the inclusion and exclusion of firms in indices. To further strengthen our identification, we use variation in cross holdings caused by the 2003 mutual fund trading scandal, which affected funds that held 25% of total mutual fund assets. Again, we find results that are similar to those in panel regressions: higher cross-holdings predict higher settlement rates. The estimated economic magnitude increases under this specification.

Next, we ask whether settlements accepted by generic manufacturers with top shareholders holding more shares in the brand are anticompetitive. Although settlement contents are confidential, we infer the nature of these settlements through stock returns around the event. If a settlement is anticompetitive, it will likely extend the brand's monopoly status beyond the expected date of generic entry had the two parties gone to trial. If cross-holdings have anticompetitive effects, the brand's stock price around the date in which the two parties settle should increase with generic shareholders' weight on the brand.[8] By contrast, if the payment to a generic manufacturer simply reflects a "risk premium" risk-averse brand-name managers pay to resolve uncertainty, the stock price should decrease upon settlement.[9] Under the risk premium story, we expect the brand's stock price to decline in proportion to the level of institutional cross-holdings.

Both our OLS and instrumental variable (IV) estimates suggest that settlement agreements signed between brands and generics jointly held by the same set of institutional investors are anticompetitive. The brand's daily returns around the event window $(-3, +3)$ are

[8]Drake, Starr, and McGuire (2015) document evidence indicating anticompetitive settlements for those with an indication of reverse payment. They find a brand's stock prices rises on average 6% at the announcement of these settlements.

[9]The risk-premium hypothesis relies on the assumption that the brand manager holds an undiversified portfolio. See Drake, Starr, and McGuire (2015) for a similar discussion.

positively correlated with our measure of institutional cross-holdings. However, no relation exists between cross-holdings and the generic's daily returns.

Anecdotes suggest that brand-name incumbents can prevent all generic entries by paying the first generic entrant—the earliest filer of the Paragraph IV application—to substantially delay the entry. This delay can occur because the FDA grants a 180 day period of marketing exclusivity to reward the first generic, allowing it to be the only seller of the generic substitutes for the branded drug within the first 180 days. Nevertheless, we do not find a more pronounced effect of institutional cross-holdings on the likelihood of settlement between the brand and the first generic. In Section 5, we discuss several possible reasons for this result, including the FTC's escalated monitoring of settlement agreements after 2003, as well as the uncertainty for the first filer to secure its exclusivity.

The above reasons do not, however, indicate that common owners do not leverage the 180 day exclusivity. We therefore next examine how institutional cross-holdings contribute to the negative externalities of "pay-for-delay" settlements through the 180 day exclusivity. We read approval letters provided by the FDA to identify which generic drugs are granted with exclusivity. We find that settled generic manufacturers with a higher level of institutional cross-holdings market the cheaper alternative of a branded drug much later if, and only if, they were granted exclusivity.

One limitation with this approach is that we do not observe the resolutions of challenges filed near the end of the sample period. We address this right-truncation problem by using the forward-looking nature of stock prices. We examine the impact of institutional cross-holdings on stock prices of other potential entrants around the event in which the focal brand and generic settle. We find institutional cross-holdings are negatively associated stock returns for other generics challenging the same drug around the short window, and this negative effect is much larger when the brand settles with the first generic. This finding is consistent with common ownership increasing the possibility of collusion to preclude other potential entrants.

2. Background

In 1984, Congress adopted the Hatch-Waxman Act, which reduced regulatory barriers to the entry of generic drugs. Prior to 1984, generic drug manufacturers had to repeat the same expensive, lengthy clinical trials that brand-name companies conducted. Furthermore, the investigation and testing of a branded drug covered by patents could subject generic manufacturers to patent infringement lawsuits.

Hatch-Waxman offers four paths (or "Paragraphs") for a generic manufacturer to produce a branded drug product. The entry process begins with the generic manufacturer filing an abbreviated new drug application (ANDA) with the FDA under one of the four Paragraph certifications. A Paragraph I certification is issued when the drug innovator (i.e., brand company) has not filed patents to cover its branded product. Paragraph II certification involves a branded drug's patents having expired (i.e., end of market exclusivity), and Paragraph III certification relates to the generic manufacturer acknowledging that patents covering the branded product will expire on a certain date and that it will enter only after that date.[10] Under Paragraph IV certification, the generic manufacturer argues that the generic drug does not infringe on patents covering a branded product or that the patents at issue are simply invalid. Under this provision, generic manufacturers file ANDAs to challenge the validity of patents so that generic drugs can be marketed before patents expire.

Two unique features underlie Paragraph IV certification. The first is the automatic "30 month stay" protection. Under this protection, the generic applicant must notify the patent holder with justification that a patent is invalid or that the generic product does not infringe upon it. After receiving the notice, the brand company has 45 days to file an infringement suit. The advantage of filing such a suit is that it delays FDA approval until

[10]The Hatch-Waxman Act provides certain market-exclusivity periods for new drug applicants based on both non-patent based and patent based factors. For example, orphan drug exclusivity is granted to drugs that treat a disease that affects less than 200,000 people in the U.S. or when U.S. sales of the drug will recoup its development costs. This exclusivity period is seven years.

the earliest of (1) the date the patent expires, (2) a court determination of patent invalidity or non-infringement, or (3) 30 months after the patent holder receives the notice.

The second unique feature is that the first generic to submit a Paragraph IV certification is entitled to 180 day exclusivity if it successfully defends a patent infringement suit.[11] Once this exclusivity right is granted, the FDA may not approve another Paragraph IV application for the same product until six months after the first generic markets its product.

Figure 1 illustrates that the introduction of generics leads to sharp declines in drug prices. Throughout the 1990s, brand incumbents often used two methods to delay generic entry. The first was to list additional patents after the initial Paragraph IV filing, triggering non-concurrent 30 month stays for each patent at issue. However, on June 12, 2003, President Bush, HHS Secretary Thompson, and FDA Commissioner McClellan announced a new regulation limiting an innovator drug company to only one 30 month stay of a generic drug applicant's entry into the market for resolution of a patent challenge.[12]

The second practice, which is the focus of our study, is for brand-name pharmaceutical companies to pay the generic manufacturer filing Paragraph IV to hold the generic product off the market for a certain period of time. In recent years, these so-called "pay-for-delay" agreements have arisen as part of patent litigation settlement agreements. The Federal Trade Commission's (FTC) investigations and enforcement actions against pay-for-delay agreements deterred their use from April 1999 through 2004. In 2003, an appellate court held that such agreements were illegal. Since 2005, however, several appellate courts have upheld these agreements. Following those court decisions, there has been a reemergence of patent settlements that combine restrictions on generic entry with compensation from the brand to the generic.

According to an FTC staff study released in January 2010, agreements with compensation

[11]The "successful defense" requirement was established to eliminate "an incentive for frivolous claims of patent invalidity or non-infringement because it would give ANDA applicants exclusivity even if the applicant was unsuccessful in defending against the patent owner's lawsuit."

[12]Due to court rulings favoring generics and the Medicare Act of 2003, ANDA applications with Paragraph IV certifications increased from 10–20% in the early 1990s to more than 40% by the end of the 2000s (Higgins and Graham, 2009; Berndt, Mortimer, and Parece, 2007).

from the brand to the generic, on average, prohibit generic entry for nearly 17 months longer than agreements without payments. Most of these agreements are still in effect. They currently protect at least $20 billion in sales of brand-name pharmaceuticals from generic competition. The FTC estimates that pay-for delay agreements cost American consumers $3.5 billion per year.[13]

However, the brand and generic can also settle litigation in a variety of ways that do not involve monetary payments. For example, brand-name pharmaceutical companies have sometimes compensated generics by agreeing not to compete through a so-called "authorized generic." Under the Hatch-Waxman Act, although the first generic can market its drugs with no competition from other generics for 180 days, the rule does not protect the first-filer generic from competition from an "authorized generic" during those 180 days. Authorized generics are brand-name pharmaceutical products marketed as generics and can substantially reduce the revenues a first generic earns. According to the same FTC staff study, about 25% of patent settlement agreements from 2004–2008 that were with a first generic involved an explicit agreement by the brand not to launch an authorized generic, combined with an agreement by the first generic to defer entry past the date of the agreement.

Since 2001, the FTC has filed a number of lawsuits to stop these deals, and it supports legislation to end such settlements. In Appendix A, we provide three examples that illustrate why FTC filed complaints against the brand and generic manufacturers involved in "pay-for-delay" settlements.

[13]See "Pay for delay: How Drug Company Pay-Offs Cost Consumers Billions," An FTC Staff Study, January, 2010.

3. Data

3.1. Paragraph IV lawsuit documents

Our data come from The Paragraph Four Report®, which is an electronic publication of Parry Ashford Inc. The company tracks and analyzes Paragraph IV activities. Parry Ashford Inc. database starts with Paragraph IV cases that were deemed "active" as of November 1, 2003. Active branded products are those that had a Paragraph IV challenge, had a pending lawsuit, and were not available as a generic as of November 1, 2003. The company followed each case through completion (i.e., settlement or court of appeals). Once a generic product enters the market after final termination of litigation, the product is removed from the list and sent to the "Old Cases" section. The "Old Cases" section includes products and cases closed after November 1, 2003.

From the online Paragraph Four Report®, we manually extract the relevant data fields. Specifically, for each challenge, we collect (1) the name of the brand and generic manufacturers involved in the litigation, (2) the timeline of the litigation (for example, the date the first challenge to a brand drug was filed and the date on which a brand company files a patent infringement suit), (3) the trade name and formulation of the challenged product, (4) patents at issue, (5) the district court, (6) the names of the lead attornies/law firms and judge, and (7) a brief summary on the progress of the case with critical scheduled dates.

For each case closed before July 23, 2016, we read the progress summary and documents attached for each case to discern the final outcome. We classify litigation outcomes into five categories: the brand does not file suit, the brand wins, the brand loses, the parties settle, and unknown. Figure 2 provides a snapshot of the online publication.[14]

[14]In real life, the brand and generic either enter into a settlement agreement or dismiss the case. A consent judgment is issued when two parties agree to a settlement to end the lawsuit. The parties write up an agreement for the judge to sign. A dismissal, in theory, allows the brand to re-open the case. But, it almost never happens in practice. The two terms (dismissal and consent judgement) are interchangeable. When the two parties settle and agree to dismiss the suit, the brand manufacturer usually just states that the case is dismissed without giving a reason. Parry Ashford Inc. just reports "dismissed" to label the litigation outcome.

Our sample starts with active Paragraph IV cases as of November 1, 2003, and ends with Paragraph IV cases closed before July 23, 2016. Our sample unit is each distinct Paragraph IV application filed by generic firms to challenge a branded drug. We treat different formulations (e.g., tablets, capsule, and injection) under the same trade name as different drug markets. In other words, we define a challenge at the level of the date on which a brand manufacturer files patent infringement lawsuits against a ANDA filer challenging the formulation of a trade name (i.e., the name of branded drug).

Table 1 presents descriptive statistics for our sample of drug patent challenges. The sample consists of 1,399 unique challenges to 1,170 unique patents covering 377 unique trade names. The 1,399 challenges are launched by 133 distinct generic manufacturers. The 377 trade names are invented by 120 distinct brand companies. Table 2 presents the sample distributions of the challenge outcomes following the filing of an ANDA under Paragraph IV certification with the FDA.

3.2. Institutional cross-holdings

We gather institutional holdings from the Thomson-Reuters Spectrum dataset of 13F filings. We use this data to construct cross-holdings by generic shareholders of brand companies. The dataset covers investment in all U.S. publicly traded stocks by institutional investors managing more than $100 million. Thomson-Reuters assigns a manager number to each institutional investor. The dataset includes the percentage of shares and percentage of shares with voting rights. We measure institutional shareholding as the percentage of ownership, including voting and non-voting shares.

We measure cross-holdings as of the calendar quarter before the brand sues the generic for patent infringement. Our measure of institutional cross-holdings follows Harford, Jenter, and Li (2011), who present a shareholder-by-shareholder analysis. The idea is that for this mechanism work, we need to identify influential generic shareholders who at the same time

hold shares on the brand side. The following equation illustrates the conceptual framework:

$$\Delta W = (\alpha_b + \alpha_g)(\frac{\alpha_b}{\alpha_b + \alpha_g}\Delta Brand\ Value + \frac{\alpha_g}{\alpha_b + \alpha_g}\Delta Generic\ Value), \tag{1}$$

where $\alpha_b = \sum_{k=1}^{n} \alpha_b^k$ and $\alpha_g = \sum_{k=1}^{n} \alpha_g^k$ are top generic shareholders' percentages of ownership in the brand and generic companies. $1 \leq k \leq n$ denotes the kth largest generic shareholder. α_b^k is the kth largest generic shareholder's ownership in the brand company. α_g^k is the kth largest generic shareholder's ownership in the generic company. $\frac{\alpha_b}{\alpha_b+\alpha_g}$ in equation (1) is the measure of institutional cross-holdings. To have generic shareholders to act for the interests of the brand incumbent, the relative weight in equation (1) does not need to exceed 50%. This is because the size of monopoly profits, even after deducting a settlement payment, is often strictly greater than that under competition among generic entrants. Thus, top generic shareholders with both generic and brand stakes wants to maximize a weighted average of both firms' values. The higher the relative weight on the brand, the more likely generic shareholders will want to maximize value for the brand.

For each group consisting of the top 10, 15, 20, 25, and 30 largest institutional shareholders of a public generic firm, we calculate the group's ownership of the brand firm, which is α_b in equation (1). We then calculate the ratio of the group's ownership in the brand divided by the sum of the group's ownerships in the brand and the generic. Top generic shareholders' ownership is donated as α_g. If two or more generic manufacturers file the same ANDA under Paragraph IV certification in the same date, and an institution is at the same time ranked as top N shareholder in more than one generic manufacturer, we take the sum of its ownerships across all generics to calculate that shareholder's percentage ownership on the generic side. In other words, we ignore brand ownership of entrant A's non-top shareholders if they happen to be entrant B's top shareholders. The measure guarantees that common owners included in the regression analysis have sufficient control rights on both A and B (O'Brien and Waehrer, 2017; Schmalz, 2018). For cases in which multiple generic

manufacturers file the same ANDA, we also take the mean, market-cap-weighted average, minimum and maximum of ownerships for F13 institutional shareholders owning multiple generic firms. Our results are not materially altered.

In Table 3, we use the litigation between Mylan (generic) and Bristol-Myers Squibb (brand) in the second quarter of 2013 as an illustration. We list the ownership of the top 30 institutional shareholders on Mylan and the ownership of these same institutional shareholders on Bristol-Myers Squibb. Table 3 suggests that at the individual-shareholder level, common ownership is common and varies across institutions. To calculate the cross-holdings for the top ten shareholders, we first calculate $\alpha_g = 35.3\%$ and $\alpha_b = 20.1\%$. The relative weight of the top ten Mylan shareholders invested in Bristol-Myers is $20.1\%/(35.3\% + 20.1\%) = 36.2\%$.

Table 4 presents descriptive statistics for our cross-holdings measure on the subsample in which both the brand plaintiff and generic defendant(s) are public firms. As we increase the number of top generic shareholders from 10 to 30, the mean of generic ownership increases from 24.7% to 37% and the mean of brand ownership increases from 9.5% to 17.4%. Generic cross-holdings, on the other hand, increase from 29.1% to 34.9%. The standard deviation of the cross-holdings measure is around 20%.

4. Institutional cross-holdings and settlements

4.1. Baseline analysis

We start with our baseline linear probability regression model:

$$\begin{aligned} Settlement_{i,j,s} = \alpha + \beta \times Top\ N\ Weight_{j,s-1} + X'_{t-1} \times \gamma_1 + \gamma_2 \times Group + \\ \phi_j \times Group + \phi_j + \phi_l + \phi_k + \phi_t + \epsilon_{i,j,s}, \end{aligned} \tag{2}$$

where $Settlement_{i,j,s}$ is an indicator variable set equal to one if the two parties entered into a settlement agreement with respect to challenge i launched in year-quarter s by generic firm j, and zero otherwise. *Top N Weight* is $\frac{\alpha_b}{\alpha_b+\alpha_g}$ in equation 1. X'_{t-1} is several sets of control variables. We first introduce three indicator variables indicating whether (1) the generic is a public firm but the brand is a private firm (*Generic public*), (2) the brand is a public firm but the generic is a private firm (*Brand public*), and (3) both are private firms (*Neither public*). The three indicator variables help prevent zero cross-holdings from influencing the estimates. Second, we control for drug performance, which is an important determination of litigation outcome. Specifically, we control for *log*(*drug sales*), the logarithm of retail sales of the top pharmaceutical drugs. The top 200 drug sales are publicly available from 2000 to 2010 and top 100 drug sales are publicly available from 2000 to 2013. For drugs that were previously ranked as the top 200/100 but currently were not on the list, we use their most recent sales from the top 200/100 list. We also add an indicator of *non-top drug*, which is coded as one if a drug has never been listed on the top 200/100 list, and zero otherwise. Third, we use ϕ_j, ϕ_l, ϕ_k and ϕ_t to capture fixed effects from the generic entrant j, brand incumbent l, federal district court k, and the year in which the outcome is known t.

Our sample unit is at the entry level. However, nearly 50% entries were made by at least two generics simultaneously filing the same ANDA and targeting at the same brand drug. The combination of generic firms within a group varies substantially across entires. To reduce the number of generic-fixed effects, we rank all the generic entrants based on the frequency with which they file ANDAs in our sample. We first use the most frequent publicly listed ANDA filer to represent the whole group. If all entrants are private firms, we use the most frequent private filer. To distinguish group entries from normal ones, we create an indicator variable *Group* to capture whether an entry is made by multiple generic firms. We interact *Group* with the set of generic-fixed effects, as illustrated by equation 2.

In alternative specifications, we use variations within trade names instead of variation within brand and generic firms. Each trade name identifies a unique active ingredient and

thus captures unobservables such as expected revenue of the brand before patent expiration, elasticity of demand, customer mix, switching costs, FDA regulations, and advertising intensity (Scott Morton, 1999, 2000). Therefore, much of the variation in brand-generic(s) combination across entries is per-determined by trade names. Within a trade name, we still observe large variation of litigation outcomes across drug formulations.

Table 5 presents linear probability estimates of the effect of institutional cross-holdings on the likelihood that the two parties will enter into a settlement agreement. In Panel A, we present baseline results without exploiting variations within either firms or trade names. Columns (1)–(5) of Panel A show the results excluding fixed effects. We separately estimate the impact of top 10, 15, 20, 25, and 30 generic shareholders' ownership in the brand relative to their ownership in the generic on the probability of settlement. For coefficients, both their economic and statistical significances progressively increase as we include more top N generic shareholders into the calculation of institutional cross-holdings. We use column (5) to illustrate economic magnitude. A one-standard-deviation increase in the top 30 shareholders' relative weight on the brand increases the probability of settlement by 5 percentage points (0.223×0.224). This number is about 11 percent of a standard deviation of settlement rate in the sample. Columns (6)–(10) present the results with court and year fixed effects. The statistical and economical significance are not materially altered.

In columns (1)–(5) of Panel B, we control for both generic and brand firm fixed effects, as we illustrated in equation 2. Fixed effects difference out many alternative interpretations at the incumbent- or entrant- level. After controlling for firm fixed effects, the economic magnitude of the estimated coefficients is not reduced but the statistical significance of them is slightly improved. In columns (6)–(10), we exploit variations within trade name fixed effects. The statistical significance of the estimated coefficients is further improved.

Our results might be driven by nonlinearities in the way institutional cross-holdings is calculated. We rank our observations in an ascending order based on the level of top N cross-holdings and scale the resulting rank by the total number of lawsuits. We refer to the

measure as "relative ranking of institutional cross-holdings" and the value of it ranges from zero to one. Table 6 reports the results. Comparing to Table 5, the economic magnitude of estimated coefficients drop in columns (6)–(10), possibly because the ranking method reduces the variation of cross-holdings. However, the implied economic magnitudes for coefficients in columns (1)–(5) are similar to those reported in Table 5.

4.2. Identification

Institutional ownership could be related to litigation outcomes. For example, fund managers could make portfolio allocation choices based on expectations about whether challenges will be successful. Such an effect could drive the results presented in Table 5 could be driven by the endogenous . For this reason, we use two approaches to identify the impact of common ownership on entry outcomes. In the first approach, we use variation in ownership of index funds of generic firms. In the second approach, we use the mutual fund trading scandal of September 2003 as a quasi-natural experiment.

4.2.1. Index fund ownership

We use variation in ownership of index funds to examine the role of "passive" ownership of generic firms in driving the litigation outcomes. We use institutional investor classification data provided by Brain Bushee on his website.[15] In the data, investment strategies adopted by F13 institutional investors are classified into three types: dedicated (DED), quasi-indexer (QIX) and transient (TRA). This classification is based on the approach used by Bushee and Noe (2000) and Bushee (2001). We use quasi-indexers as index funds. For each group consisting of funds that are ranked as top N ($N = 10, 15, 20, 25, 30$) largest F13 institutional shareholders of a generic firm, we calculate *Top N index weight* as the ratio of the index-fund group's ownership in the brand divided by the sum of its ownerships in the brand and the generic.

[15] `http://acct.wharton.upenn.edu/faculty/bushee/IIvars.html#mgrno`.

Following Azar et al. (2016), we argue that index fund ownership can cause cross-sectional differences in the cross-holdings as follows. Some generic manufacturers are part of stock indices. Index funds' ownership of these generics grows when the overall fund size grows. The growth of index fund ownership is due to two factors: (1) households' investment of their savings in the funds and (2) the value of funds' aggregate holdings. Neither of the two depends on the litigation outcomes of lawsuits at the drug level. Some generic/brand firms are part of an index. Our sample also include many privately-owned generic/brand firms, whose index-fund cross-holdings are always zero despite how index funds grow. Moreover, some generic-brand pairs are more heavily held by index funds than other pairs to start with. Index fund growth thus affects the institutional cross-holdings differentially across generic-brand pairs.

Panel A of Table 7 presents results where the raw measure of cross-holdings is used as the main independent variable. Instead of using indicator variables for the listing status of each brand/generic pair, we use three indicator variables to capture the "index status" of each pair, which refers to the three dummy variables as follows. *Brand indexed* is coded as one if the brand stock is held by at least one quasi-index fund and the generic is not, and zero otherwise. *Generic indexed* is coded as one if the generic stock is held by at least one quasi-index fund and the brand is not, and zero otherwise. *Neither indexed* is coded as one if neither the generic nor the brand is held by any quasi-index funds, and zero otherwise. Although the statistical significance in columns (1)–(5) is slightly reduced, the coefficients in other columns are both statistically and economically significant and comparable to those reported in Table 5. Panel B reports results when we use the relative rankings of index funds' cross-holdings. The estimated coefficients again are comparable to those reported in Table 6.

4.2.2. Mutual fund trading scandal

One limitation of the approach used in subsection 4.2.1 is that "passive" ownership does not only arise from the aggregate growth of index funds, but also from the inclusion and exclusion of firms into indices. As an alternative approach, we use an instrument that relies on the mutual fund trading scandal of 2003, in which 25 mutual fund groups were accused of engaging in illegal trading practices.[16] Kisin (2011), Antón and Polk (2014), and Antón, Ederer, Giné, and Schmalz (2016) also employ this setting, and the implicated fund families include large fund families such as Janus, Columbia Management Group, Franklin Templeton... The news became public on September 3, 2003, when New York Attorney General Eliot Spitzer announced a settlement with certain hedge funds accused of illegal trades with funds that belonged to four mutual fund families: Bank of America, Janus, Strong, and Bank One. Following this event, investors aggressively pulled out money from those families over the subsequent years.

Kisin (2011) shows the effect of outflows of implicated families amounted to 14% in the first year and over 21% the second year of total assets under management. The four fund families had an aggregate amount of assets under management of $236.5 billion, which amounts to 24.8% of the U.S. mutual fund universe. Table A.3 presents the list of implicated funds and the dates at which a Securities and Exchange Commission (SEC) investigation was mentioned in the press.

To use this shock, we decompose total brand shares held by the largest generic investors into "scandal" brand ownership and "non-scandal" brand ownership. We sum ownership of brand companies only across scandal funds that are ranked as top N shareholders on the

[16]The two illegal trading practices are late trading and market timing. Late trading involves trading in the funds' shares after the closing deadline but at the closing prices. Market timing is a form of rapid trading that takes advantage of stale prices.

generic side as of the end of September 2003.

$$\alpha_{Scandal,b}^{k,2003Q3} = \sum_{k=1}^{N} \alpha_{Scandal,b}^{k,2003Q3}.$$

We then calculate the ratio of top N brand ownership of to all top N brand scandal fund ownership at the time of when the scandal broke out.

$$Brand\ Scandal\%^{k} = \frac{\alpha_{Scandal,b}^{k,2003Q3}}{\alpha_{b}^{k,2003Q3}}$$

The identifying assumption is that the *Brand Scandal* in 2003 per se is unrelated to whether the generic manufacturers were planning to challenge any branded drugs in following years. The ratio is also not correlated with whether the incumbent and entrant will settle, conditioning on the occurrence of a litigation.

4.2.3. IV Estimation

In our first stage, we regress institutional cross-holdings on *Treatment* and several control variables to predict the value of cross-holdings in the sample period from the fourth quarter of 2003 onwards. *Treatment* is an indicator variable set equal to one if $Brand\ Scandal\%$ of top 30 generic institutional shareholders in the third quarter of 2003 is greater than 10%, and zero otherwise. The regression is as follows:

$$\begin{aligned} Top\ N\ Weight_{i,j,s} = \alpha + \beta \times Treatment_j + X'_{j,t-1} \times \gamma_1 + \gamma_2 \times Group\ Entry + \\ \phi_j \times Group\ Entry + \phi_j + \phi_l + \phi_k + \phi_t + \epsilon_{i,j,s}. \end{aligned} \tag{3}$$

The three indicator variables—*Brand public*, *Generic public* and *Neither public*—are strongly correlated with *Treatment*. We therefore exclude them from $X'_{j,t-1}$ in equation 3 to prevent our IV estimation results from being inflated by a weak instrument (Jiang, 2017). As re-

ported in columns (1)–(5) of Table A.4, *Treatment* is a strong instrument that is significantly positively associated with the largest generic shareholders' cross-holdings. More specifically, the F-stats from weak identification tests range from 43 to 102. In columns (6)–(10), the endogenous variable is measured as relative rankings and we reach at the same conclusion. In our untabulated statistics, the partial R^2 of the *Treatment* ranges from 0.15 to 0.32. Hence, the excluded instrumental variable explains a large variation in the endogenous variable

Table 8 reports the second-stage results using the discrete treatment. We find a positive and economically sizable and also statistically significant effect of the instrumented cross-holdings on the likelihood of settlement. The estimated coefficients of interest is markedly higher than the effects estimated in panel regressions.

5. First generic

Under the Hatch-Waxman Act, the FDA sets a requirement that the first ANDA filer submitting a paragraph IV certification successfully defend a patent infringement suit to be entitled the 180 day of marketing exclusivity. Settlements with the first-filer can prevent all generic entry. This is because every subsequent generic entrant has to wait until the first generic has been marketed for 180 days. In Appendix A, we present several high-profile cases in which the brand company paid the first generic to substantially delay the entry.

5.1. First generic, institutional cross-holdings and settlements

The Paragraph Four Report® provides us with dates in which the brand suits generic entrants for patent infringement. Unfortunately, the company does not provide with date/month in which generic firms file ANDA applications under Paragraph IV. We are also not aware of any public sources (e.g., FDA websites) providing such timings. After consulting with the data company and reading instructions on the practice of Paragraph IV litigation, we admit

that it renders non-negligible measurement errors if we decide the first ANDA filer based on when the brand incumbent suits the generic entrant.[17]

We conduct a fuzzy search for the first ANDA filer. We define "pseudo entry date" as the earliest of: (1) the date an ANDA was filed (if data is available) (2) the date the brand incumbent was noticed by the ANDA filer(s), and (3) the date the brand suited the ANDA filer. The Paragraph Four Report ® includes original documents for summons, complaints and answers, all in PDF formats, related to each lawsuit. From these documents, we search for (1) and (2) as mentioned above. Among all generics challenging the same drug, the first-filer is defined as the one with the earliest pseudo entry date. Under this method, 497 out of a total of 1,339 lawsuits are triggered by the first generic.

We specify the following linear probability regression model to assess the impact of the first generic on the likelihood of settlement through the channel of common ownership.

$$\begin{aligned} Settlement_{i,j,s} = \alpha + \beta_1 \times Top\ N\ Weight_{j,s-1} + \beta_2 \times Top\ N\ Weight_{j,s-1} \times First + \\ \beta_3 \times First + X'_{t-1} \times \gamma_1 + \gamma_2 \times Group + \phi_j \times Group + \phi_j + \phi_l + \phi_k + \phi_t + \epsilon_{i,j,s}, \end{aligned} \tag{4}$$

where *First* is an indicator coded as one if the challenge was launched by the first-generic as defined above, and zero otherwise. Table 9 reports the regression results. Surprisingly, despite all regression specifications, we fail to find evidence suggesting that common ownership increases the likelihood of the brand settling with the first generic.

5.2. Possible explanations

In this subsection, we provide two possible explanations to rationalize our findings in Table 9. The first is the escalated monitoring of settlement agreements by FTC. The second

[17]When generics submit their ANDAs, the FDA will take 2-6 months to accept the application and notify the ANDA filer. Once notified, the ANDA filer then has 20 days to notify the brand company that it has filed an ANDA with a Paragraph IV certification. Once that notice is received by the brand company, the brand has 45 days to suit generics for patent infringement. In real-life scenarios, however, it can actually file at any time, longer than 45 days.

is the ex ante uncertainty of the eligibility of the 180 day exclusivity. As we show in section 6, however, results in Table 9 does not suggest that, when the two parties are negotiating for the settlement agreement, the brand incumbent will not exploit the 180 day exclusivity to preclude other generic entrants.

5.2.1. Escalated monitoring by FTC

In recent years, FTC has been actively monitoring those anti-competitive settlement agreements. Following its 2002 study, which concluded that settlements substantially delayed generic entries, FTC recommended that Congress pass legislation to require pharmaceutical companies to file agreements with the FTC. After passing in Congress by a close margin, the Medicare Prescription Drug, Improvement, and Modernization Act (MMA Act) was signed by President George W. Bush on December 8, 2003. Pursuant to the MMA Act, pharmaceutical companies must file settlement agreements with the FTC and the Department of Justice within ten days of their execution. On June 17, 2013, the Supreme Court ruled that the FTC can pursue antitrust challenges of drug patent settlements. However, the court did not completely reject these so-called "pay for delay" deals between brand-name and generic drug makers, suggesting that drug makers will have some room to keep making them as long as they meet federal antitrust rules.

After 2003, pharmaceutical companies thus were not able to sidestep competition by only settling with the first generic. They can, however, settle with multiple generics to prevent all generics from entering at the same time. The brand need to settle with all generics but to allow them to enter at different time points. By doing so, the incumbent's profits will decline more slowly.

5.2.2. Uncertainty of eligibility

The second explanation for the results in Table 9 is that settlement agreement may not resolve the patent dispute. In this case, the generic firm receives no assurance of being enti-

tled with the exclusivity period. According to the 1984 Hatch-Waxman Act, the first generic submitting a Paragraph IV certification is entitled to 180 day exclusivity if it successfully defends in the court. The "successful defense" requirement was established to eliminate "an incentive for frivolous claims of patent invalidity or non-infringement because it would give ANDA applicants exclusivity even if the applicant was unsuccessful in defending against the patent owner's lawsuit".

In many cases, however, the two parties settle before hearing court rulings. By reaching an agreement on entry dates, the first generic firm retains its eligibility for the 180 day exclusivity. On one hand, because the patent is never adjudicated, the first-filer does not risk the possibility that it might lose the patent suit. On the other hand, however, the generic is not absolutely certain of owning exclusivity because, for example, a later-filing generic might win the suit, triggering the exclusivity period prior to the first filer's FDA approval. Hence, the brand has an equal incentive to settle with later ANDA filers.

6. Are settlements anticompetitive?

In this section, we examine whether settlements are more anticompetitive where top institutional shareholders of the generic manufacturer hold more shares in the brand. Unfortunately, settlement contents are mostly confidential. However, we can infer the anticompetiveness of these settlements through (1) brands' and generics' stock returns around settlement and (2) the delay of marketing a generic version of branded drug by generic manufactures entering into a settlement agreement. In subsections 6.1 and 6.2, we examine the impact of generic cross-holdings on firm value when the two parties settle. In subsection 6.3, we examine how cross-holdings affects the timing to market a generic drug. In subsection 6.4, we examine the negative spillover effects of settlements on other potential entrants through cross-holdings.

6.1. Institutional cross-holdings, settlements, and the brand's returns around settlement

In this subsection, we show that taking into account cross-holdings in the generic manufacturers makes a significant difference in brand-name firm returns around settlement. Such a difference manifests itself around the date on which the two parties settle. The regression specification of the event study is as follows:

$$AR^{b}_{i,j,s} = \alpha + \beta \times \textit{Top N Weight}_{j,s-1} + X'_{j,s-1} \times \gamma + \phi_h + \phi_k + \phi_t + \epsilon_{i,j,s}. \tag{5}$$

where $AR^{b}_{i,j,s}$ is the accumulative market adjusted returns for brand firms over the $(-3, +3)$ day window around the event in which generic manufacturer j initiating challenge i in year-quarter s enters into a settlement agreement with the brand. ϕ_h is a set of trade-name-fixed effects. Other variables are defined similarly as in equation 2

Anticompetitiveness means that a settlement agreement extends the brand's monopoly status beyond the expected value of the date of generic entry had the two parties gone to trial. If cross-holdings have anticompetitive effects, the brand's stock price around the settlement date is expected to increase with the weight of top generic shareholders' ownership in the brand relative to their ownership in the generic.

Given that settlement terms are confidential, for a rational capital market to react on the settlement date, we need to require that the public knows the date on which the two parties entered into the agreement. One assumption in equation (5) is that all the Paragraph IV litigations are conducted in the form of public hearings, in which interested parties are well aware of the resolution of the patent disputes. Unfortunately, our data do not distinguish between public and private hearings in recording the disputes. We therefore have measurement errors in our dependent variable. However, the errors should be random in such a context, and the only impact of the errors on the regression is to increase standard errors.

Columns (1)–(10) of Table 10 present the OLS results. In columns (1)–(5), we mea-

sure cross-holdings by including all index funds belonging to the Top N generic institutional shareholders. The relative weight of top generic shareholders' ownership in the brand (i.e., $\frac{\alpha_b}{\alpha_b+\alpha_g}$ in equation 1) is positively significantly correlated with brands' market-model abnormal returns over the $(-3,+3)$ day window. The economic magnitude, however, is moderate. For example, in column (3), a one-standard-deviation increase in cross-holdings increases the brand's accumulative market adjusted returns over the $(-3,+3)$ window by 0.35 percentage points (0.14×0.025).

In columns (6)–(10), we report the IV estimates of the impact of *Top N Weight* on a brand's daily abnormal returns in the post-scandal period (the fourth quarter of 2003 onward). The economic magnitude is improved by almost four times. A one-standard-deviation increase in cross-holdings increases almost 1.2 percent of the brand incumbents' market capitalization. Such a big increase in market value suggests that our findings are hardly explained by a save of legal fees.

In Table A.5, we repeat the same analysis in equation 5 by translating the raw measure of cross-holdings into relative rankings. The results are robust to this alternative specification.

6.2. Institutional cross-holdings, settlements and the generic's returns

We next investigate the value implication of cross-holdings for generic manufacturers (Paragraph IV filers) entering into a settlement agreement. Intuitively, our measure of *Top N generic cross-holdings* helps to identify differential incentives across institutional shareholders in the generic during the litigation. That is, a generic shareholder with more ownerships in the brand has incentives to seal a deal that makes other shareholders of the same generic manufacturer worse off. The conflicts of interest among institutional shareholders is in a spirit similar to the argument by Matvos and Ostrovsky (2008). We thus expect a negative relation between top generic cross-holdings and returns around the settlement date.

However, two possible reasons might prevent us from finding results consistent with the above intuition. First, although most high-profile anticompetitive settlements are made by

brand manufacturers, many Paragraph IV filers accepting the deal are private firms. Our untabulated statistics show that only less than 40% of 1,339 lawsuits are associated with public generic manufacturers challenging 187 distinct trade names, which only account for less than 50% of the total number of drugs. In other words, our sample for event study on the generic side is not representative of the sample universe. Second, it is also likely that top generic shareholders force the two litigated parties to coordinate by quickly entering into a settlement without sacrificing generic investors' interests.

Table 11 presents estimates of the effect of cross-holdings on the generic's accumulative market adjusted returns over the $(-3, +3)$ day window centered on the settlement event. All the estimated coefficients in columns (1)–(10) are not significant. Interestingly, the IV coefficients presented in columns (6)–(10) are negative, which is consistent with the notion that there are conflicts of interest among generic institutional shareholders with differential number of shares in the brand incumbent.

In Table A.6, we measure institutional cross-holdings, either including all F13 institutions or only index funds, use relative rankings. The results are similar to those reported in Table 11.

6.3. Institutional cross-holdings and the timing to market generic drugs

Our event study suggests a settlement between brand and generic manufactures with cross-holdings is anticompetitive. We pay particular attention to generic manufacturers that were granted with the 180 day exclusivity by the FDA. The key to define an anticompetitive settlement is whether the brand's monopoly status is extended afterwards. In this subsection, we examine whether cross-holdings are associated with the delay in the marketing of generic drugs by Paragraph filers who settle with the brand plaintiff.

We download the "product file" which is publicly available from FDA's official website. The product file provides detailed information about the exact date in which either a drug product is marketed by which company. The company can be either a NDA filer (brand

manufacturer) or an ANDA filer (generic manufacturer). We extract marketing dates associated with ANDA filers. We match these marketing dates to our Paragraph IV lawsuit documents based on active ingredient, drug formulation, and the name of generic manufacturer. Among patent infringement lawsuits that are settled, there are about 31% cases in which Paragraph IV filers marketed the generic version of branded product by the end of our observation period (June 8, 2017).

To search for generic manufacturers who secured with the 180 day exclusivity with respect to the branded drug at issue, we rely on web directories linking approval letters publicized by the FDA. According to this method, the search is precise. We only find 399 entries were associated with approval letters and in 46% of these letters FDA mentioned about the exclusivity.[18]

We specify the following linear probability model to estimate the effect of institutional cross-holdings on the timing of generic manufacturers to market drugs after settling with a brand plaintiff. In this regression, we only include lawsuits that are closed because the two parties settle.

$$\begin{aligned} Marketing5_{i,j,s} = \alpha + \beta_1 \times Top\ N\ Weight_{j,s-1} + \beta_2 \times Top\ N\ Weight_{j,s-1} \times \\ Excl + \beta_3 \times Excl + X'_{j,t-1} \times \gamma + \phi_h + \phi_k + \phi_t + \epsilon_{i,j,s}, \end{aligned} \tag{6}$$

where $Marketing5_{i,j,s}$ is an indicator variable set equal to one if a generic version of branded drug is marketed within three years after the generic j suited by the brand in year-quarter s for the challenge i enters into a settlement agreement, and zero otherwise. *Excl* is an indicator variable set equal to one if a generic manufacturer is granted with the 180 day exclusivity, and zero otherwise. It is important to control for trade name fixed effects to absorb unobservables, including patents' remaining life, technological feasibility and demand,

[18] One potential concern is that many ADNA applications have yet been approved. Because of this right-truncation problem, it is difficult for us to make unconditional statements about the percentages of first generic in our sample.

from driving the cross-sectional variation in the timing of marketing a generic drug. To avoid the truncation problem, we only include lawsuits that are settled five years prior to the end of our observation period. In our sample, about 27% of settled lawsuits end up with the generic drug being marketed within five years.

Table 12 reports our results. In columns (1)–(10), we report OLS estimates. The interaction term $Top\ N_{j,s-1} \times Excl$ turns out to be significantly negative. Interestingly, *Excl* is positively associated with the probability that a settled generic will sell within five years. However, a one-standard-deviation increase in institutional cross-holdings reduces the probability that a generic manufacturer receiving the exclusivity will sell the generic substitutes of branded drugs by about 12.3–14.5 percentage points, which is about a half of our sample mean. Columns (6)–(10) present the IV estimates. Although the estimated coefficients remain negative, they are not statistically significant.

In Table A.8, we again translate the raw measure of $Top\ N\ Weight$ into relative rankings and the interaction term is strongly negative in columns (1)–(10).

6.4. Institutional cross-holdings and the impact of settlements on other potential entrants

Collusive settlements do not only reduce consumer welfare but also hurt the economic interests of other potential entrants. If common ownership facilitates collusion, we would expect settlements between commonly owned incumbent and entrants to negatively impact on stock prices of other potential entrants. The forward-looking nature of stock prices helps us to circumvent the truncation problem as mentioned in Section 6.3.

Anticompetitive settlements can negatively impact other potential entrants via two channels. First, the brand settles with the generic entrant receiving the 180 day marketing exclusivity can delay the sell of the drug to block other entries. As we discussed in Section 5.2.2, the first generic will not necessarily receive the exclusivity at the time when the two parties

settle. As we show in Table A.9, however, the first ANDA filer is much more likely to receive the exclusivity comparing to later filers. We therefore expect investors of other entrants react to the settlement between the brand and the first filer, even the exclusivity has not been granted yet.

Second, using license agreements, the incumbent and entrants negotiate an alternative and presumably more profitable version of generic entry with the settlement (see Hemphill (2007)). The Hatch-Waxman Act does not restrain the brand to launch its own generic drugs, which is the so called "authorized generics (AG)". AG competition can substantially reduce revenues accrued to other generics. Using settlement agreements, brand companies recruit additional generic firms to sell an unbranded version of the drug under the brand's own license. In this case, institutional cross-holdings is harmful for potential entrants through any ANDA filers, not only the first one.

To distinguish the first channel from the second channel, we specify the following linear regression model

$$\begin{aligned} AR^{g}_{i,j^{'},s} = \alpha + \beta_1 \times \mathit{Top\ N\ Weight}_{j,s-1} + \beta_2 \times \mathit{Top\ N\ Weight}_{j,s-1} \times \mathit{First} \\ + \beta_3 \times \mathit{First} + X_{j,s-1} \times \mathit{gamma} + \phi_h + \phi_k + \phi_t + \varepsilon_{i,j,s}. \end{aligned} \tag{7}$$

where $AR^{g}_{i,j^{'},s}$ is the accumulative market adjusted returns for other potential entrants $j^{'}$ over the event window [-3, +3]. The event is the date in which the brand and generic j enter into a settlement agreement in year-quarter s. Other potential entrants are defined as generic firms $j^{'}$ that have challenged the validity of patents covering the same drug while the corresponding lawsuit is pending. *First* is an indicator variable set equal to one if a settled generic j is the earliest entrant based on the "pseudo entry date" (see description in Section 5.1), and zero otherwise.

Table 13 presents the estimated effects of institutional cross-holdings on other generics' abnormal returns around the event of settlement. In columns (1)–(5), institutional cross-

holdings is measured using index funds that belong to the top N generic shareholders based on the rankings of the entire group of F13 institutional investors. In columns (6)–(10), we present estimates based on the 2003 mutual fund trading scandal. Both *Top N Weight* and *Top N Weight* $\times$ *First* are negatively associated with abnormal returns around the settlement date. In Table A.10, we perform robustness check using relative rankings to measure institutional cross-holdings and the estimated coefficients are similar.

7. Concluding Remarks

Does product market become less competitive when a small set of large institutional investors hold many natural competitors? In a novel study, Azar, Schmalz, and Tecu (2017) develop a modified Herfindahl-Hirschman index (MHHI) that takes into account common institutional ownership in the U.S. airline industry. The authors find a robust, positive correlation between within-route changes in common ownership concentration and route-level changes in ticket prices. Their findings call the amendment to the Section 7 of the Calyton Act. The Section is the principal federal substantive law governing mergers and acquisitions that creates monopoly. However, its current version exempts stock acquisitions made "solely for investment"

One possible limitation with Azar et al. (2017)'s approach is that spurious correlation may arise from the fact that MHHI is a function of both institutional ownership and the Herfindahl-Hirschman index (HHI). As a result, a positive correlation between MHHI and product price exists even if common ownership does not weaken competition at all. This limitation is inevitable in a post-entry setting, where all competitors have already acquired some market shares.

In this paper, we examine how common institutional owners of incumbents and entrants affect the product market outcome in the pharmaceutical industry. Such a pre-entry setting allows us to directly regress entry outcomes on institutional ownership. More specifically,

we analyze a sample of patent infringement lawsuits filed by brand drug manufacturers against generic manufacturers filed Paragraph IV application to the FDA. Paragraph IV allows generic manufacturers to produce bioequivalent drugs before the expiration of patents covering the branded product at issue. We find institutional cross-holdings, measured by the weight of top generic shareholders' ownership in the brand-name manufacturer relative to their ownership in the generic entrant, increases the likelihood of the two litigated parties entering into a settlement agreement in which the brand manufacturer often pays the generic one for the purpose to delay entry. By investigating brand's daily stock returns around settlement and the timing to sell the drugs by generic manufacturers who accepted a settlement offer, we conclude that institutional cross-holdings facilitates collusion between incumbent and entrant in the U.S. pharmaceutical industry.

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Fig. 1. **Generic Competition and Drug Prices**

This figure plots the relation between the number of generic entries and drug prices. The horizontal axis represents the number of generic manufacturers marketing a branded drug. The vertical axis represents the average relative drug price per dose. Data Source: FDA analysis of retail sales data from IMS Health, IMS National Sales Perspective (TM), 1999–2004, extracted February 2005

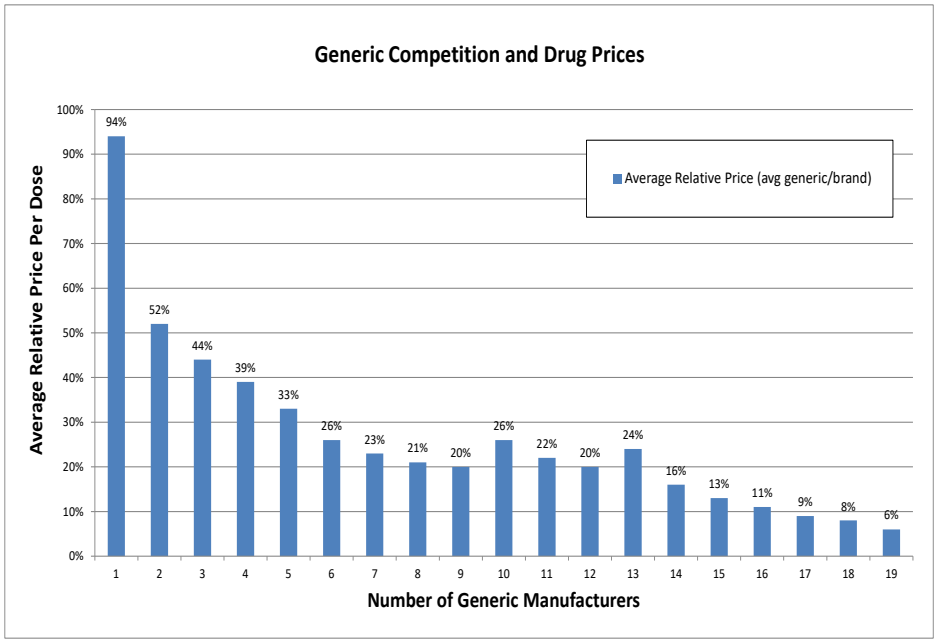

Fig. 2. **Paragraph IV report from Parry Ashford Inc.**

This figure provides an example of a sample unit in our data (i.e., a challenge by a generic manufacturer of a brand's patent). In this example, the generic manufacturer and the brand manufacturer enter into a settlement agreement.

Arthrotec®(diclofenac and misoprostol) Delayed-release Tablets
Company PFIZER
Date of First Filing November 28, 2008 (75mg/0.2mg) and June 29, 2009 (50mg/0.2mg)

Paragraph IV Applicant: Teva Pharamceuticals (Barr)
Case Name: PFIZER v. TEVA PHARMACEUTICALS
Court/Case #: New York Southern District Court (nysdc) 1:2009cv03965
Date Filed: 4/21/2009
Judge: Sullivan
Product Strength: 75 mg/0.2 mg and 50mg/0.2mg
Litigated Patents (expiration): 5,601,843 (2/11/2014)
Non-Litigated Patents (expiration): 5,698,225 (5/3/2010)
Plaintiff Lawyer/Firm: Thom Beck/Sidley Austin
Defendant Lawyer/Firm: David Hashmall/Goodwin Procter
Related Case: None. Amended Complaint adds 50mg/0.2mg strength
Status: The parties entered settlement agreement and consent judgment entered 1/22/10.
Complaint Amended Complaint Answer
Consent Judgment

Product Links from FDA and USPTO
Orange Book Patent & Exclusivity Data
'843 Patent
'225 Patent

Table 1: **Sample**

This table presents descriptive statistics for our sample of patent challenges by generic drug manufacturers. The sample consists of 1,399 challenges to 1,170 patents covering 377 trade names (i.e., the name of the branded drug). A challenge occurs when a generic drug manufacturer files an ANDA under Paragraph IV certification with the FDA. In a Paragraph IV certification, the generic manufacturer argues that its generic drug does not infringe on patents covering a branded product or that the patents at issue are simply invalid. Under this provision, generic manufacturers can challenge the validity of patents so that the effective patent life of a branded drug can be reduced. We start from active cases as of November 1, 2003, and end our sample with cases in which challenge outcomes were known by July 23, 2016. Active cases refer to those that had a pending lawsuit. We define a challenge at the level of the date that a brand files a patent infringement lawsuit against a generic manufacturer challenging the formulation (e.g., tablet, capsule, and injection) of a brand name drug. Panel A presents the data structure of the sample and the frequency with which drugs and patents in the sample are challenged. Panel B presents the distribution of private and public firms at the challenge level.

Panel A: Data structure

Brand name drugs	377
Brand incumbents	120
Generic entrants	133
Formulations of brand name drugs	451
Challenges	1,339

Panel B: Distribution by listing status

	N	Percentage
Generic public & brand public	293	21.9%
Generic public & brand private	252	18.8%
Generic private & brand public	310	23.2%
Generic private & brand private	484	36.1%
Total	1,339	100.0%

Table 2: **Sample distribution of challenge outcomes**

This table presents the sample distributions of the challenge outcomes following the filing of an ANDA under Paragraph IV certification with the FDA. We start from active cases as of November 1, 2003, and end our sample with cases whose challenge outcomes were known by July 23, 2016. Active cases refer to those that had a pending lawsuit. We define a challenge at the level of the date that a brand files a patent infringement lawsuit against a generic manufacturer challenging the formulation (e.g., tablet, capsule, and injection) of a trade name (i.e., the name of the branded drug).

	% at patent level	# of patents	# of challenge
		Total	
Settlement	72.3%	2599	1339
Brand win	9.9%	357	1339
Brand lose	8.8%	316	1339
Brand does not suit	8.0%	286	1339
Unknown	1.1%	39	1339
		Both public	
Settlement	70.9%	514	293
Brand win	15.4%	112	293
Brand lose	10.8%	78	293
Brand does not suit	1.4%	10	293
Unknown	1.5%	11	293
		Generic public & brand private	
Settlement	78.3%	642	252
Brand win	11.7%	96	252
Brand lose	9.0%	74	252
Brand does not suit	0.4%	3	252
Unknown	0.6%	5	252
		Brand public & generic private	
Settlement	80.8%	588	310
Brand win	8.4%	61	310
Brand lose	8.2%	60	310
Brand does not suit	1.2%	9	310
Unknown	1.4%	10	310
		Both private	
Settlement	64.6%	855	484
Brand win	6.6%	88	484
Brand lose	7.9%	104	484
Brand does not suit	19.9%	264	484
Unknown	1.0%	13	484

Table 3: **Cross-holding example**

This table presents an example of cross-holdings. In the second quarter of 2013, Bristol-Myers Squibb filed a patent infringement lawsuit against Mylan, who challenged Bristol-Myers Squibb's patents covering a branded drug. *Generic shares* refers the percentage ownership of Mylan's top 30 institutional shareholders invested in Mylan. *Brand shares* refers to percentage ownership of Mylan's top 30 institutional shareholders invested in Bristol-Myers Squibb. Institutional ownership is measured as of the end of the first quarter of 2013.

First quarter of 2013
Generic firm: Mylan
Brand firm: Bristol-Myers Squibb

	Generic shares	Brand shares
Vanguard	7.04%	4.61%
Paulson & Co. Inc.	4.72%	0.00%
BlackRock	5.03%	4.50%
State Street	4.35%	4.06%
Bank of America	3.91%	1.09%
Goldman Sachs	2.72%	0.46%
Fidelity	0.89%	0.40%
Wellington Management	3.67%	2.46%
Jennison Associates	1.15%	0.94%
Mellon Bank	1.79%	1.55%
Nordea Investment Management	1.65%	0.02%
Sectoral Asset Management	1.27%	0.00%
JPMorgan Chase	1.15%	1.15%
Northern Trust	1.39%	1.70%
MSDW	0.86%	1.12%
Janus Capital Management	2.40%	0.19%
Amvescap	1.22%	1.11%
College Retire Equities	1.22%	0.52%
BlackRock Advisors	0.52%	0.82%
Investeco Asset Management	1.25%	0.00%
TCM Asset Management	0.84%	0.05%
ING Investment Management	0.59%	0.07%
Orbimed Advisors	1.11%	0.25%
Credit Agricole	0.82%	0.04%
S.A.C. Capital Advisors	0.08%	0.00%
Sustainable Growth Advisers	0.52%	0.00%
Lord, Abbett & Co	0.63%	0.13%
Geode Capital Management	0.69%	0.67%
Deutsche Bank	0.58%	0.34%
Citigroup	0.31%	0.16%

	Top 10	Top 20	Top 30
Cross-holding	36.3%	35.5%	34.3%

Table 4: **Cross-holdings of brands by the largest institutional shareholders of generics**

This table presents descriptive statistics for our cross-holdings measure on the sample in which both the brand and generic are public firms. For each group consisting of the top 10, 15, 20, 25, and 30 largest institutional shareholders of a public generic firm, we calculate the group's ownership of the brand firm. We then calculate *Top N ($N = 10, 15, 20, 25, 30$) generic cross-holdings* as the ratio of the group's ownership in the brand divided by the sum of the group's ownerships in the brand and the generic. If two or more generic firms file the same ANDA under Paragraph IV certification with the FDA, and an institution is ranked as top N shareholder in more than one generic manufacturer, we take the sum of its ownerships across all generics to calculate that institutional shareholder's percentage ownership on the generic side. *Cross-holdings* is measured as of the beginning of the quarter in which a patent infringement lawsuit is filed by brand manufacturers. We start from active cases as of November 1, 2003, and end our sample on cases whose challenge outcomes were known by July 23, 2016. Active cases refer to those that had a pending lawsuit. We define a challenge at the level of the date that brand suits a generic manufacturer challenging the formulation (e.g., tablet, capsule, and injection) of a trade name (i.e., the name of branded drug).

	Mean	SD	Min	p1	p25	p50	p75	p99	Max	N
Generic shares held by top 10 generic shareholders	24.7%	14.7%	0.0%	0.0%	9.1%	24.6%	36.7%	54.0%	54.5%	291
Generic shares held by top 15 generic shareholders	29.3%	17.5%	0.0%	0.0%	10.9%	29.6%	44.1%	63.6%	64.1%	291
Generic shares held by top 20 generic shareholders	32.5%	19.6%	0.0%	0.0%	11.5%	33.0%	48.9%	70.1%	72.1%	291
Generic shares held by top 25 generic shareholders	35.0%	21.1%	0.0%	0.0%	11.8%	35.7%	52.7%	75.5%	78.0%	291
Generic shares held by top 30 generic shareholders	37.0%	22.4%	0.0%	0.0%	12.0%	38.2%	55.6%	81.1%	83.2%	291
Brand shares held by top 10 generic shareholders	9.5%	7.8%	0.0%	0.0%	2.9%	8.1%	15.1%	30.1%	41.9%	291
Brand shares held by top 15 generic shareholders	12.4%	9.0%	0.0%	0.0%	4.9%	12.4%	18.8%	39.1%	49.1%	291
Brand shares held by top 20 generic shareholders	14.3%	9.9%	0.0%	0.0%	5.2%	14.5%	21.4%	48.7%	50.4%	291
Brand shares held by top 25 generic shareholders	16.1%	11.0%	0.0%	0.1%	6.1%	16.9%	23.3%	50.4%	53.8%	291
Brand shares held by top 30 generic shareholders	17.4%	11.7%	0.0%	0.1%	6.5%	18.8%	25.3%	51.3%	55.6%	291
Top 10 generic shareholders' weight on brand	29.1%	20.4%	0.0%	0.0%	12.9%	29.1%	40.4%	86.1%	99.9%	291
Top 15 generic shareholders' weight on brand	32.3%	21.3%	0.0%	0.2%	16.2%	30.5%	45.6%	85.0%	99.9%	291
Top 20 generic shareholders' weight on brand	33.3%	21.7%	0.0%	0.3%	18.5%	31.5%	45.8%	85.6%	99.9%	291
Top 25 generic shareholders' weight on brand	34.3%	22.0%	0.0%	0.4%	19.2%	32.5%	46.1%	85.9%	99.9%	291
Top 30 generic shareholders' weight on brand	34.9%	22.3%	0.0%	0.4%	20.1%	33.2%	46.9%	86.3%	99.9%	291

Table 5: **Effect of cross-holdings on the likelihood of settlement**

This table presents linear probability model estimates of the effect of institutional cross-holdings on the likelihood of settlement. Panel A presents results without firm or trade name fixed effects. Panel B presents results with firm or trade name fixed effects. The dependent variable is an indicator coded as one if the brand and generic firms settle a Paragraph IV litigation, and zero otherwise. Cases in which the brand does not sue the generic firms for patent infringement are excluded. We measure cross-holdings as of the beginning of the quarter in which a brand files infringement suit. For each group consisting of the *Top N ($N = 10, 15, 20, 25, 30$) largest institutional shareholders of a generic firm, we calculate* Top *N generic cross-holdings* as the ratio of the group's ownership in the brand divided by the sum of its ownerships in the brand and the generic. If two or more generic firms file the same ANDA under Paragraph IV certification with the FDA, and an institution is ranked as top N shareholder in more than one generic manufacturer, we take the sum of its ownerships across all generics to calculate that institutional shareholder's percentage ownership on the generic side. *log (drug sales)* is the logarithm of sales of the top pharmaceutical drugs by retail sales. The top 200 drug sales are publicly available from 2000 to 2010, and the top 100 drug sales are publicly available from 2000 to 2013. For drugs that were previously, but are not currently, ranked in the top 200/100, we use their most recent sales from the top 200/100 list. *non-top drug* is an indicator coded as one if the trade name has never been listed on the top 200/100 list, and zero otherwise. *Group* is an indicator coded as one if more than two generic manufacturers challenge the same drug in the same date, and zero otherwise. *Public status* refers to three indicator variables as follows. *Brand public* is an indicator coded as one if the brand is a public firm and the generic is a private firm, and zero otherwise. *Generic public* is an indicator coded as one if the generic is a public firm and the brand is a private firm, and zero otherwise. *Neither public* is an indicator coded as one if neither the generic nor the brand is public firm, and zero otherwise. Standard errors are clustered at the U.S. Federal District Court level.

Panel A: Without firm or trade name fixed effects

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Top 10	0.169					0.130				
	(0.115)					(0.086)				
Top 15		0.204					0.172*			
		(0.123)					(0.101)			
Top 20			0.192*					0.158*		
			(0.101)					(0.082)		
Top 25				0.211**					0.173**	
				(0.093)					(0.076)	
Top 30					0.224**					0.190**
					(0.092)					(0.076)
log(drug sales)	−0.024**	−0.024*	−0.023*	−0.023*	−0.023*	−0.040**	−0.040**	−0.040**	−0.040**	−0.040**
	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.019)	(0.019)	(0.019)	(0.019)	(0.019)
Non-top drug	−0.313*	−0.307*	−0.305*	−0.303*	−0.302*	−0.557**	−0.553**	−0.551**	−0.550**	−0.550**
	(0.156)	(0.155)	(0.156)	(0.157)	(0.157)	(0.250)	(0.251)	(0.251)	(0.252)	(0.252)
Constant	0.988***	0.965***	0.965***	0.954***	0.947***	0.935***	0.914***	0.914***	0.907***	0.900***
	(0.158)	(0.149)	(0.156)	(0.157)	(0.157)	(0.285)	(0.280)	(0.285)	(0.286)	(0.286)
Public status	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE						Yes	Yes	Yes	Yes	Yes
District court FE						Yes	Yes	Yes	Yes	Yes
Generic Firm FE										
Generic Firm FE × Group										
Brand firm FE										
Trade name FE										
N	1234	1234	1234	1234	1234	1202	1202	1202	1202	1202
Adj. R^2	0.004	0.005	0.004	0.005	0.005	0.046	0.047	0.047	0.047	0.048

Panel B: With firm or trade name fixed effects

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Top 10	0.151*					0.146*				
	(0.080)					(0.085)				
Top 15		0.186**					0.191**			
		(0.082)					(0.088)			
Top 20			0.136					0.188**		
			(0.100)					(0.079)		
Top 25				0.164*					0.196**	
				(0.095)					(0.075)	
Top 30					0.191**					0.215***
					(0.087)					(0.075)
log (drug sales)	−0.003	−0.003	−0.003	−0.003	−0.003	0.162***	0.164***	0.163***	0.164***	0.164***
	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)	(0.054)	(0.054)	(0.055)	(0.054)	(0.054)
Non-top drug	−0.104	−0.099	−0.097	−0.095	−0.095					
	(0.234)	(0.234)	(0.235)	(0.235)	(0.235)					
Group	−0.194**	−0.195**	−0.193**	−0.194**	−0.195**	0.009	0.008	0.007	0.007	0.007
	(0.082)	(0.083)	(0.081)	(0.082)	(0.082)	(0.019)	(0.019)	(0.019)	(0.019)	(0.019)
Constant	1.325***	1.309***	1.319***	1.310***	1.302***	−1.223**	−1.255***	−1.254***	−1.263***	−1.275***
	(0.353)	(0.355)	(0.355)	(0.355)	(0.355)	(0.452)	(0.450)	(0.454)	(0.453)	(0.448)
Public status	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
District court FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Generic Firm FE	Yes	Yes	Yes	Yes	Yes					
Generic Firm FE × Group	Yes	Yes	Yes	Yes	Yes					
Brand firm FE	Yes	Yes	Yes	Yes	Yes					
Trade name FE						Yes	Yes	Yes	Yes	Yes
N	1,201	1,201	1,201	1,201	1,201	1,202	1,202	1,202	1,202	1,202
Adj. R^2	0.29	0.29	0.29	0.29	0.29	0.45	0.45	0.45	0.45	0.45

Table 6: **Effect of cross-holdings (rankings) on the likelihood of settlement**

This table presents estimates linear probability model regressions of the effect of rankings of institutional cross-holdings on the likelihood of settlement. The dependent variable is an indicator coded as one if the brand and generic firms settle a Paragraph IV litigation, and zero otherwise. Cases in which the brand does not sue the generic firms for patent infringement are excluded. We measure cross-holdings as of the beginning of the quarter in which a brand files infringement suit. We rank Top N ($N = 10, 15, 20, 25, 30$) generic cross-holdings in an ascending order and scale the resulting ranking by the total number of lawsuits. For each group consisting of the top N largest institutional shareholders of a generic firm, we calculate generic cross-holdings as the ratio of the group's ownership in the brand divided by the sum of its ownerships in the brand and the generic. If two or more generic firms file the same ANDA under Paragraph IV certification with the FDA, and an institution is ranked as top N shareholder in more than one generic manufacturer, we take the sum of its ownerships across all generics to calculate that institutional shareholder's percentage ownership on the generic side. See Table 5 for descriptions of other dependent variables. Standard errors are clustered at the U.S. Federal District Court level.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Top 10	0.422***					0.168				
	(0.115)					(0.101)				
Top 15		0.752***					0.301**			
		(0.145)					(0.145)			
Top 20			0.620**					0.283*		
			(0.241)					(0.139)		
Top 25				0.675***					0.294**	
				(0.231)					(0.139)	
Top 30					0.743***					0.334**
					(0.193)					(0.151)
log (drug sales)	−0.004	−0.004	−0.004	−0.003	−0.004	0.161***	0.162***	0.161***	0.161***	0.162***
	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)	(0.055)	(0.055)	(0.056)	(0.056)	(0.055)
Non-top drug	−0.117	−0.109	−0.107	−0.105	−0.107					
	(0.238)	(0.231)	(0.233)	(0.233)	(0.233)					
Group	−0.193**	−0.197**	−0.195**	−0.196**	−0.197**	0.011	0.011	0.011	0.011	0.011
	(0.083)	(0.083)	(0.081)	(0.082)	(0.082)	(0.019)	(0.018)	(0.018)	(0.018)	(0.018)
Constant	1.016***	0.727*	0.838**	0.788*	0.733*	−1.318***	−1.441***	−1.422***	−1.433***	−1.469***
	(0.358)	(0.379)	(0.408)	(0.400)	(0.385)	(0.434)	(0.490)	(0.503)	(0.506)	(0.508)
Public status	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
District court FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Generic Firm FE	Yes	Yes	Yes	Yes	Yes					
Generic Firm FE × Group	Yes	Yes	Yes	Yes	Yes					
Brand firm FE	Yes	Yes	Yes	Yes	Yes					
Trade name FE						Yes	Yes	Yes	Yes	Yes
N	1,201	1,201	1,201	1,201	1,201	1,202	1,202	1,202	1,202	1,202
Adj. R^2	0.29	0.29	0.29	0.29	0.29	0.45	0.45	0.45	0.45	0.45

Table 7: **Effect of cross-holdings by index funds on the likelihood of settlement**

This table presents the linear probability model estimates of the effect of index fund cross-holdings on the likelihood of and timing settlement. The dependent variable is an indicator coded as one if the brand and generic firms settle a Paragraph IV litigation, and zero otherwise. Cases in which the brand does not sue the generic firms for patent infringement are excluded. We measure cross-holdings by index funds as of the beginning of the quarter in which a brand files infringement suit. We define a F13 institution investor as a quasi-index fund based on the method used by Bushee (2001) and Bushee and Noe (2000). For each group consisting of index funds that belong to the top N ($N = 10, 15, 20, 25, 30$) largest institutional shareholders of a generic firm, we calculate generic cross-holdings by index funds as the ratio of the group's ownership in the brand divided by the sum of its ownerships in the brand and the generic. If two or more generic firms file the same ANDA under Paragraph IV certification with the FDA, and an index fund is ranked as top N shareholder in more than one generic manufacturer, we take the sum of its fund ownerships across all generics to calculate that index fund's percentage ownership on the generic side. Panel A and B report regression results when cross-holdings and rankings of cross-holdings are used. We rank Top N generic cross-holdings by index funds in an ascending order and scale the resulting ranking by the total number of lawsuits. The number N appears at top of each column. Controls include *log (drug sales)*, *Non-top drug*, *Group*, and *Index status*. *Index status* refers to three indicator variables as follows. *Brand indexed*, *Generic indexed* and *Neither indexed*. *Brand indexed* is an indicator coded as one if the brand stock is held by at least one quasi-index fund and the generic is not, and zero otherwise. *Generic indexed* is an indicator coded as one if the generic stock is held by at least one quasi-index fund and the brand is not, and zero otherwise. *Neither indexed* is an indicator coded as one if neither the generic nor the brand is held by any quasi-index funds, and zero otherwise. See Table 5 for descriptions of other independent variables. Standard errors are clustered at the U.S. Federal District Court level.

N=	10	15	20	25	30	10	15	20	25	30
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Panel A: Continuous measure									
Top N	0.192**	0.201**	0.118	0.147	0.175*	0.157*	0.187**	0.172**	0.179**	0.198**
	(0.074)	(0.082)	(0.101)	(0.092)	(0.089)	(0.086)	(0.087)	(0.082)	(0.077)	(0.077)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	1,201	1,201	1,201	1,201	1,201	1,202	1,202	1,202	1,202	1,202
Adj. R^2	0.29	0.29	0.29	0.29	0.29	0.45	0.45	0.45	0.45	0.45
	Panel B: Rankings									
Top N	0.480***	0.806***	0.623**	0.663***	0.738***	0.188	0.312**	0.273**	0.265**	0.302**
	(0.127)	(0.138)	(0.256)	(0.234)	(0.203)	(0.111)	(0.134)	(0.133)	(0.124)	(0.138)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	1,201	1,201	1,201	1,201	1,201	1,202	1,202	1,202	1,202	1,202
Adj. R^2	0.29	0.29	0.29	0.29	0.29	0.45	0.45	0.45	0.45	0.45
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
District court FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Generic Firm FE	Yes	Yes	Yes	Yes	Yes					
Generic Firm FE × Group	Yes	Yes	Yes	Yes	Yes					
Brand firm FE	Yes	Yes	Yes	Yes	Yes					
Trade name FE						Yes	Yes	Yes	Yes	Yes

$*p < 0.10, **p < 0.05, ***p < 0.01$

Table 8: **Effect of cross-holdings on the likelihood of settlement: IV Regressions, Second Stage**

This table presents the instrumental variable (IV) estimates of the effect of institutional cross-holdings on the likelihood of settlement. The sample starts from patent infringement lawsuits occurring in the fourth quarter of 2003. The dependent variable is an indicator coded as one if the brand and generic firms settle a Paragraph IV litigation, and zero otherwise. We exclude cases in which the brand does not sue the generic firms for patent infringement. We measure cross-holdings as of the beginning of the quarter in which a brand files infringement suit. In columns (1)–(5), we measure top N generic cross-holdings as the ratio of the group's ownership in the brand divided by the sum of the group's ownerships in the brand and the generic. See Table 5 for descriptions of top N generic cross-holdings and other independent variables. In columns (6)–(10), we use the cross-holding ranks. We rank top N generic cross-holdings in an ascending order and scale the resulting ranking by the total number of lawsuits. Starting from September 2003, 25 fund families experienced large outflows of capital as a consequence of a settlement regarding alleged illegal trading. *Top N generic cross-holdings* is instrumented with *Treatment*, which is an indicator variable set equal to one if *Brand Scandal%* exceeds 10%. *Brand Scandal%* is the sum of brand ownerships of scandal funds that belong to the top 30 generic institutional shareholders as a fraction of the sum of brand ownerships of all top 30 generic institutional shareholders as of September 2003. Standard errors are in parentheses and are clustered at the U.S. Federal District Court level.

	Cross-holdings					Rankings				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Top 10	0.518∗					0.183∗				
	(0.286)					(0.096)				
Top 15		0.461∗					0.185∗			
		(0.243)					(0.096)			
Top 20			0.447∗					0.185∗		
			(0.238)					(0.096)		
Top 25				0.440∗					0.185∗	
				(0.227)					(0.096)	
Top 30					0.434∗					0.185∗
					(0.222)					(0.096)
log (drug sales)	−0.017	−0.016	−0.016	−0.016	−0.016	−0.018	−0.017	−0.017	−0.017	−0.017
	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)
Non-top drug	−0.285	−0.265	−0.268	−0.261	−0.259	−0.286	−0.278	−0.279	−0.278	−0.278
	(0.209)	(0.210)	(0.211)	(0.212)	(0.212)	(0.222)	(0.222)	(0.223)	(0.223)	(0.223)
Group	−0.163	−0.151	−0.147	−0.146	−0.147	−0.131	−0.131	−0.130	−0.131	−0.131
	(0.119)	(0.111)	(0.110)	(0.108)	(0.107)	(0.102)	(0.102)	(0.102)	(0.102)	(0.102)
Constant	2.043∗∗∗	2.035∗∗∗	2.045∗∗∗	2.039∗∗∗	2.043∗∗∗	2.075∗∗∗	2.067∗∗∗	2.068∗∗∗	2.068∗∗∗	2.068∗∗∗
	(0.348)	(0.351)	(0.353)	(0.354)	(0.354)	(0.374)	(0.374)	(0.374)	(0.374)	(0.374)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
District court FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Generic firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Generic firm FE × Group	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Brand firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	1,042	1,042	1,042	1,042	1,042	1,042	1,042	1,042	1,042	1,042

$*p < 0.10, **p < 0.05, ***p < 0.01$

Table 9: **Effect of cross-holdings on the likelihood of settlement: first generic vs. others**

This table presents estimates of the effect of institutional cross-holdings on the likelihood of settlement. The dependent variable is an indicator coded as one if the brand and generic firms settle a Paragraph IV litigation, and zero otherwise. Cases in which the brand does not sue the generic firms for patent infringement are excluded. We measure cross-holdings as of the beginning of the quarter in which a brand suits a generic manufacturer filing Paragraph IV application for patent infringement. *First* is an indicator coded as one if the generic manufacturer is the first challenger based on *pseudo entry date*, which is the earliest of: (1) the date an ANDA was filed, (2) the date the brand incumbent was noticed by the ANDA filer(s), and (3) the date the brand suits the ANDA filer. *Top N × First* is the interaction between top N ($N = 10, 15, 20, 25, 30$) generic cross-holdings and *First*. Columns (1)–(10) present coefficients estimated from linear probability regressions. In columns (1)–(5), only ownership of index funds that belong to the top N generic shareholders is used to calculate cross-holdings. See Table 5 and 7 for descriptions of the construction of cross-holdings and other independent variables. Columns (6)–(10) present coefficients estimated from instrumental variable (IV) regressions. Starting from September 2003, 25 fund families experienced large outflows of capital as a consequence of a settlement regarding alleged illegal trading. *Top N generic cross-holdings* is instrumented with *Treatment*, which is an indicator variable set equal to one if *Brand Scandal%* exceeds 10%. *Brand Scandal%* is the sum of brand ownerships of scandal funds that belong to the top 30 generic institutional shareholders as a fraction of the sum of brand ownerships of all top 30 generic institutional shareholders as of September 2003. Standard errors are in parentheses and are clustered at the U.S. Federal District Court level.

	Index funds					IV Estimation				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Top 10	0.220**					0.449**				
	(0.087)					(0.213)				
Top 15		0.224**					0.381**			
		(0.088)					(0.173)			
Top 20			0.153					0.365**		
			(0.112)					(0.167)		
Top 25				0.176					0.363**	
				(0.104)					(0.164)	
Top 30					0.202*					0.358**
					(0.100)					(0.161)
Top N × First	−0.088	−0.089	−0.136*	−0.115	−0.108	0.153	0.185	0.196	0.181	0.180
	(0.098)	(0.093)	(0.080)	(0.075)	(0.074)	(0.441)	(0.419)	(0.415)	(0.390)	(0.383)
First	−0.006	−0.004	0.001	−0.001	−0.001	−0.043	−0.044	−0.044	−0.044	−0.044
	(0.035)	(0.034)	(0.036)	(0.035)	(0.036)	(0.043)	(0.042)	(0.042)	(0.042)	(0.041)
log (drug sales)	−0.005	−0.004	−0.004	−0.004	−0.004	−0.019	−0.017	−0.018	−0.017	−0.017
	(0.016)	(0.016)	(0.017)	(0.017)	(0.017)	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)
Non-top drug	−0.124	−0.112	−0.114	−0.111	−0.110	−0.299	−0.279	−0.283	−0.276	−0.275
	(0.228)	(0.228)	(0.232)	(0.233)	(0.232)	(0.206)	(0.205)	(0.205)	(0.207)	(0.207)
Group	−0.192**	−0.190**	−0.177**	−0.182**	−0.184**	−0.205	−0.200	−0.199	−0.196	−0.197
	(0.088)	(0.090)	(0.085)	(0.084)	(0.085)	(0.170)	(0.166)	(0.169)	(0.163)	(0.162)
Constant	1.336***	1.321***	1.350***	1.337***	1.327***	2.059***	2.048***	2.057***	2.053***	2.056***
	(0.353)	(0.354)	(0.356)	(0.356)	(0.356)	(0.340)	(0.340)	(0.341)	(0.342)	(0.342)
Index status	Yes	Yes	Yes	Yes	Yes					
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
District court FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Generic Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Generic Firm FE × Group	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Brand firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	1,199	1,199	1,199	1,199	1,199	1,042	1,042	1,042	1,042	1,042
Adj. R^2	0.29	0.29	0.29	0.29	0.29					

$*p < 0.10, **p < 0.05, ***p < 0.01$

Table 10: **Effect of cross-holdings on brand's abnormal returns around settlement**

This table presents estimates of the effect of cross-holdings on the abnormal returns around the date on which the generic filer of Paragraph IV and the brand enter into a settlement agreement. The dependent variable is the cumulative market adjusted returns (winterized at 1% and 99% percentiles) for public brand firms over the window [−3, +3]. The event denotes the date in which the two parties settle. We measure cross-holdings as of the beginning of the quarter in which a Paragraph IV application is filed. Columns (1)–(10) present coefficients estimated from linear probability regressions. In columns (1)–(5), only ownership of index funds that belong to the top N generic shareholders is used to calculate cross-holdings. See Table 5 and 7 for descriptions of institutional cross-holdings and other independent variables. Columns (6)–(10) present coefficients estimated from instrumental variable (IV) regressions. Starting from September 2003, 25 fund families experienced large outflows of capital as a consequence of a settlement regarding alleged illegal trading. *Top N generic cross-holdings* is instrumented with *Treatment*, which is an indicator variable set equal to one if *Brand Scandal%* exceeds 10%. *Brand Scandal%* is the sum of brand ownerships of scandal funds that belong to the top 30 generic institutional shareholders as a fraction of the sum of brand ownerships of all top 30 generic institutional shareholders as of September 2003. Standard errors are in parentheses and are clustered at the U.S. Federal District Court level.

	Index funds					IV Estimation				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Top 10	0.021***					0.098*				
	(0.007)					(0.054)				
Top 15		0.025***					0.090*			
		(0.006)					(0.050)			
Top 20			0.025***					0.085*		
			(0.007)					(0.048)		
Top 25				0.028***					0.083*	
				(0.007)					(0.046)	
Top 30					0.029***					0.081*
					(0.006)					(0.045)
Brand public						0.023*	0.023*	0.023*	0.023*	0.023**
						(0.012)	(0.012)	(0.012)	(0.012)	(0.012)
Brand indexed	0.007	0.009	0.009	0.010	0.011					
	(0.007)	(0.006)	(0.006)	(0.006)	(0.006)					
log (drug sales)	−0.003	−0.002	−0.002	−0.001	−0.001	0.004	0.004	0.003	0.004	0.003
	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)	(0.010)	(0.011)	(0.012)	(0.012)	(0.012)
Constant	0.028	0.021	0.021	0.018	0.017	0.042	0.038	0.044	0.041	0.045
	(0.173)	(0.173)	(0.173)	(0.172)	(0.171)	(0.140)	(0.160)	(0.164)	(0.167)	(0.166)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
District court FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Trade name FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	490	490	490	490	490	429	429	429	429	429
Adj. R^2	0.15	0.16	0.16	0.16	0.16					

$*p < 0.10, **p < 0.05, ***p < 0.01$

Table 11: **Effect of cross-holdings on generic's abnormal returns around settlement**

This table presents estimates of the effect of cross-holdings on generic filers' abnormal returns around the date in which the generic filer of Paragraph IV and the brand enter into a settlement agreement. The dependent variable is the cumulative market adjusted returns (winterized at 1% and 99% percentiles) for public generic firms over the window [−3, +3]. In cases in which at least two generic firms file the same Paragraph IV application and settle with the brand in the same date, we take the market value-weighted means of abnormal return. The event denotes the date on which the two parties settle. We measure cross-holdings as of the beginning of the quarter in which a Paragraph IV application is filed. Columns (1)–(10) present coefficients estimated from linear probability regressions. In columns (1)–(5), only ownership of index funds that belong to the top N generic shareholders is used to calculate cross-holdings. See Table 5 and 7 for descriptions of institutional cross-holdings and other independent variables. Columns (6)–(10) present coefficients estimated from instrumental variable (IV) regressions. Starting from September 2003, 25 fund families experienced large outflows of capital as a consequence of a settlement regarding alleged illegal trading. *Top N generic cross-holdings* is instrumented with *Treatment*, which is an indicator variable set equal to one if *Brand Scandal%* exceeds 10%. *Brand Scandal%* is the sum of brand ownerships of scandal funds that belong to the top 30 generic institutional shareholders as a fraction of the sum of brand ownerships of all top 30 generic institutional shareholders as of September 2003. Standard errors are in parentheses and are clustered at the U.S. Federal District Court level.

	Index funds					IV Estimation				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Top 10	0.008					−0.247				
	(0.029)					(0.979)				
Top 15		0.007					−0.063			
		(0.024)					(0.188)			
Top 20			0.004					−0.045		
			(0.022)					(0.137)		
Top 25				0.003					−0.044	
				(0.021)					(0.132)	
Top 30					0.003					−0.041
					(0.022)					(0.123)
Generic public						−0.035	−0.019	−0.017	−0.017	−0.017
						(0.101)	(0.025)	(0.018)	(0.018)	(0.017)
Generic indexed	−0.008	−0.008	−0.008	−0.008	−0.008					
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)					
log (drug sales)	−0.007	−0.007	−0.007	−0.007	−0.007	−0.033	−0.015	−0.013	−0.013	−0.012
	(0.021)	(0.021)	(0.021)	(0.021)	(0.021)	(0.134)	(0.040)	(0.033)	(0.033)	(0.032)
Constant	0.054	0.054	0.117	0.057	0.057	0.731	0.322	0.278	0.282	0.275
	(0.200)	(0.203)	(0.211)	(0.206)	(0.207)	(2.609)	(0.688)	(0.548)	(0.556)	(0.537)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
District court FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Trade name FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	400	400	400	400	400	353	353	353	353	353
Adj. R^2	0.35	0.35	0.35	0.35	0.35					

$*p < 0.10, **p < 0.05, ***p < 0.01$

Table 12: **Effect of cross-holdings on the probability of settled generic manfuacurers marketing drugs within five years**

This table presents the estimates of the effect of cross-holdings on the timing of settled generic manufacturers to market drugs. The dependent variable is an indicator coded as one if a generic manufacturer markets a generic version of branded drugs within five years after entering into settlement agreements, and zero otherwise. We only include Paragraph IV litigations in which the brand and generic(s) settle at least five years before June 8, 2017. We measure cross-holdings as of the beginning of the quarter in which a patent litigation lawsuit is filed by the brand. *Excl* is an indicator coded as one if a generic manufacturer is granted with the 180 day exclusivity by the FDA. During the exclusivity period, other generic manufacturers are not allowed to market the same generic drug. We measure cross-holdings as of the beginning of the quarter in which a Paragraph IV application is filed. Columns (1)–(10) present coefficients estimated from linear probability regressions. In columns (1)–(5), only ownership of index funds that belong to the top N generic shareholders is used to calculate cross-holdings. See Table 5 and 7 for descriptions of the construction of cross-holdings and other independent variables. Columns (6)–(10) present coefficients estimated from instrumental variable (IV) regressions. Starting from September 2003, 25 fund families experienced large outflows of capital as a consequence of a settlement regarding alleged illegal trading. *Top N generic cross-holdings* is instrumented with *Treatment*, which is an indicator variable set equal to one if *Brand Scandal%* exceeds 10%. *Brand Scandal%* is the sum of brand ownerships of scandal funds that belong to the top 30 generic institutional shareholders as a fraction of the sum of brand ownerships of all top 30 generic institutional shareholders as of September 2003. Standard errors are in parentheses and are clustered at the U.S. Federal District Court level.

	Index funds					IV Estimation				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Top 10	−0.205					−0.071				
	(0.328)					(0.217)				
Top 10 × Excl	−0.614***					−1.056				
	(0.195)					(0.793)				
Top 15		−0.236					−0.065			
		(0.332)					(0.199)			
Top 15 × Excl		−0.597***					−1.079			
		(0.208)					(0.807)			
Top 20			−0.260					−0.062		
			(0.317)					(0.189)		
Top 20 × Excl			−0.583**					−1.079		
			(0.212)					(0.806)		
Top 25 cross-holdings				−0.282					−0.060	
				(0.312)					(0.185)	
Top 25 × Excl				−0.558***					−1.061	
				(0.197)					(0.791)	
Top 30					−0.290					−0.059
					(0.288)					(0.182)
Top 30 × Excl					−0.515***					−1.003
					(0.185)					(0.749)
Excl	0.295*	0.294*	0.293*	0.293*	0.294*	0.300**	0.300**	0.300**	0.300**	0.300**
	(0.159)	(0.160)	(0.160)	(0.160)	(0.161)	(0.122)	(0.123)	(0.123)	(0.123)	(0.123)
log (drug sales)	−0.113	−0.115	−0.115	−0.116	−0.116	−0.013	−0.014	−0.014	−0.015	−0.015
	(0.123)	(0.125)	(0.125)	(0.125)	(0.124)	(0.072)	(0.073)	(0.073)	(0.073)	(0.073)
Constant	1.144	1.152	1.186	1.194	1.200	0.712	0.725	0.728	0.730	0.731
	(1.417)	(1.450)	(1.456)	(1.452)	(1.450)	(0.763)	(0.777)	(0.779)	(0.781)	(0.780)
Index status	Yes	Yes	Yes	Yes	Yes					
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Court FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Trade Name FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	629	629	629	629	629	513	513	513	513	513
Adj. R^2	0.20	0.20	0.20	0.20	0.20					

$*p < 0.10, **p < 0.05, ***p < 0.01$

Table 13: **Effect of cross-holdings on other generics' abnormal returns around settlement**

This table presents estimates of the effect of cross-holdings on abnormal returns of other potential entrants around the date in which one generic filer challenging the monopoly status of a drug and the brand enter into a settlement agreement. Potential entrants are generic manufacturers that have entered into patent infringement litigation but the case was still pending upon settlement between the brand and another generic filer challenging the same branded drug. The dependent variable is the cumulative market adjusted returns (winsorized at 1% and 99% percentiles) for public generic firms over the window [−3, +3]. In cases in which at least two generic firms file the same Paragraph IV application, we take the market value-weighted means of abnormal return. The event denotes the date on which the two parties settle. *First* is an indicator coded as one if the generic manufacturer is the first challenger based on *pseudo entry date*, which is the earliest of: (1) the date an ANDA was filed, (2) the date the brand incumbent was noticed by the ANDA filer(s), and (3) the date the brand suits the ANDA filer. We measure cross-holdings as of the beginning of the quarter in which a patent litigation lawsuit is filed by the brand. Columns (1)–(5) present coefficients estimated from linear probability regressions. In columns (1)–(5), only ownership of index funds that belong to the top N generic shareholders is used to calculate cross-holdings. See Tables 5 and 7 for descriptions of institutional cross-holdings and other independent variables. Columns (6)–(10) present coefficients estimated from instrumental variable (IV) regressions. Starting from September 2003, 25 fund families experienced large outflows of capital as a consequence of a settlement regarding alleged illegal trading. *Top N generic cross-holdings* is instrumented with *Treatment*, which is an indicator variable set equal to one if *Brand Scandal%* exceeds 10%. *Brand Scandal%* is the sum of brand ownerships of scandal funds that belong to the top 30 generic institutional shareholders as a fraction of the sum of brand ownerships of all top 30 generic institutional shareholders as of September 2003. Standard errors are in parentheses and are clustered at the U.S. Federal District Court level.

	Index funds					IV Estimation				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Top 10	−0.059***					0.042				
	(0.011)					(0.069)				
Top 10 × First	−0.072*					−0.062*				
	(0.040)					(0.037)				
Top 15		−0.052***					0.031			
		(0.011)					(0.052)			
Top 15 × First		−0.075*					−0.053*			
		(0.043)					(0.029)			
Top 20			−0.052***					0.028		
			(0.011)					(0.047)		
Top 20 × First			−0.075					−0.052*		
			(0.044)					(0.028)		
Top 25				−0.051***					0.028	
				(0.010)					(0.047)	
Top 25 × First				−0.062*					−0.049*	
				(0.036)					(0.027)	
Top 30					−0.051***					0.026
					(0.009)					(0.044)
Top 30 × First					−0.064*					−0.048*
					(0.036)					(0.026)
First	−0.010	−0.010	−0.010	−0.010	−0.010	−0.008	−0.008	−0.008	−0.008	−0.008
	(0.008)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)
log (drug sales)	0.009	0.009	0.009	0.009	0.009	0.020**	0.020**	0.020**	0.020**	0.020**
	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
Constant	−0.244*	−0.250*	−0.246*	−0.246*	−0.246*	−0.465***	−0.467***	−0.465***	−0.466***	−0.465***
	(0.121)	(0.120)	(0.120)	(0.120)	(0.119)	(0.115)	(0.119)	(0.118)	(0.119)	(0.118)
Index status	Yes	Yes	Yes	Yes	Yes					
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
District court FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Trade name FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	604	604	604	604	604	503	503	503	503	503
Adj. R^2	0.15	0.15	0.15	0.15	0.15					

$*p < 0.10, **p < 0.05, ***p < 0.01$

Appendix A. Examples of pay-for-delay settlements

Since 2001, the Federal Trade Commission (FTC) has filed a number of lawsuits to stop the so called "pay-for-delay" settlement agreements signed between brand and generic manufactures.

Example 1. Endo Pharmaceuticals vs. other generics

On March 30, 2016, FTC filed a complaint in the U.S. District Court for the Eastern District of Pennsylvania alleging that Endo Pharmaceuticals Inc. and several other drug companies violated antitrust laws by using pay-for-delay settlements to block consumers' access to lower-cost generic versions of Opana ER and Lidoderm.

The complaint charges that:

- In 2010, Endo and Impax illegally agreed that until January 2013, Endo would not compete by marketing an authorized generic version of Endo's Opana ER.[19] In exchange, Endo paid Impax more than $112 million, including $10 million under a development and co-promotion agreement signed during the same time period. Endo used this period of delay to transition patients to a new formulation of Opana ER, thereby maintaining its monopoly power even after Impax's generic entry. In 2010, Opana ER sales in the United States exceeded $250 million.

- In May 2012, Endo and its partners, Teikoku Seiyaku Co. Ltd. and Teikoku Pharma USA, Inc., illegally agreed with Watson Laboratories, Inc. that until September 2013, Watson would not compete with Endo and Teikoku by marketing a generic version of Endo's Lidoderm patch. In exchange, Endo paid Watson hundreds of millions of dollars, including $96 million of free branded Lidoderm product that Endo and Teikoku gave to Watson. As a result, Endo illegally maintained its monopoly over Lidoderm. In 2012, Lidoderm sales in the United States approached $1 billion.

[19] Authorized generics are prescription drugs produced by brand pharmaceutical companies and marketed under a private label, at generic prices. The courts have ruled that 180 day exclusivity does not preclude a brand-name company from entering with its own generic because it already has approval for its product; therefore, it can sell an authorized generic during that exclusivity period.

- Endo and Watson illegally agreed that, for 7.5 months after September 2013 (including the 180 day first-filer exclusivity period for which Watson was eligible), Endo would not compete by marketing an authorized generic version of Lidoderm. This agreement left Watson as the only generic version of Lidoderm on the market, substantially reducing competition and increasing prices for generic lidocaine patches. As a result, Watson made hundreds of millions of dollars more in generic Lidoderm sales.Brand manufacturers have been able to sidestep competition by offering patent settlements that pay generic companies not to bring lower-cost alternatives to market. According to an FTC study, these anticompetitive deals cost consumers and taxpayers $3.5 billion in higher drug costs every year.

Example 2. Solvay Pharmaceuticals vs. Watson & Par

On January 28, 2009, FTC filed a complaint in the U.S. District Court for the Central District of California challenging agreements in which Solvay Pharmaceuticals, Inc. paid generic drug makers Watson Pharmaceuticals, Inc. and Par Pharmaceutical Companies, Inc. to delay generic competition to Solvay's branded testosterone-replacement drug AndroGel. The annual sales of AndroGel was more than $400 million. The complaint was filed jointly with the Office of the Attorney General of California.

The complaint is summarized as follows.

- The court action seeks to promote competition between Solvay and generic drug makers that had sought to introduce generic versions of the branded prescription drug AndroGel. AndroGel, Solvay's second highest selling pharmaceutical product, is a pharmaceutical gel containing synthetic testosterone. It is approved for testosterone replacement therapy in men with low testosterone levels, which often are associated with advancing age, certain cancers, and HIV/AIDS, among other conditions.

- In May 2003, Watson and Paddock, which partnered with Par, each filed applications for FDA approval to market generic versions of AndroGel. Solvay's patent on Androgel

had been issued in January 2003, with an expiration date of August 2020. By early 2006, Watson had received final approval to market its generic product. According to the complaint, it was well-known that if Watson or Par were to enter with cheaper generic versions of AndroGel, Solvay's AndroGel sales would plummet and consumers would benefit from the lower prices.

- The complaint alleges that Solvay, realizing the devastating effect generic entry would have on its AndroGel franchise, acted unlawfully to eliminate this threat: Solvay paid Watson and Par a share of its AndroGel profits to abandon their patent challenges and agree to delay generic entry until 2015. As a result, the complaint states that the defendants are cooperating on the sale of AndroGel and sharing the monopoly profits, rather than competing.

Example 3. Cephalon vs. Teva

On February 13, 2008, The FTC filed a complaint in the U.S. District of Columbia against Cephalon, Inc., a pharmaceutical company based in Frazer, Pennsylvania, for a course of anticompetitive conduct that is preventing competition to its branded drug Provigil. Provigil is a prescription drug approved to treat excessive sleepiness in patients with sleep apnea, narcolepsy, and shift-work sleep disorder. In the year before generic entry, Provigil sales in the United States exceeded $1 billion.

The complaint alleges that:

- Cephalon entered into agreements with four generic drug manufacturers that each planned to sell a generic version of Provigil. Each of these companies had challenged the only remaining patent covering Provigil, one relating to the size of particles used in the product. The complaint charges that Cephalon was able to induce each of the generic companies to abandon its patent challenge and agree to refrain from selling a generic version of Provigil until 2012 by agreeing to pay the companies a total amount in excess of $200 million.

- By late 2005, generic competition to Provigil appeared imminent. Several years earlier, on the first day permitted by regulation, four companies — Teva Pharmaceuticals USA, Inc. (Teva), Ranbaxy Pharmaceuticals, Inc. (Ranbaxy), Mylan Pharmaceuticals Inc. (Mylan), and Barr Laboratories, Inc. (Barr) — submitted applications with the FDA to market their own generic versions of Provigil. Each generic manufacturer had either designed around, or challenged the validity of, the only remaining patent on Provigil – a narrow formulation patent related to the size of the particles used in the product. Cephalon filed patent infringement lawsuit against each of the generic companies. By late 2005, however, the litigation was still pending and Cephalon, the generic firms, and Wall Street analysts all expected generic Provigil entry in the near term.

- Facing the prospect of billions of dollars in lost revenue, Cephalon entered into agreements through which it compensated each of the four generic companies to settle the patent litigation and agree to forgo generic entry until April 2012, the FTC alleges. These agreements contained payments to the generic companies totaling more than $200 million. No other generic company could compete with branded Provigil, unless and until all four "first filers" either relinquished their marketing exclusivity or 180 days after one of them entered the market. Cephalon therefore was able to erect a barrier that protected it from other companies that have also sought approval to sell generic Provigil.

On May 28, 2015, FTC has reached a settlement resolving the Commission's antitrust suit charging Cephalon, Inc. The settlement ensures that Teva, the largest generic drug manufacturer in the world, which had acquired Cephalon in 2012, will make a total of $1.2 billion available to compensate purchasers, including drug wholesalers, pharmacies, and insurers, who overpaid because of Cephalon's illegal conduct. As part of the settlement, Teva also has agreed to a prohibition on the type of anticompetitive patent settlements that Cephalon used to artificially inflate the price of Provigil.

Table A.1: **Paragraph IV litigation outcomes across U.S. Federal District Courts**

This table presents the distributions of the challenge outcomes at the patent-level across the U.S. Federal District Courts following the filing of an ANDA under Paragraph IV certification with the FDA. We start with cases active as of November 1, 2003, and end our sample with cases for which the challenge outcomes were known by July 23, 2016. Active cases refer to those that had a pending lawsuit. We define a challenge at the level of the date that a brand files a patent infringement lawsuit against a generic manufacturer challenging the formulation (e.g., tablet, capsule, and injection) of a trade name (i.e., the name of the branded drug).

Federal District Court	Challenges	Patents	Settlements	Brand wins	Brand loses	Unknown	Settlements	Patents/ challenge
California Central	16	39	35	0	4	0	89.7%	2.44
California Northern	12	50	47	1	2	0	94.0%	4.17
Colorado	2	9	9	0	0	0	100.0%	4.50
Delaware	379	1,069	805	121	113	30	75.3%	2.82
District of Columbia	4	4	4	0	0	0	100.0%	1.00
Florida Middle	2	2	2	0	0	0	100.0%	1.00
Florida Southern	8	15	10	4	1	0	66.7%	1.88
Georgia Northern	7	12	8	3	1	0	66.7%	1.71
Illinois Northern	55	138	114	12	12	0	82.6%	2.51
Indiana Southern	44	111	81	27	3	0	73.0%	2.52
Maryland	29	52	51	0	1	0	98.1%	1.79
Massachusetts	14	25	25	0	0	0	100.0%	1.79
Michigan Eastern	9	24	18	0	6	0	75.0%	2.67
Michigan Western	1	2	2	0	0	0	100.0%	2.00
Minnesota	5	11	9	0	2	0	81.8%	2.20
Nevada	8	45	20	23	2	0	44.4%	5.63
New Jersey	432	1,097	862	114	113	8	78.6%	2.54
New York Eastern	7	10	7	0	3	0	70.0%	1.43
New York Southern	118	395	356	28	11	0	90.1%	3.35
North Carolina Eastern	11	19	15	4	0	0	78.9%	1.73
North Carolina Middle	4	13	9	4	0	0	69.2%	3.25

Federal District Court	Challenges	Patents	Settlements	Brand wins	Brand loses	Unknown	Settlements	Patents/ challenge
Ohio Northern	1	12	0	2	10	0	0.0%	12.00
Ohio Southern	2	9	9	0	0	0	100.0%	4.50
Pennsylvania Eastern	18	55	38	0	17	0	69.1%	3.06
Pennsylvania Western	1	4	0	4	0	0	0.0%	4.00
Pennsylvania Middle	1	3	3	0	0	0	100.0%	3.00
Puerto Rico	1	3	3	0	0	0	100.0%	3.00
Texas Eastern	5	13	8	3	2	0	61.5%	2.60
Texas Northern	7	14	14	0	0	0	100.0%	2.00
Vermont	1	1	0	1	0	0	0.0%	1.00
Virginia Eastern	12	21	11	1	9	0	52.4%	1.75
West Virginia North	12	25	16	5	4	0	84.2%	2.08
N/A	6	9	8	0	0	1	88.9%	1.50
Brand does not suit	105	286						
Total	1,339	3,597	2,599	357	316	39	72.3%	2.69

Table A.2: **Paragraph IV litigation outcomes across years**

This table presents the distributions of the challenge outcomes at the patent-level across years following the filing of an ANDA under Paragraph IV certification with the FDA. We start with cases active as of November 1, 2003 and end our sample with cases for which the challenge outcomes were known by July 23, 2016. Active cases refer to those that had a pending lawsuit. We define a challenge at the level of the date that a brand files a patent infringement lawsuit against a generic manufacturer challenging the formulation (e.g., tablet, capsule, and injection) of a trade name (i.e., the name of the branded drug).

Federal District Court	Challenges	Patents	Settlements	Brand wins	Brand loses	Unknown	Settlements	Patents/challenge
1999	5	9	2	1	6	0	0	1.80
2000	12	21	7	1	13	0	0	1.75
2001	21	107	101	3	2	0	1	5.10
2002	21	63	59	0	4	0	0	3.00
2003	68	194	159	11	15	0	9	2.85
2004	59	137	104	18	4	7	4	2.32
2005	65	153	101	36	15	0	1	2.35
2006	73	153	115	28	9	0	1	2.10
2007	109	304	212	33	28	27	4	2.79
2008	101	253	195	32	26	0	0	2.50
2009	134	381	289	41	48	0	3	2.84
2010	191	504	415	59	26	0	4	2.64
2011	125	344	269	33	40	2	0	2.75
2012	91	271	206	26	37	2	0	2.98
2013	59	174	139	22	10	1	2	2.95
2014	53	153	131	8	14	0	0	2.89
2015	4	27	27	0	0	0	0	6.75
NA	148	349	68	5	19	0	257	2.36
Total	1,339	3,597	2,599	357	316	39	286	2.69

Table A.3: **List of implicated funds**

This table presents the mutual fund families with known investigations and/or settlements related to market timing or late trading. The news date is the first date in which an investigation is mentioned in the press. If initial news date is missing, we use the date on which the fund family settled with the SEC. Sources: Morningstar.com, The Wall Street Journal, the SEC, and Wikipedia.

Name of Fund Family	News Date
Alliance Capital	September 30, 2003
Bear Stearns	March 16, 2006
Bank One	September 3, 2003
Canary Capital Partners	September 3, 2003
Columbia Management Advisors	February 9, 2005
Deutsche Bank	May 11, 2003
Edward Jones Investments	December 22, 2004
Federated Investors	October 22, 2003
Franklin Templeton	September 3, 2003
Fred Alger Management	October 3, 2003
Fremont Group	November 24, 2003
Goldman Sachs	September 4, 2003
Invesco	October 8, 2004
Janus Capital Group	September 3, 2003
Marsh & McLennan Companies	September 19, 2003
Morgan Stanley	January 25, 2005
MFS Investment Management	December 9, 2003
Nations Funds (Bank of America)	September 3, 2003
Pilgrim Baxter (PBHG)	November 13, 2003
PIMCO	February 13, 2004
Prudential Securities	unknown
Putnam Investments	September 19, 2003
RS Investments	March 3, 2004
Seligman	January 7, 2004
Strong Capital Management	September 3, 2003
Wachovia	August 4, 2004
Waddell & Reed	unknown

Table A.4: **Effect of cross-holdings on the likelihood of settlement: IV Regressions, First Stage**

This table presents the first-stage regression of the instrumental variable (IV) estimation. The sample period starts from patent infringement lawsuits occurring in the fourth quarter of 2003. The dependent variable is cross-holdings measured as of the beginning of the quarter in which a Paragraph IV application is filed. Starting from September 2003, 25 fund families experienced large outflows of capital as a consequence of a settlement regarding alleged illegal trading. *Treatment* is an indicator variable set equal to one if *Brand Scandal%* is greater than 10%, and zero otherwise. *Brand Scandal%* is the sum of brand ownerships of scandal funds that belong to the top 30 generic institutional shareholders as a fraction of the sum of brand ownerships of all top 30 generic institutional shareholders as of September 2003. Standard errors are in parentheses and are clustered at the U.S. Federal District Court level. See Table 5 for descriptions of the constructions of institutional cross-holdings and other independent variable. Standard errors are clustered at the U.S. Federal District Court level.

	Cross-holdings					Rankings				
Top N	10	15	20	25	30	10	15	20	25	30
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Treatment	0.157***	0.177***	0.182***	0.185***	0.187***	0.444***	0.245***	0.441***	0.440***	0.439***
	(0.015)	(0.023)	(0.023)	(0.027)	(0.028)	(0.050)	(0.029)	(0.054)	(0.055)	(0.055)
log (drug sales)	−0.008	−0.012	−0.012	−0.014	−0.014	−0.022	−0.013	−0.024	−0.024	−0.024
	(0.012)	(0.011)	(0.010)	(0.011)	(0.011)	(0.024)	(0.013)	(0.023)	(0.023)	(0.023)
Non-top drug	−0.111	−0.170	−0.168	−0.187	−0.194	−0.310	−0.186	−0.348	−0.350	−0.351
	(0.160)	(0.149)	(0.137)	(0.146)	(0.147)	(0.339)	(0.175)	(0.319)	(0.319)	(0.319)
Group	0.178***	0.174***	0.170***	0.171***	0.174***	0.327**	0.170**	0.321**	0.321**	0.322**
	(0.049)	(0.052)	(0.057)	(0.057)	(0.055)	(0.147)	(0.082)	(0.145)	(0.146)	(0.145)
Constant	0.171	0.204	0.188	0.206	0.202	0.325	0.186	0.360	0.362	0.357
	(0.169)	(0.171)	(0.175)	(0.186)	(0.196)	(0.470)	(0.251)	(0.448)	(0.449)	(0.452)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
District court FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Generic firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Generic firm FE × Group	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Brand firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	1,042	1,042	1,042	1,042	1,042	1,042	1,042	1,042	1,042	1,042
Adj R^2	0.54	0.58	0.58	0.59	0.59	0.66	0.65	0.66	0.66	0.66
F-stat	102.99	58.53	63.38	46.57	43.32	78.25	70.22	67.7	64.9	63.45

Table A.5: **Effect of cross-holdings (rankings) on brand's abnormal returns around settlement**

This table presents estimates of the effect of cross-holding rankings on brand companies' abnormal returns around the date on which the generic filer of Paragraph IV and the brand enter into a settlement agreement. The dependent variable is the cumulative market adjusted returns (winsorized at 1% and 99% percentiles) for public brand firms over the window [−3, +3]. The event denotes the date in which the two parties settle. We measure cross-holdings as of the beginning of the quarter in which a Paragraph IV application is filed. We rank top N ($N = 10, 15, 20, 25, 30$) generic cross-holdings in an ascending order and scale the resulting ranking by the total number of lawsuits. Columns (1)–(10) present coefficients estimated from linear probability regressions. In columns (1)–(5), only ownership of index funds that belong to the top N generic shareholders is used to calculate cross-holdings. See Table 5 and 7 for descriptions of the construction of institutional cross-holdings and other independent variables. Columns (6)–(10) present coefficients estimated from instrumental variable (IV) regressions. Starting from September 2003, 25 fund families experienced large outflows of capital as a consequence of a settlement regarding alleged illegal trading. The rankings of top N generic cross-holdings is instrumented with *Treatment*, which is an indicator variable set equal to one if *Brand Scandal%* exceeds 10%. *Brand Scandal%* is the sum of brand ownerships of scandal funds that belong to the top 30 generic institutional shareholders as a fraction of the sum of brand ownerships of all top 30 generic institutional shareholders as of September 2003. Standard errors are in parentheses and are clustered at the U.S. Federal District Court level.

	Index funds					IV Estimation				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Top 10	0.020**					0.046**				
	(0.008)					(0.022)				
Top 15		0.021**					0.046**			
		(0.008)					(0.022)			
Top 20			0.021**					0.046**		
			(0.008)					(0.022)		
Top 25				0.021**					0.046**	
				(0.008)					(0.022)	
Top 30					0.021**					0.046**
					(0.007)					(0.022)
Brand public						0.033***	0.033***	0.033***	0.033***	0.033***
						(0.012)	(0.012)	(0.012)	(0.012)	(0.012)
Brand indexed	0.015***	0.016***	0.016***	0.016***	0.016***					
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)					
log (drug sales)	−0.002	−0.002	−0.002	−0.002	−0.002	−0.001	−0.001	−0.001	−0.001	−0.001
	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)	(0.007)	(0.008)	(0.008)	(0.008)	(0.008)
Constant	0.012	0.010	0.010	0.010	0.010	0.112	0.110	0.112	0.112	0.112
	(0.150)	(0.149)	(0.150)	(0.149)	(0.149)	(0.111)	(0.115)	(0.116)	(0.116)	(0.116)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
District court FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Trade name FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	486	486	486	486	486	426	426	426	426	426
Adj. R^2	0.16	0.16	0.16	0.16	0.16					

$*p < 0.10, **p < 0.05, ***p < 0.01$

Table A.6: **Effect of cross-holdings (rankings) on generic's abnormal returns around settlement**

This table presents estimates of the effect of cross-holding rankings on the generic manufacturers' abnormal returns around the date on which the generic filer of Paragraph IV and the brand enter into a settlement agreement. The dependent variable is the cumulative market adjusted returns (winsorized at 1% and 99% percentiles) for public generic firms over the window [−3, +3]. The event denotes the date in which the two parties settle. When at least two generic firms file the same Paragraph IV application and settle with the brand in the same date, we take the market value-weighted means of abnormal return. We measure cross-holdings as of the beginning of the quarter in which a Paragraph IV application is filed. We rank top N ($N = 10, 15, 20, 25, 30$) generic cross-holdings in an ascending order and scale the resulting ranking by the total number of lawsuits. Columns (1)–(10) present coefficients estimated from linear probability regressions. In columns (1)–(5), only ownership of index funds that belong to the top N generic shareholders is used to calculate cross-holdings. See Table 5 and 7 for descriptions of the construction of institutional cross-holdings and other independent variables. Columns (6)–(10) present coefficients estimated from instrumental variable (IV) regressions. Starting from September 2003, 25 fund families experienced large outflows of capital as a consequence of a settlement regarding alleged illegal trading. The ranking of top N generic cross-holdings is instrumented with *Treatment*, which is an indicator variable set equal to one if *Brand Scandal* exceeds 10%. *Brand Scandal* is the sum of brand ownerships of scandal funds that belong to the top 30 generic institutional shareholders as a fraction of the sum of brand ownerships of all top 30 generic institutional shareholders as of September 2003. Standard errors are in parentheses and are clustered at the U.S. Federal District Court level.

	Index funds					IV Estimation				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Top 10	0.007					−0.022				
	(0.013)					(0.072)				
Top 15		0.006					−0.020			
		(0.013)					(0.066)			
Top 20			0.006					−0.019		
			(0.013)					(0.063)		
Top 25				0.006					−0.019	
				(0.013)					(0.063)	
Top 30					0.006					−0.019
					(0.013)					(0.064)
Generic public						−0.019	−0.018	−0.018	−0.018	−0.018
						(0.025)	(0.023)	(0.022)	(0.022)	(0.022)
Generic indexed	−0.006	−0.006	−0.007	−0.007	−0.007					
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)					
log (drug sales)	−0.006	−0.006	−0.006	−0.006	−0.006	−0.011	−0.011	−0.011	−0.011	−0.011
	(0.021)	(0.021)	(0.021)	(0.021)	(0.021)	(0.030)	(0.029)	(0.029)	(0.029)	(0.029)
Constant	0.107	0.107	0.108	0.109	0.109	0.238	0.232	0.230	0.231	0.231
	(0.211)	(0.211)	(0.212)	(0.212)	(0.212)	(0.464)	(0.439)	(0.430)	(0.432)	(0.434)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
District court FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Trade name FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	397	397	397	397	397	351	351	351	351	351
Adj. R^2	0.33	0.33	0.33	0.33	0.33					

$*p < 0.10, **p < 0.05, ***p < 0.01$

Table A.7: **Effect of cross-holdings (rankings) on the probabiity of settled generic manufacturers marketing drugs within five years**

This table presents the estimates of the effect of cross-holdings on the timing of settled generic manufacturers to market drugs. The dependent variable is an indicator coded as one if a generic manufacturer markets a generic version of branded drugs within five years after entering into settlement agreements, and zero otherwise. We only include Paragraph IV litigations in which the brand and generic(s) settle at least five years before June 8, 2017. We measure cross-holdings as of the beginning of the quarter in which a patent litigation lawsuit is filed by the brand. Excl is an indicator coded as one if a generic manufacturer is granted with the 180 day exclusivity by the FDA. During the exclusivity period, other generic manufacturers are not allowed to market the same generic drug. Columns (1)–(10) present coefficients estimated from linear probability regressions. In columns (1)–(5), only ownership of index funds that belong to the top N generic shareholders is used to calculate cross-holdings. See Table 7 for descriptions of the construction of institutional cross-holdings and other independent variables. Columns (6)–(10) present coefficients estimated from instrumental variable (IV) regressions. Starting from September 2003, 25 fund families experienced large outflows of capital as a consequence of a settlement regarding alleged illegal trading. *Top N generic cross-holdings* is instrumented with *Treatment*, which is an indicator variable set equal to one if *Brand Scandal%* exceeds 10%. *Brand Scandal%* is the sum of brand ownerships of scandal funds that belong to the top 30 generic institutional shareholders as a fraction of the sum of brand ownerships of all top 30 generic institutional shareholders as of September 2003. Standard errors are in parentheses and are clustered at the U.S. Federal District Court level.

	Index funds					IV Estimation				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Top 10	−0.252					−0.064				
	(0.626)					(0.073)				
Top 10 × Excl	−0.580***					−0.661*				
	(0.181)					(0.355)				
Top 15		−0.315					−0.064			
		(0.702)					(0.073)			
Top 15 × Excl		−0.576***					−0.662*			
		(0.187)					(0.355)			
Top 20			−0.340					−0.064		
			(0.692)					(0.073)		
Top 20 × Excl			−0.577***					−0.662*		
			(0.190)					(0.355)		
Top 25				−0.386					−0.064	
				(0.704)					(0.073)	
Top 25 × Excl				−0.569***					−0.662*	
				(0.189)					(0.356)	
Top 30					−0.394					−0.064
					(0.634)					(0.073)
Top 30 × Excl					−0.560***					−0.662*
					(0.187)					(0.357)
Excl	0.317*	0.315*	0.314*	0.313*	0.313*	0.300**	0.300**	0.300**	0.300**	0.300**
	(0.163)	(0.164)	(0.163)	(0.163)	(0.165)	(0.124)	(0.124)	(0.124)	(0.124)	(0.124)
log(drug sales)	−0.113	−0.114	−0.114	−0.114	−0.114	−0.011	−0.012	−0.012	−0.012	−0.012
	(0.129)	(0.129)	(0.129)	(0.129)	(0.129)	(0.072)	(0.072)	(0.072)	(0.072)	(0.072)
Constant	1.356	1.418	1.437	1.476	1.477	0.659	0.664	0.664	0.664	0.664
	(1.646)	(1.651)	(1.649)	(1.633)	(1.588)	(0.771)	(0.773)	(0.773)	(0.773)	(0.773)
Index status	Yes	Yes	Yes	Yes	Yes					
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
District court FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Trade name FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	625	625	625	625	625	511	511	511	511	511
Adj. R^2	0.20	0.20	0.20	0.20	0.20					

$*p < 0.10, **p < 0.05, ***p < 0.01$

Table A.8: **Effect of cross-holdings on the probability of settled generic manufacturers marketing drugs within three years**

This table presents the estimates of the effect of cross-holdings on the timing of settled generic manufacturers to market drugs. The dependent variable is an indicator coded as one if a generic manufacturer markets a generic version of branded drugs within five years after entering into settlement agreements, and zero otherwise. We only include Paragraph IV litigations in which the brand and generic(s) settle at least five years before June 8, 2017. We measure cross-holdings as of the beginning of the quarter in which a patent litigation lawsuit is filed by the brand. *Excl* is an indicator coded as one if a generic manufacturer is granted with the 180 day exclusivity by the FDA. During the exclusivity period, other generic manufacturers are not allowed to market the same generic drug. Columns (1)–(10) present coefficients estimated from linear probability regressions. In columns (1)–(5), only ownership of index funds that belong to the top N generic shareholders is used to calculate cross-holdings. See Table and 5 and 7 for descriptions of the construction of institutional cross-holdings and other independent variables. Columns (6)–(10) present coefficients estimated from instrumental variable (IV) regressions. Starting from September 2003, 25 fund families experienced large outflows of capital as a consequence of a settlement regarding alleged illegal trading. *Top N generic cross-holdings* is instrumented with *Treatment*, which is an indicator variable set equal to one if *Brand Scandal%* exceeds 10%. *Brand Scandal%* is the sum of brand ownerships of scandal funds that belong to the top 30 generic institutional shareholders as a fraction of the sum of brand ownerships of all top 30 generic institutional shareholders as of September 2003. Standard errors are in parentheses and are clustered at the U.S. Federal District Court level.

Top N	10	15	20	25	30	10	15	20	25	30
	Index funds					IV Estimation				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Panel A: Raw measure of cross-holdings									
Top N × Excl	−0.449***	−0.332**	−0.328**	−0.319**	−0.323**	−0.344	−0.325	−0.324	−0.313	−0.301
	(0.160)	(0.161)	(0.156)	(0.135)	(0.124)	(0.433)	(0.410)	(0.411)	(0.395)	(0.380)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	838	838	838	838	838	712	712	712	712	712
Adj. R^2	0.23	0.23	0.23	0.23	0.23					
	Panel B: Rankings									
Top N × Excl	−0.438*	−0.402*	−0.404	−0.399*	−0.397*	−0.156	−0.156	−0.156	−0.156	−0.156
	(0.226)	(0.235)	(0.240)	(0.233)	(0.229)	(0.209)	(0.209)	(0.210)	(0.209)	(0.209)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	838	838	838	838	838	712	712	712	712	712
Adj. R^2	0.23	0.23	0.23	0.23	0.23					
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
District court FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Trade name FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

$*p < 0.10, **p < 0.05, ***p < 0.01$

Table A.9: **Effect of the first filer on the probability of generic manufacturers being eligible for the 180 day exclusivity**

This table presents linear probability model estimates of the effect of the first filer of an ANDA under Paragraph IV certification with the FDA on the probability of generic manufacturers being eligible for the 180 day exclusivity. The dependent variable (Excl) is an indicator coded as one if a generic manufacturer is granted with the 180 day exclusivity by the FDA. During the exclusivity period, other generic manufacturers are not allowed to market the same generic drug. *First* is an indicator coded as one if the generic manufacturer is ranked as the first filer based on *pseudo entry date*, which is the earliest of: (1) the date an ANDA was filed, (2) the date the brand incumbent was noticed by the ANDA filer(s), and (3) the date the brand suits the ANDA filer. See Table 5 for descriptions of other independent variables. Standard errors are clustered at the U.S. Federal District Court level.

	(1)	(2)	(3)	(4)
First	0.121***	0.118***	0.102***	0.131***
	(0.021)	(0.016)	(0.022)	(0.020)
log (drug sales)	−0.031**	−0.040**	−0.046***	−0.011
	(0.013)	(0.018)	(0.010)	(0.051)
Non-top drug	−0.400**	−0.512**	−0.593***	
	(0.174)	(0.224)	(0.125)	
Constant	0.492**	0.531**	0.549***	0.138
	(0.188)	(0.212)	(0.159)	(0.501)
Year FE		Yes	Yes	Yes
Court FE		Yes	Yes	Yes
Generic firm FE			Yes	
Trade name FE				Yes
N	1,250	1,180	1,180	1,180
Adj. R^2	0.04	0.08	0.10	0.23

$*p < 0.10, **p < 0.05, ***p < 0.01$

Table A.10: **Effect of cross-holdings (rankings) on other generics' abnormal returns around settlement**

This table presents estimates of the effect of cross-holdings on abnormal returns of other potential entrants around the date in which one generic filer challenging the monopoly status of a drug and the brand enter into a settlement agreement. Potential entrants are generic manufacturers that have entered into patent infringement litigation but the case was still pending upon settlement between the brand and another generic filer challenging the same branded drug. The dependent variable is the cumulative market adjusted returns (winsorized at 1% and 99% percentiles) for public generic firms over the window $[-3, +3]$. The event denotes the date on which the two parties settle. *First* is an indicator coded as one if the generic manufacturer is the first challenger based on *pseudo entry date*, which is the earliest of: (1) the date an ANDA was filed, (2) the date the brand incumbent was noticed by the ANDA filer(s), and (3) the date the brand suits the ANDA filer. We measure cross-holdings as of the beginning of the quarter in which a patent litigation lawsuit is filed by the brand. We rank top N ($N = 10, 15, 20, 25, 30$) generic cross-holdings in an ascending order and scale the resulting ranking by the total number of lawsuits. *Top N × First* is the interaction between the rankings of top N ($N = 10, 15, 20, 25, 30$) generic cross-holdings and *First*. Columns (1)–(5) present coefficients estimated from linear probability regressions. In columns (1)–(5), only ownership of index funds that belong to the top N generic shareholders is used to form the ranking. See Table 5 and 7 for descriptions of institutional cross-holdings and other independent variables. Columns (6)–(10) present coefficients estimated from instrumental variable (IV) regressions. Starting from September 2003, 25 fund families experienced large outflows of capital as a consequence of a settlement regarding alleged illegal trading. Rankings of *top N generic cross-holdings* is instrumented with *Treatment*, which is an indicator variable set equal to one if *Brand Scandal* exceeds 10%. *Brand Scandal* is the sum of brand ownerships of scandal funds that belong to the top 30 generic institutional shareholders as a fraction of the sum of brand ownerships of all top 30 generic institutional shareholders as of September 2003. Standard errors are in parentheses and are clustered at the U.S. Federal District Court level.

	Index funds					IV Estimation				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Top 10	−0.014					0.034				
	(0.032)					(0.051)				
Top 10 × First	−0.009					−0.055∗				
	(0.015)					(0.031)				
Top 15		−0.003					0.033			
		(0.025)					(0.050)			
Top 15 × First		−0.009					−0.055∗			
		(0.016)					(0.030)			
Top 20			−0.007					0.033		
			(0.028)					(0.050)		
Top 20 × First			−0.009					−0.055∗		
			(0.016)					(0.030)		
Top 25				−0.006					0.033	
				(0.028)					(0.050)	
Top 25 × First				−0.009					−0.055∗	
				(0.016)					(0.030)	
Top 30					−0.011					0.033
					(0.031)					(0.050)
Top 30 × First					−0.009					−0.055∗
					(0.016)					(0.030)
First	−0.012	−0.012	−0.012	−0.012	−0.012	−0.008	−0.008	−0.008	−0.008	−0.008
	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)
log (drug sales)	0.011	0.011	0.011	0.011	0.011	0.019∗∗	0.019∗∗	0.019∗∗	0.019∗∗	0.019∗∗
	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
Constant	−0.304∗∗∗	−0.315∗∗∗	−0.310∗∗∗	−0.312∗∗∗	−0.307∗∗∗	−0.464∗∗∗	−0.464∗∗∗	−0.464∗∗∗	−0.464∗∗∗	−0.464∗∗∗
	(0.101)	(0.107)	(0.103)	(0.105)	(0.104)	(0.108)	(0.108)	(0.108)	(0.108)	(0.108)
Index status	Yes	Yes	Yes	Yes	Yes					
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Court FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Trade name FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	604	604	604	604	604	503	503	503	503	503
Adj. R^2	0.14	0.14	0.14	0.14	0.14					

$*p < 0.10, **p < 0.05, ***p < 0.01$