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COMMON OWNERSHIP AND MARKET ENTRY: EVIDENCE FROM THE PHARMACEUTICAL INDUSTRY*

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Abstract

Common ownership - where several firms are (partially) owned by the same investors - and its impact on product market competition has recently drawn much attention. This paper focuses on its implications for market entry. Specifically, we consider the entry decisions of generic pharmaceutical firms into drug markets that are opened up by the end of regulatory protection and which were previously dominated by a single firm selling the brand name drug. We find evidence that common ownership affects entry in US pharmaceutical markets. In particular, we find that an increase in common ownership leads to a reduction in entry, both at the individual and market level. This key finding is robust to different measures of common ownership, different sets of potential entrants, different estimation methods and specifications, different market definitions, and different outcome variables.

JEL-code: G23, K21, L11, L41, L65

Key words: Market Entry, Ownership Structure, Pharma

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I. Introduction

Common ownership - where several firms are (partially) owned by the same investors - and its impact on product market competition has recently drawn much attention from policy makers and academics alike.[1] In the pharmaceutical industry, common ownership is widespread.[2] Common investors hold shares in both "brand firms," such as Johnson & Johnson, that primarily launch new drugs on the market, and "generic firms," such as Mylan, that primarily produce generic drugs and enter the drug markets of brand firms once patents and other regulatory protection of these markets expire. This fact is illustrated by Table I which describes the top 5 largest shareholders in Johnson & Johnson and Mylan.[3] The three largest shareholders in these two firms are the same: BlackRock, Vanguard and State Street, some of the world's largest institutional investors.[4] A controversial question is if, and if so in which way, firms' decision-making is altered by the presence of common ownership as, rather than maximizing their own value, commonly-owned firms may maximize their shareholders' *portfolio* values.

TABLE I. Top 5 largest shareholders (2013)

Brand		Generic	
Johnson & Johnson		**Mylan**	
State Street Global	6%	Vanguard Group	7%
BlackRock	6%	BlackRock	6%
Vanguard Group	5%	State Street Global	4%
Royal Bank of Canada	2%	Wellington Mgmt.	4%
Wellington Mgmt.	2%	John Paulson	4%

Source: Thomson Global Ownership Database

This article investigates the effect of common ownership on one of the most important decisions firms make: market entry. Specifically, we analyze generic firms' entry decisions

[1] Media attention includes e.g. The Economist (2015, 2022), The New York Times (2016), Handelsblatt Global (2016) and OECD (2017). For a review of the academic literature see Backus et al. (2019) and Schmalz (2021).

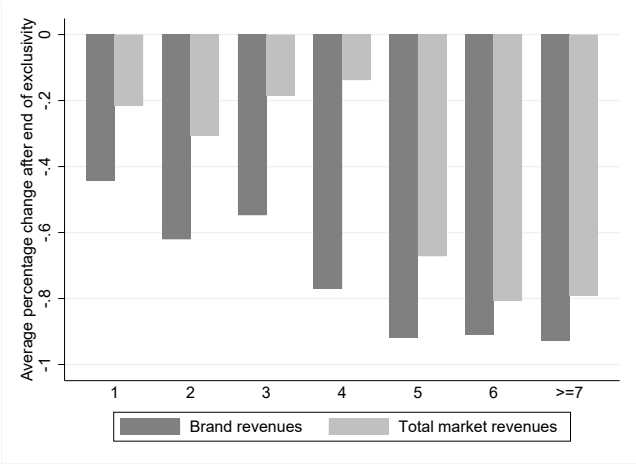
[2] For example, Johnson & Johnson, Pfizer, Abbott Laboratories, Perrigo and Allergan, some of the largest pharmaceutical companies in the US, all had the exact same top two shareholders in 2005: BlackRock and Vanguard (Thomson Reuters Global Ownership Database, 2015).

[3] In Banal-Estanol et al. (2021), we provide a full network analysis of the common ownership patterns in the US pharmaceutical industry over the same sample period as the one used in this paper.

[4] Institutional investors, such as Blackrock, Vanguard and State Street, manage other people's money by buying and controlling equity in companies.

into pharmaceutical markets opened up by the end of regulatory protection. Monopolized markets are a vital source of revenue for brand firms. Brand revenues can decline by as much as 90% following generic entry (Branstetter et al., 2016). Moreover, losses to the brands and gains to the generics are highly asymmetric. According to one estimate, brand firms value deterring entry at about $4.3 billion on average (Jacobo-Rubio et al., 2020). In contrast, generic firms value the right to enter at about $204.3 million. This is also true in our sample. As shown by Figure I, with the event of generic entry, not only brand revenues decrease, but also total market revenues decrease, although to a relatively lesser extent.[5] Thus, the entry decision of a generic firm, into a pharmaceutical market opened up by the end of regulatory protection, may crucially depend on whether the owners of this generic firm also have an ownership stake in the brand.[6]

FIGURE I. Decline in brand and total revenues by number of generic entrants



Notes: This figure illustrates the average decline in brand revenues and total market revenues, defined as the sum of brand and generic revenues, two years after the end of regulatory protection relative to two years before, by the number of generic entrants in the market. The declines reported are relative to the average revenue change when there are no entrants.

[5]Revenues are proxied by Medicaid reimbursements (see Section 5 for a description of these data). Note that two outliers where total market revenues increased by over 1500% after the end of exclusivity have been removed from the sample when creating this figure.

[6]Our data indicates that top shareholders in generic firms should have a substantial interest in brand profits. For pairs where both the brand and generic are publicly listed we find that on average, the top 10 shareholders in the *generic* firm collectively own 51%, valued at $3.7 billion, in the *generic* firm. They collectively own 6.5%, valued at $7.6 billion, in the *brand* firm. For 75% of the brand-generic pairs, the value held in the brand firm by the top 10 shareholders of the generic firm exceeds the value held in the generic firm. Given the large losses to brand profits upon generic entry, even small stakes in the brand would incentivize the common owners to influence the generic entry decision.

In this paper, we investigate whether a higher level of common ownership between potential generic entrants and the market's incumbent brand reduces the likelihood of market entry. Our empirical analysis combines patent and drug approval data from the US Food and Drug Administration's (FDA) Orange Book with ownership data of publicly listed pharmaceutical companies from the Thomson Reuters Global Ownership Database. The US pharmaceutical industry is an attractive industry for studying entry because (i) pharmaceutical markets are well defined, (ii) one can identify clear entry windows and (iii) US health care expenditure as a percentage of GDP is among the highest in the world and generic medicines are crucial to keeping healthcare costs down. Indeed, promoting generic entry has become an important goal for the FDA in recent years and there are hundreds off-patent branded drugs which do not face any generic competition yet (FDA, 2019).

We first present a simple framework to lay out the effects of common ownership on generic entry, where we consider a set of generic firms that have the possibility to simultaneously enter a market currently dominated by the product of a brand firm. We analyse, first, how an increase in the levels of common ownership between a focal generic and the brand should affect this individual generic's entry decision. We further propose several pairwise measures of common ownership between generic and brand firms.

Thereafter we empirically test and corroborate the proposition that higher pairwise levels of common ownership between generic and brand firms reduce individual generic entry. Our results hold if we instrument common ownership with stock market index membership. The results are also robust to several measures of common ownership, covering different channels of investor influence, different econometric methods, different definitions of the potential entrant set, different time-horizons and different sets of fixed effects. Our regressions include the controls used in previous literature, including generic prior experience, pre-entry market size, the number of drug substitutes and the presence of an authorized generic. The average effect is large: a one-standard-deviation increase in common ownership between a given generic and the brand decreases the probability of entry by that generic firm by 15-21%, depending on the measure of common ownership. Furthermore, our results indicate a non-linear impact, with high levels of common ownership, i.e. "strong links," having a much larger impact on generic entry than low levels.

In order to obtain further insights on what drives our average results, we perform a heterogeneous effect analysis for different types of potential generic entrants. Our main regression results, using the full sample, indicate that prior generic experience is an important factor to explain differences in generic entry probability. More experienced generic entrants are significantly more likely to enter. Therefore, we explore heterogeneous effects

of common ownership along this dimension. We find that the (average) negative effects of common ownership on entry are mainly driven by the most experienced generics. Less experienced generics, on the other hand, are less affected by changes in common ownership.

In a next step, we analyse how common ownership impacts overall market outcomes. We find that an increase in market-level measures of common ownership, i.e., between all potential generics and the brand, has a negative effect on the overall number of entrants, as well as on the share of potential entrants that actually enter. We also find that common ownership delays generic entry and increases the probability that the brand will face zero competition from generic entrants. In terms of magnitudes, a one-standard-deviation increase in the market level of common ownership decreases the number of generics in that market by 13-15%, extends the time of generic entry by 24% and increases the probability of no generic entry at all by 32% relative to the mean.

Our pairwise and market-level results thus suggest that the individual reduction of entry, due to an increase in the level of common ownership between a particular generic and the brand, is not (entirely) filled by entry of other generics. While our data is not suited to perform granular analyses at the market-level, we can make use of the analysis of our conceptual framework to propose a tentative explanation for this finding. As we show in an appendix, entry decisions between potential generic entrants may exhibit strategic complementarities in the presence of common ownership. Therefore, an increase in common ownership between a given generic and the brand may also reduce the likelihood of entry of other generics, as long as they also have some common ownership with the brand. The remaining generics, such as less experienced generics, may either be non-strategic or have a too high entry cost to fill the gap. This leads to an overall decrease in the level of entry.

Common ownership is a pervasive feature not only of pharmaceutical companies, but of many industries in the US as well as in Europe (Backus et al., 2021b; Fichtner et al., 2017; Seldeslachts et al., 2017). Although large institutional investors may own "only" 5-8% of a single company, this is often enough to position them as a top investor with privileged access to the firms' management (Malenko and Shen, 2016). There is indeed growing evidence that institutional investors engage in active discussions with companies' board and management with a view to influence the companies' strategies (e.g., McCahery, 2016; Fichtner and Garcia-Bernardo, 2017). Specifically, in pharmaceutical markets, institutional investors with common holdings can be seen taking an active interest in the corporate decision-making. We present some anecdotal evidence in Appendix A that confirms this view. Further examples of interventions by common owners are documented by

Shekita (2022).

However, institutional investors do not need to actively influence companies to have an impact on firm strategies. They may employ "selective omission"; encouraging actions that increase both firm and portfolio value and remaining silent when this is not the case (Hemphill and Kahan, 2019). They may also influence competition between firms through managerial incentives (Antón et al., 2022). Moreover, managers of firms that are largely owned by shareholders who also have sizeable stakes in competitors might just simply act in these shareholders' interest, which leads them to maximize the return of their shareholders' portfolios rather than maximizing their own firm profits (Azar, 2017). In our conceptual framework, we present different measures of common ownership that reflect the different channels by which common ownership might influence firms' behavior.

This article is the first to directly consider the influence of common ownership on market entry. Whereas pricing decisions are typically made on a regular basis by specialized pricing teams, market entry is a one-off decision with substantial consequences for the firm. Common ownership may be especially relevant for this type of decisions. Another advantage of the current article over other empirical studies is the fact that we do not only look at the effects of market levels of common ownership, but also at the effects of the pairwise common ownership links (between individual generics and the brand).[7]

The rest of the article is organized as follows. Section II. provides a literature overview of entry in pharmaceutical markets, on the one hand, and common ownership, on the other. Section III. introduces the conceptual framework. Section IV. describes the data. Section V. presents the sample, variables and descriptive statistics. Section VI. shows the empirical analysis and results of the effect of common ownership on the individual entry decision. Section VII. deals with the effect of common ownership on market outcomes. Section 8 concludes. We include appendices on (A) anecdotal evidence on how institutional investors influence firms' decisions, (B) data construction, (C) formel model and proofs, and (D) empirical robustness checks.

II. Literature

We separately discuss the most relevant articles on the entry decisions of generic firms in pharmaceutical markets and common ownership.

[7]For example, empirical studies by Azar et al. (2018) and Azar et al. (2022) focusing on the price effects of common ownership in airlines and banking respectively consider the effect of common ownership only at the market level.

Generic entry. Several articles have considered the determinants of generic entry decisions in off-patent drug markets, i.e., markets where the patent of the brand company has expired. A common finding from this literature is that generic entry increases with the size of the branded drug's market prior to the loss of patent protection, where market size is commonly measured as brand-generated revenues (Scott Morton, 1999, 2000; Hudson, 2000; Saha et al., 2006; Moreno-Torres et al., 2008; Appelt, 2015).

Scott Morton (1999) considers other aspects of generic entry decisions in US pharmaceutical markets. She finds that generic firms are more likely to enter markets in which they have previous experience in drug form, therapy class or ingredient. Kyle (2006) and Appelt (2015) similarly confirm the importance of generic firm characteristics. Scott Morton (1999, 2000) also highlight the role of the characteristics of the drugs e.g. drug form/route. Appelt (2015) examines the impact of authorized generics, i.e., the distribution and marketing of the brand product under a generic label through an authorized generic distributor (typically just before the loss of the patent). She finds that authorized generic entry has no significant effect on the likelihood of 'independent' generic entry. Using a structural model approach, Wang et al. (2022) find that manufacturing complexity significantly reduces the likelihood of generic entry.

Scott Morton (2002) analyzes how direct ownership links between the brand firm and a generic firm influences the likelihood of generic entry. She finds that generics owned by the original innovator (i.e., the brand company) are less likely to enter the market. In the US, generic firms can enter markets early by legally challenging the brand's patents via Paragraph IV. Helland and Seabury (2016) investigate the link between Paragraph IV challenges, settlements and entry. They find that a Paragraph IV challenge increases generic entry, although a settlement effectively reverses the effect. Hovenkamp and Lemus, finally, (2017) confirm that settlements after Paragraph IV challenges cause generics to stay out of the market.

Common ownership. In terms of theoretical work, beginning with Rubinstein and Yaari (1983) and Rotemberg (1984), a number of authors have remarked that shareholder diversification can lead firms to internalize the externalities they impose on rivals; see Schmalz (2018, 2021) for a full overview. These models show that common ownership of competitors reduces incentives to compete as the gains of aggressive competition to one firm come at the expense of other firms in the investors' portfolio. Consequently, common ownership is predicted to lead to higher prices and boost industry profits. On the other hand, Lopez and Vives (2019) find that cost-reducing R&D investment with spillovers in

a Cournot oligopoly may lead to higher welfare when there is higher common ownership.

Previous empirical studies on common ownership have often centered on price effects. Focusing on the US airline industry, Azar et al. (2018) use the modified Herfindahl-Hirschman index (MHHI), developed by O'Brien and Salop (2000), which provides a measure of the extent of common ownership at the market level. They find that ticket prices are about 3-12% higher than would be the case under separate ownership. Azar et al. (2022) study the US banking industry, extending the MHHI to take into account cross-ownership –the degree of which banks own shares in each other– and find that common and cross-ownership are positively correlated with banking fees. Backus et al. (2021a) focus on common ownership in the ready-to-eat cereal industry. They find that while the potential magnitude of common ownership effects on price would be large, standard own-firm profit maximization is more consistent with the data for this industry. Scott Morton and Boller (2020) study the effect of common ownership on future expected profits as captured by stock prices. They find that increases in common ownership cause increases in stock returns, consistent with a hypothesis that common ownership raises profit.

Xie and Genakos (2020) find that institutional investors' common holdings between US generic and brand companies increase the likelihood of settlement agreements after generic companies have disputed the brand's patent validity through a Paragraph IV challenge, which is the section of the Hatch-Waxman act under which generic entrants dispute pharmaceutical patents. Their study, thus, is complementary to this article as it showcases a plausible way through which entry can be deterred in pharmaceutical markets.

Some recent empirical studies highlight the positive effects that common ownership can have on innovation and vertical relations. Antón et al. (2021) examine how common ownership affects R&D investments and innovation output. Geng et al. (2016) find that vertical common-ownership links can mitigate hold-up problems arising from patent complementarities, which in turn is correlated with more innovation. Cici et al. (2015) and Freeman (2021) find that common ownership between vertically connected firms can help strengthen business relationships. Eldar and Grennan (2019) find evidence from VC funds' returns and startups' exits which suggests common ownership helps weaker startups improve rather than biasing competition toward winners.

There is also a body of literature in corporate finance that investigates channels through which institutional investors might have an impact on governance, policies and strategic decisions of firms (e.g., Aghion et al., 2013; Brav et al., 2018). Appel et al. (2016) find that passive mutual funds have a significant and positive impact on several aspects of corporate governance (board composition, anti-takover provisions and unequal voting rights). Their

evidence suggests that a key mechanism by which these investors exert their influence is through their large voting blocks.

Furthermore, institutional investors state that they have a fiduciary duty to weigh on firms' decisions and do so through informal meetings with management and through voting at annual general meetings by the employment, for example, of proxy voters such as Institutional Shareholder Services (ISS) (Malenko and Shen, 2016). Boone and White (2015) examine the effects of institutional ownership on firm transparency and information production. They find that higher institutional ownership is associated with greater management disclosure; resulting in lower informational asymmetries. In line with the findings of Appel et al. (2016), they discover that indexing investors have the highest influence on information production. Finally, Antón et al. (2022) show that managerial incentives can serve as a mechanism that connects common ownership to softer competition.

III. Conceptual framework

We now present a simple framework to lay out the effects of common ownership on market entry. We consider a set of generic firms that have the possibility to simultaneously enter a market currently dominated by the product of a brand firm. We then analyse how an increase in the levels of common ownership between a focal generic and the brand should affect this individual generic's entry decision. We further propose several pairwise measures of common ownership between generic and brand firms. In section VII. we will consider the effects of common ownership on market level outcomes.[8]

Common ownership and individual entry. Consider a set of N (≥ 1) generic firms, assumed symmetric for notational simplicity, that can simultaneously enter the market of a brand firm b.[9] We focus on the decision of one of these generic firms, the *focal* generic g, as a function of its beliefs about the entry decisions of the other generics. Denote by p_k the probability, assigned by this (risk-neutral) focal generic, to the event that a number k of the *other* generic firms enter the market, where $k = 0, ..., N-1$ and $\sum_{k=0}^{N-1} p_k = 1$.

[8]Note that throughout the paper, we disregard the common ownership links among generic firms. Banal-Estanol et al. (2021) show that the network of generic firms is very sparse and stays that way over the span of the sample period. Instead, as we also show later in this paper and more in detail in Banal-Estanol et al. (2021), the common ownership links between brands firms, on the one hand, and generic firms, on the other, are more dense and have increased in density over time

[9]Our main empirical specification specifies an entry window of 6 quarters, where entry decisions should be considered as simultaneous. This is because the entire application process for generic drugs takes about 6 quarters on average, during which period information on ANDA's received by the FDA is kept secret until approval.

Denote by π_g^k the focal generic's profits in a market that also includes k other generic firms (and thus the market contains in total $k+2$ firms, when also counting the brand firm). Profits π_g^k may also include fixed costs of entry, and are thus net of these entry costs. Profits in the absence of entry are normalized to 0, so π_g^k is also the gain or loss in profits upon entry. Denote by $\Delta\pi_b^k(<0)$ the loss in profits of the brand firm b due to an increase from k to $k+1$ in the total number of generic entrants in the market.

We posit that any possible gain the focal generic can obtain with entry is lower than the losses suffered by the brand, as generic competition reduces brand firm's profits significantly (Branstetter et al., 2015). In other words, although a generic firm's profits may increase with entry, i.e., π_g^k may be positive, joint profits decrease, i.e., $\pi_g^k + \Delta\pi_b^k < 0$, independently of the number k of other generics that decide to enter the market. This is consistent with the evidence we provide in Figure I on the relationship between number of entrants on the one hand, and brand and total market revenues on the other hand.[10]

Common ownership between the focal generic and the brand firm makes the generic's entry decision non-trivial. Indeed, shareholders of the generic that also own shares in the brand should also care about the reduction of joint profits. As a result, the decision-makers of g may also take into account the reduction of joint profits when deciding whether to enter. Formally, let us denote by δ the weight the decision-makers of g place on joint profits, rather than on individual generic firm profits. g should enter the market if the expected "net gains" from entry Π_g are positive, where

$$\Pi_g(p_0, ..., p_{N-1}, \delta) \equiv \sum_{k=0}^{N-1} p_k[(1-\delta)\pi_g^k + \delta(\pi_g^k + \Delta\pi_b^k)].^{11} \quad (1)$$

An increase in common ownership between g and b will naturally increase δ, and thus δ can also be viewed as a "measure of common ownership". In the absence of common ownership between g and b, the generic g should place no weight on joint profits, and thus $\delta = 0$. Entry should occur as long as the generic profits increase with entry, $\pi_g^k > 0$. At the other extreme, in the case where common ownership is so high that joint profits are as important as individual generic profits, $\delta = 1$, entry should not occur, as $\pi_g^k + \Delta\pi_b^k < 0$ for

[10] That also means that the business stealing effects caused by generic entry on the brand firm are larger than any market expansion effect. This should hold true for markets with low demand elasticity of which pharmaceutical markets are a primary example (Duggan and Scott Morton, 2010). In practice, even in the absence of business stealing effects, post-entry joint profits may be lower than pre-entry monopoly profits because of the entry costs of the generic.

[11] Equivalently, δ is the weight that the decision-makers of the generic place on the change of profits of the brand relative to the weight they place on the change in profits of the generic itself, $\Pi_g(p_0, ..., p_{N-1}, \delta) = \sum_{k=0}^{N-1} p_k[\pi_g^k + \delta\Delta\pi_b^k]$.

any k. More generally, the expected net gains from entry of a generic g should decrease in its level of common ownership with the brand, as

$$\partial \Pi_g(p_0, ..., p_{N-1}, \delta)/\partial \delta = \sum_{k=0}^{N-1} p_k \Delta \pi_b^k < 0 \text{ for any } p_0, ..., p_{N-1}. \tag{2}$$

Thus, an increase in the level of common ownership between a generic and the brand should reduce the likelihood of entry by this individual generic. Indeed, the entry of the focal generic reduces the brand firm's profits, independently of the entry decisions of the other generic firms (and the beliefs the focal generic may have over these).[12]

Common ownership measures. We propose several measures of common ownership that aim to capture how common investors' interests in the two firms affect the weight that the generic firm's decision-maker places on joint rather than on individual firm profits. We posit that ownership of the brand provides common investors with *incentives* to steer decisions towards joint profits and ownership of the generic provides them with the *ability* to influence such decisions (Posner et al., 2017). The main difference between our various measures is how incentives and ability to influence decisions are taken into account.

We propose three approaches that cover different channels of investor influence. In broad terms, the first two approaches suppose that common investors actively engage with decision-making, as they explicitly parametrize the effect of the common shareholders' ability and incentives to steer a generic firm's decisions towards joint profits. The first approach assumes that there exists a "production function" that transforms common investors' shareholdings in brand and generic firms (the inputs) into a "joint profit steering index" (the output). The second approach posits that only the top investors in each firm may have the ability and incentives to influence the generic firm's decision. Whereas the first approach makes use of the *size* the shareholdings, the second approach relies only on their *ranking*. The third approach assumes that the generic firm's decision-makers are aware of and take into account the portfolio interests of all the shareholders (common and non-common and top and non-top), and hence investors do not need to explicitly engage.

Production function approach. This approach assumes that there exists a production function that transforms common investors' shareholdings in brand and generic firms into a "joint profit steering index", as a production function that transforms two inputs into an output. The index (the output) increases with the size of the common in-

[12] In Appendix C, we present a simple model of strategic interaction. We illustrate the type of strategic effects that may appear in this setting and characterize the equilibrium entry decisions of N symmetric generics as a function of their level of common ownership with the brand.

vestor's shareholdings in the brand (an input) because an increase in the shares increases her concerns about the reduction of joint profits. The index also increases with the size of the investor's shareholdings in the generic (another input) because larger shareholdings naturally imply a greater capacity to influence the generic firm's decisions. A higher value of the index steers the decision-maker in the generic towards joint profit maximization, as opposed to individual profit maximization, as illustrated in (1).

Assuming perfect coordination among common investors, the weight that the generic firm should place on joint profits is the sum of joint profit steering indices across common investors.[13] In formal terms, we assume there exists a function f such that

$$\delta(g,b) = \textstyle\sum_j f(\gamma_{jg}, \gamma_{jb}), \tag{3}$$

where γ_{jg} and γ_{jb} are the shareholdings of a common shareholder j in the generic and brand, respectively. The marginal effect of each of the two arguments of f should be positive, but there could additionally be some degree of complementarity between the two. In other words, the marginal effect of incentives may be larger if the ability is higher, and vice versa. We apply two extreme production function examples. First, the two shareholdings can be "perfect substitutes,"i.e., $f(\gamma_{jg}, \gamma_{jb}) = (\gamma_{jg} + \gamma_{jb})/2$, and thus:

$$\delta_S(g,b) \equiv \textstyle\sum_j (\gamma_{jg} + \gamma_{jb})/2. \tag{4}$$

Second, the two shareholdings can be "perfect complements,"i.e., $f(\gamma_{jg}, \gamma_{jb}) = \min\{\gamma_{jg}, \gamma_{jb}\}$, and thus:

$$\delta_C(g,b) \equiv \textstyle\sum_j \min\{\gamma_{jg}, \gamma_{jb}\}. \tag{5}$$

The perfect substitutes measure (equation (4)) assumes that the marginal effect of an increase in incentives does not depend on the level of ability, and vice versa. On the other hand, the perfect complements measure (equation (5)) assumes that incentives require ability, and vice versa. This means that the perfect substitutes measure does not penalize unequal shareholdings in the two firms whereas the perfect complements measure does. For instance, a shareholder that owns 5% of the shares of one firm and 15% of the other would have the same contribution to $\delta(g,b)$ as someone that owns 10% in both firms when applying the perfect substitutes measure but only half of it when applying the perfect complements measure. Of course, both measures are similar if the relative holdings of all

[13] We assume thus that common investors coordinate their collective decision making. This assumption makes sense if common owners have similar interests. For example, a case study of a shareholder vote at the company DuPont indicates how common investors can group together and use the power of their large voting block to implement their objectives (Schmalz, 2015).

common investors in the brand and generic are similar.[14]

RANK-BASED APPROACH. Our second approach assumes that only the top investors can have ability and incentives to steer decisions towards joint profit maximization. We consider that the presence of a common investor increases the joint profit steering index if and only if it is a top N investor in both the generic and brand firms. However, we assume that within the group of the top N investors, they all count equally. On the basis of this, we construct two measures: the ratio of the top 5 (respectively 10) investors in the generic that are also one of the top 5 (respectively 10) investors in the brand firm.

$$\delta_{R5}(g,b) = \textstyle\sum_j I(\gamma_{jg} \geq \gamma_{(5)g} \text{ and } \gamma_{jb} \geq \gamma_{(5)b})/5$$

and

$$\delta_{R10}(g,b) = \textstyle\sum_j I(\gamma_{jg} \geq \gamma_{(10)g} \text{ and } \gamma_{jb} \geq \gamma_{(10)b})/10,$$

where γ_{jg} and γ_{jb} are again the shareholdings of a common shareholder j in the generic and brand, respectively, $\gamma_{(n)g}$ and $\gamma_{(n)b}$ are the n-th largest shareholding in the generic and brand firm (overall, also including those of non-common shareholders), and $I()$ is the indicator function which is equal to 1 if the argument is true, and to 0 otherwise.[15]

These measures are related to the complementarity measure of the previous approach, as investors need to have both incentives and ability to influence decision-making. However, these measures are based on the investors' rankings within a company rather than in their absolute levels of ownership. This means that they disregard the structure of the ownership holdings of the non-top investors, as well as the exact ownership holdings of the top investors.

WEIGHTED SUM OF INTERESTS APPROACH. Our third approach, following O'Brien and Salop (2000), assumes that the decision-makers maximize a weighted sum of the interests of *all* the shareholders of the generic firm. The interests of the shareholders are hereby defined by their shares of the profits of both generic and brand firms. That is, the interests of any (common or non-common) shareholder i of the generic, who has holdings γ_{ig} and γ_{ib} (where γ_{ib} can be zero) are given by $\gamma_{ig}\pi_g + \gamma_{ib}\pi_b$. The weight of each investor in generic firm decision-making is equal to her degree of control of the generic

[14]Note that both functions are symmetric with respect to the two inputs. Moreover, the scale is such that both measures range between zero and one. Further, the generic firm will place no weight on joint profits ($\delta = 0$) if there are no common shareholders, and a necessary condition for full-weight on joint profits ($\delta = 1$) is that all shareholders are common.

[15]The scale is such that both measures range between zero and one. The generic firm will place no weight on joint profits ($\delta = 0$) if there are no top N common shareholders, and a necessary condition for full-weight on joint profits ($\delta = 1$) is that all top N shareholders are common.

firm. Assuming that control is proportional to ownership, the degree of control of each shareholder is given by γ_{ig}. Decision-makers of the generic firm should then maximize

$$\sum_i \gamma_{ig} \left[\gamma_{ig}\pi_g + \gamma_{ib}\pi_b\right].$$

Straightforward algebra shows that maximizing this function is equivalent to maximizing $(1-\delta_L)\pi_g + \delta_L(\pi_g + \Delta\pi_b)$, where

$$\delta_L(g,b) \equiv \frac{\sum_i \gamma_{ig}\gamma_{ib}}{\sum_i \gamma_{ig}^2}.$$

This measure captures the importance of the shareholdings in the generic (ability) and shareholdings in the brand (incentives) taking into account the ownership concentration of the generic.[16]

IV. Data

We explain both the pharmaceutical and common ownership data in this section. More details on the data and the construction of the dataset can be found in Appendix B.

Entry in the pharmaceutical industry. Broadly speaking, pharmaceutical firms can be categorized as brand or generic firms.[17] Brand firms undertake costly research and development to discover new medications and bring them to market, and must apply for FDA approval through the new drug application (NDA) procedure. Once a brand has received FDA approval, it is awarded "data exclusivity" for a period of three, five or seven years, depending on the drug type. Data exclusivity protects the underlying clinical data and runs concurrently with patent protection. The period that spans between the end of data exclusivity and the expiration of the last patent, if any, is commonly referred to as "market exclusivity."

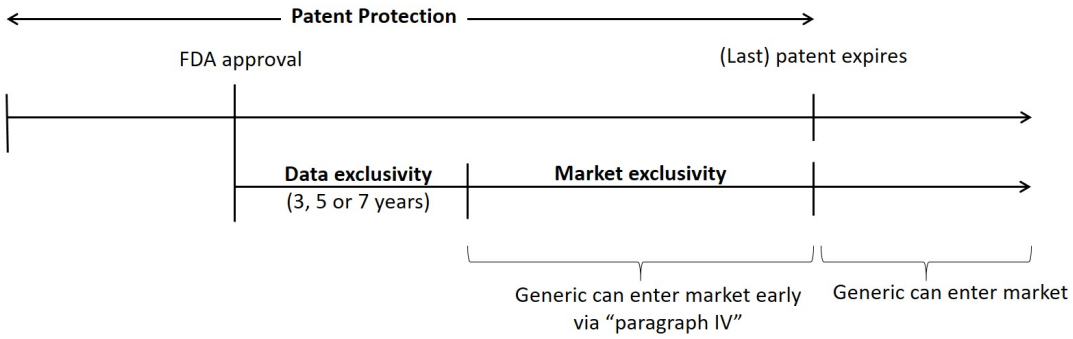
Generic firms produce bioequivalent replications of brand drugs at a much lower cost,

[16] As opposed to the previous two, this common ownership measure is not symmetric with respect to the two ownership stakes. Further, δ_L can be, as opposed to the others, larger than 1. This would imply that the decision-makers of the generic put more weight on the profits of the brand than on those of the generic itself (see footnote 11). This might lead to the phenomenon of "tunneling," i.e., a transfer of profits from generic to brand to the benefit of the common owners. See O'Brien and Waehrer (2017) and Backus et al. (2019) for a thorough discussion of this measure.

[17] Note that we define firms as being a "brand" or a "generic" on a drug market basis. It is possible that the same firm is a potential generic entrant for one market and the brand company in another market. This can occur because some companies produce both branded drugs and generic drugs.

after they have already been marketed as brand-name products. Generic firms are able to enter a particular drug market once the regulatory protections afforded to the brand product have expired. During the market exclusivity period, generics can challenge the monopoly rights of the brand in court through Paragraph IV certification. Generic companies can also apply for FDA approval once all patents are expired. In both instances, an abbreviated new drug application (ANDA) must be submitted to the FDA. The protection conferred to new drugs is illustrated in Figure II.

FIGURE II. Exclusivities and patent protection in pharmaceuticals



Notes: This figure illustrates the two types of protection awarded to new drugs. Data exclusivity protects the underlying clinical data and runs concurrently with patent protection. At the end of data exclusivity, a drug is protected only by its patents until they expire, a period termed "market exclusivity."

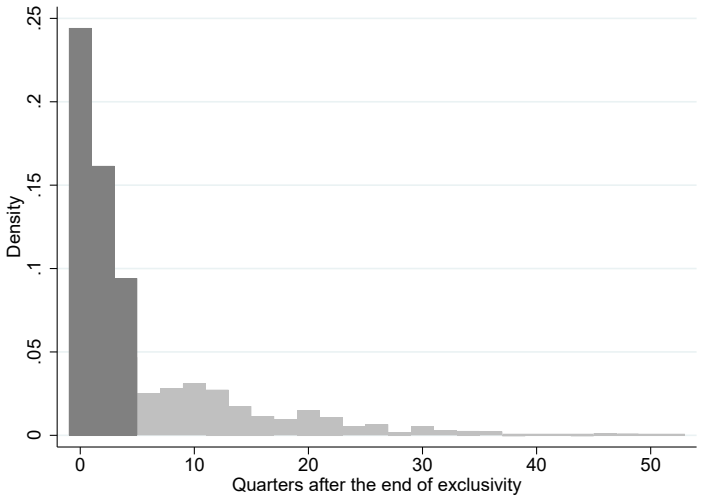
We use ANDA FDA approval as an indicator of generic entry, in line with several articles on the topic (e.g., Helland and Seabury, 2016; Hovenkamp and Lemus, 2018; Scott Morton, 1999, 2000). We consider a market to be open for generic entry at the earlier of either the date of first generic entry or the end of the market exclusivity period.[18] We term this point in time the end of "exclusivity" or end of "regulatory protection."[19] We focus on entry that occurs within 6 quarters after the end of exclusivity, as generics prefer to

[18]That is, we consider a market to be open for generic entry at the earlier of either the date at which the *last* patent listed in the Orange Book for the drug expires or the date of first generic entry. To check the robustness of our results to an earlier date for the end of market exclusivity, we use information (where available in the Orange Book) on the type of patent. We take the end of market exclusivity to be the earlier of either the date at which the *substance* patent expires and the date of first generic entry. We re-run our main specification with this adjustment, and find that our results hardly change. We repeat this process by taking the earlier of either the date at which the *product* patent expires and the date of first generic entry. We re-run our main specification with this adjustment, and find that our results hardly change.

[19]If we observe FDA approval of the first generic entrant before the end of the market exclusivity period, then a generic successfully challenged the brand's patent through a Paragraph IV procedure. Other generics can then enter too, although possibly with a delay of 2 quarters due to temporary monopoly rights conferred to the first paragraph IV filer (see e.g., Hovenkamp and Lemus, 2018).

enter a market as early as possible (Wang et al., 2022, Scott Morton, 1999) and it indeed captures most of the actual generic entries in our sample (see Figure III). However, given the potential sensitivity of results to our time window, we will show that results are robust to other entry period definitions.

FIGURE III. Histogram of entry



Notes: This figure depicts the histogram of relative frequencies of entry, on a bi-quarterly basis, after the "end of exclusivity." The dark gray area shows the share of entry occurs within 6 quarters after the end of exclusivity.

Pharma data. We obtain data on NDAs and ANDAs from the FDA Orange Book. The FDA Orange Book provides data on all launched pharmaceutical products in the United States since 1982. The data includes information on the launching company, type of drug (NDA or ANDA), associated patents, list of ingredients, drug form/route, strength, approval date and status (prescription, over-the-counter, or discontinued). Information on the submission class of the brand product is merged in from the Drugs@FDA database using the FDA application number.[20] Products are linked to their therapeutic field using the ATC/DDD Index 2015 and applying exact text matching, based on compound-name.[21]

We define drug markets at the ingredient-form level. For example, the drug with the brand-name Zyrtec in syrup form with the ingredient Cetirizine Hydrochloride 5mg/5ml

[20]See also Helland and Seabury (2016) and Hovenkamp and Lemus (2018) for more details on this source.

[21]The ATC/DDD Index 2015 categorizes all chemical compounds used in any therapeutic field according to a five-level hierarchical system, called the Anatomical Therapeutic Chemical (ATC) Classification System.

is considered to be in the same drug market as Zyrtec in syrup form with the ingredient Cetirizine Hydrochloride 10mg/10ml. However, the product Zyrtec Allergy with the ingredient Cetirizine Hydrochloride 10mg in the form of a tablet constitutes a different market. The therapeutic field in which Zyrtec falls, at the ATC-2 level, is "Antihistamines for systemic use."

We match the brand product (NDA) with the sample of potential generic entrants to form a brand product-generic pair. The sample of potential generic entrants in the market includes all pharmaceutical companies that launched at least one generic product in our drug markets and have previous experience in launching generic drugs of the same form/route (i.e. oral, injection etc.) as the relevant brand drug. Results are robust to a set of different definitions of the entrant set, as we will show when discussing the results.

Common ownership data. We use the Thomson Reuters Global Ownership Database, which includes holdings by each shareholder in each publicly listed firm worldwide for every year-quarter. For US-listed firms Thomson Reuters collects ownership information from 13F, 13D and 13G filings, and forms 3, 4, and 5. For companies outside the US, information is sourced from stock exchange filings, trade announcements, company websites, company annual reports and financial newspapers. For each pharmaceutical firm for each quarter in the period 2003-2014 we extracted data on all the shareholders that own at least 1% of the shares, and computed yearly ownership averages.

The advantages with regard to datasets used by most other papers on common ownership in the US, which use Thomson's Spectrum database, are considerable. That database is limited to 13F filings, which contains only large investors in US companies, whereas some pharma companies are not listed on a US stock market. Moreover, the Thomson's Spectrum database shows holdings assigned to the owner that filed the 13F. This is what is commonly referred to as an "as-filed view." Our database utilizes a "money-manager view." With this view, the database combines together one or more filings to link the holdings to the actual firm that manages the investments. In other instances, it might break apart a single filing in order to accomplish the same. The holdings would then be assigned to one or more of the managers listed on the file.[22]

[22]For a detailed explanation of our data and dynamic assignment of ultimate owners, see data repository https://www.openicpsr.org/openicpsr/project/120781/version/V1/view attached to the paper Banal-Estañol et al. (2020), available at: https://doi.org/10.1257/pandp.20201026

V. Sample, variables and descriptive statistics

Our final sample consists of 395 drug product markets and 34,144 potential generic-branded drug pairs. We consider drug products that faced generic entry or patent expiry between 2004 and 2014, as this is the range for which we have data on all relevant variables. In total there are 93 unique brand companies and 10,453 unique generic-brand pairs.

We now describe the main dependent and independent variables used in the empirical analysis, i.e., the outcome and the common ownership variables, as well as the control variables.

V.A Main variables

Individual entry decision. We define the variable *Entry* as an indicator variable equal to 1 if the generic has entered within 6 quarters after the end of exclusivity, and to 0 if not. In the robustness checks, we will show that results are robust to other entry period definitions

Pairwise common ownership. We construct empirical counterparts of the five pairwise measures introduced in the conceptual framework: δ_S, δ_C, δ_{R5}, δ_{R10} and δ_L.[23] To investigate whether greater levels of common ownership have a larger impact, we also construct categorical variables of common ownership. We focus on δ_S, as it can be interpreted as the fraction of total ownership in the pair held by common investors, and hence presents natural thresholds. We define the following indicator variables: $I(0 < \delta_S \leq 0.3)$ which takes on the value 1 if $\delta_S \in (0; 0.3]$, $I(0.3 < \delta_S \leq 0.5)$ which takes on the value 1 if $\delta_S \in (0.3; 0.5]$, and $I(\delta_S > 0.5)$ which takes on the value 1 if $\delta_S \in (0.5; 1]$.[24]

We pay particular attention to the case in which the potential generic entrant is a subsidiary of the brand firm. We create an indicator variable that takes on the value 1 if the potential generic entrant is a subsidiary of the brand and 0 if it is not. In the former,

[23] In particular, when constructing the measure of δ_S, for each brand-generic pair, the denominator comprises of the sum all shareholdings in the brand and the generic in our database. As our database includes only investors with at least 1% ownership stake, the denominator may be smaller than the theoretical 2. Formally, $\delta_S(g, b) = \frac{\sum_j(\gamma_{jg}+\gamma_{jb})}{\sum_i(\gamma_{ig}+\gamma_{ib})}$ where the denominator runs over all i investors in our database.

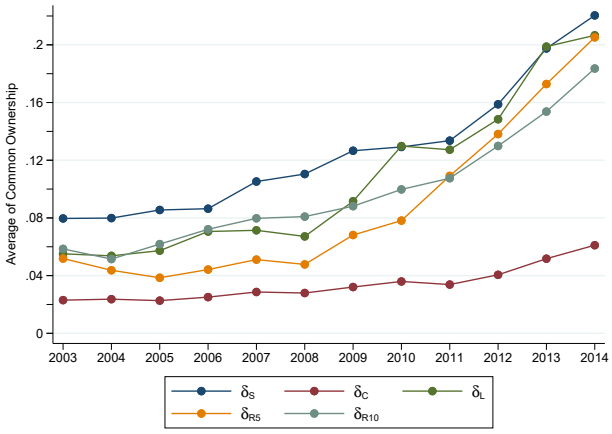
[24] For private firms, i.e., not listed on a stock-exchange, we assume that they do not have common investors with any other firm. For firms with a presence in the UK, we verified that this assumption holds true using annual return filings with full shareholder lists that are also available for private firms from the company registry (Companies House).

all the common ownership variables are set to zero.[25]

Our main results use common ownership measured in the year prior to the end of exclusivity, as entry requires time to acquire an approved source of materials and suitable production facilities. Indeed, about one to two years before filing an ANDA application, the generic firm should start preparing to enter (Reiffen and Ward, 2005). However, as it is unclear at exactly what point time the final entry decision of the generic firm is made, we also check and confirm that our results are robust to the use of common ownership measured two and zero years prior to the end of exclusivity.

Figure IV shows the evolution of the common ownership measures over time. It is evident that common ownership has increased significantly from 2003 to 2014. The growth of common ownership was relatively low until the beginning of 2010. But, the average level of common ownership almost doubled in the last four years of the sample.

FIGURE IV. Evolution of common ownership



Notes: This figure illustrates the evolution of common ownership over time for our measures. We only include the company-pairs that are observed for the entire period, as this provides a clearer overview of how the degree of connectedness between brand and generic pairs has changed over time.

Data structure. Table II gives an example of the structure of our pairwise data using the drug Natrecor which was launched by Johnson & Johnson. The relevant market is defined

[25]We consider a firm X to be subsidiary of a firm Y if firm Y has a direct ownership stake of more than 50% in firm X. We can also identify minority shareholdings, i.e., where one firm has an ownership stake of less than 50% in another firm. However there are only three pairs in the dataset where the brand has a stake-holding in the potential generic entrant and one pair where the potential generic entrant has a stake-holding in the brand. As this ends up being too few observations to draw meaningful statistical conclusions, we do not consider these links in the analysis.

by the ingredients (nestiritide recombinant) and drug form/route (solution; intravenous). The patent associated with Natrecor expired in 2014q2. All pharmaceutical firms in the table had previous experience in launching generic drugs of the same form/route (solution; intravenous). Entry is defined within 6 quarters of the end of market exclusivity, in this case between 2014q2 and 2015q4. None of the generics in the table entered the market. The common ownership measures of the generic firms, one of which is Mylan (see Table 1), with the brand, Johnson & Johnson, correspond to those of the year 2013.

TABLE II. Example data structure

obs.	trade name	brand	generic entrant	entry	δ_S	δ_C	δ_{R5}	δ_{R10}	δ_L
1	natrecor	JOHNSON & JOHNSON	MYLAN	0	0.67	0.23	0.8	0.5	0.9
2	natrecor	JOHNSON & JOHNSON	BARR	0	0.51	0.02	0.4	0.2	0.25
3	natrecor	JOHNSON & JOHNSON	SANDOZ	0	0.45	0.09	0.2	0.3	0.33
4	natrecor	JOHNSON & JOHNSON	AMNEAL	0	0	0	0	0	0
5	natrecor	JOHNSON & JOHNSON	APOTEX	0	0	0	0	0	0
.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.

Descriptive statistics. Table III presents summary statistics for the individual entry decision, the pairwise measures of common ownership and the subsidiary variable. The unconditional probability of entry is 2.8%.[26]

TABLE III. Summary statistics for outcome variable and ownership measures

	(1)	(2)	(3)	(4)	(5)
VARIABLES	N	mean	sd	min	max
Entry (0/1)	34,144	0.0278	0.164	0	1
δ_S	34,144	0.0851	0.160	0	0.946
δ_C	34,144	0.0249	0.0552	0	0.363
δ_{R5}	34,144	0.0581	0.146	0	1
δ_{R10}	34,144	0.0674	0.137	0	1
δ_L	34,144	0.0712	0.172	0	1.365
Subsidiary (0/1)	34,144	0.00246	0.0495	0	1

[26]Both number of potential entrants and realized entry opportunities are comparable with previous studies: In our sample, on average there are 86 potential entrants. In Scott Morton (1999) there are 123 potential generic entrants per drug market and in Appelt (2015) there are 100 potential entrants per drug market. Furthermore, in Scott Morton (1999) 2-7% of entry opportunities are realized, in Kyle (2006) 2.5% of entry opportunities are realized, and in Appelt (2015) 10% of entry opportunities are realized.

V.B Control variables

Generic-market control variables. Controlling for generic firm characteristics has shown to be crucial (Scott Morton, 1999; Scott Morton, 2002; Kyle, 2006). Prior experience in the relevant market is one of the key characteristics of the potential generic entrants. *Experience Route* serves as a proxy for the potential entrant's experience in the brand drug form/route, by counting the number of products, with the same route of administration as the brand, previously launched by the generic one quarter prior to the end of exclusivity. Similarly, *Experience ATC2* serves as a proxy of the entrant's experience in the relevant therapeutic field at the ATC2 level. *Experience New Drug* is constructed as a count of the entrant's previously launched new (brand) drugs. Generic entrants that are also active in producing new drugs may hold some patents that ease entry. *Breadth of Experience* accounts for the breadth of the generic entrant's portfolio, by counting the number of distinct therapeutic fields in which the generic has been active in one quarter prior to the end of exclusivity.

Table IV provides descriptive statistics of the experience variables, calculated using the full FDA Orange Book. Counts start in 1994, 10 years before the start of the sample; results are robust to other starting points. For example, the average potential generic entrant has launched 21 generic products of the same route/form as the brand and is active in 14 therapeutic fields.

TABLE IV. Summary statistics for generic-market controls

	(1)	(2)	(3)	(4)	(5)
VARIABLES	N	mean	sd	min	max
Experience Route ÷ 10	34,144	2.124	3.633	0.100	29.90
Experience ATC2 ÷ 10	34,144	0.0969	0.261	0	3.200
Experience New Drug ÷ 10	34,144	0.220	0.466	0	2.800
Breadth (ATC2) ÷ 10	34,144	1.373	1.243	0.100	6.100

Drug market control variables. Following prior literature, we construct variables to control for relevant drug market characteristics (Hurwitz and Caves, 1988; Scott Morton, 1999; Kyle, 2000; Hudson, 2000; Saha et al., 2006; Regan, 2008; Glowicka et al., 2009; Moreno-Torres et al., 2009; Appelt, 2015). We proxy for drug market size using a measure of the brand's pre-generic-entry revenues obtained from Medicaid reimbursements (available publicly from the Medicaid website). We match the drugs in our sample

with Medicaid reimbursement data using National Drugs Codes (NDC) which are unique product identifiers for drugs in the US. The *Market Size* variable used in the analysis is the dollar value in billions of total national Medicaid reimbursements for the brand drug in the two years before the end of exclusivity.

We also include the following indicator variables: *Authorized Generic*, which takes on the value 1 if the brand firm has launched an authorized generic in that particular market;[27] *Pediatric Drug*, an indicator variable which takes on the value 1 if a drug can be used in children; *Orphan Drug*, an indicator variable that takes the value 1 if a drug treats a rare disease.[28] We also take into account the intensity of inter-molecular competition in the therapeutic field (Appelt, 2015; Regan, 2008). *Substitutes on Patent* provides a count of the number of on-patent substitutive active ingredients listed in the same therapeutic field at the ATC-2 level in the quarter prior to the end of exclusivity. Similarly, *Substitutes off Patent* measures the number of off-patent substitutive active ingredients. Further market characteristics include the therapeutic field of the drug (at the ATC-2 level), submission class of the brand product, drug form/route and the year of the end of exclusivity.[29,30]

Table V provides descriptive statistics of the drug market controls for the 395 drug markets in our sample. For example, in 28% of the markets the brand has launched a generic itself, i.e., started selling an authorized generic. In terms of market size, pre-entry brand revenues through Medicaid reimbursements average 100 million USD.

[27]Note that our left-hand variable is independent generic entry. Authorized generics can be launched without FDA approval and at any point in time (typically shortly before patent expiry). An authorized generic may be launched by a partially-owned generic or subsidiary of the brand, and hence would not enter as an *independent* generic.

[28]This information is obtained by looking at the exclusivities afforded to the drug in the FDA Orange Book. There are special exclusivity provisions for pediatric drugs and orphan drugs.

[29]Submission classes include Type 1 New Molecular Entity, Type 2 New Active Ingredient, Type 3 New Dosage Form, Type 4 New Combination, Type 5 New Formulation or Other Differences.

[30]We recode the FDA form/route variable to construct five form/route classes namely oral, injection, topical, ophthalmic and inhalation.

TABLE V. Summary statistics for drug market controls

VARIABLES	(1) N	(2) mean	(3) sd	(4) min	(5) max
Market Size (bn $)	34,144	0.101	0.245	0	2.143
Authorized Generic (0/1)	34,144	0.280	0.449	0	1
Orphan Drug (0/1)	34,144	0.0917	0.289	0	1
Pediatric Drug (0/1)	34,144	0.318	0.466	0	1
Substitutes on Patent (ATC2) ÷ 10	34,144	2.498	1.732	0	7.300
Substitutes off Patent (ATC2) ÷ 10	34,144	1.714	1.268	0	6.100

VI. Individual entry decisions

We investigate the impact of the pairwise common ownership linkages between a given generic and the brand firm on that particular generic's entry decision for a variety of different empirical specifications. However, it is important to note that – as in our conceptual framework – other potential generic entrants are part of the analysis through their inclusion in the set of potential entrants. We first present the empirical implementation and main results, then instrumental variable (IV) estimations, robustness checks, correlations among our measures, non-linear effects of common ownership and, finally, heterogeneous effects along different experience levels.

VI.A Empirical implementation and main results

The binary dependent variable contains the individual entry decision of generic firm g in market m of brand b. The resulting equation to be estimated is:

$$Pr[Entry_{gm} = 1] = \beta_0 + \beta\delta(g, b) + \gamma X_{gm} + \eta Z_m + A_m + A_g + \mu_t + \epsilon_{gm}.$$

$Entry_{gm}$ takes on the value 1 when generic g enters market m within 6 quarters after the end of exclusivity. δ is one of the measures of common ownership between the generic firm and the brand of the market, i.e., δ can be δ_S, δ_C, δ_{R5}, δ_{R10} or δ_L. X_{gm} is the vector of generic-market control characteristics and Z_m is the vector of market-level controls. A vector of fixed effects A_m is included for drug form/route, submission class and thera-

peutic field (ATC-2 level). A_g is a fixed effect for the region of the generic's company headquarters, and μ_t is a fixed effect for the year of the end of exclusivity.

We estimate a linear probability model. Coefficients for the probit and logit models are reported in Appendix D.[31] Table VI presents the results. All the estimates of β, across all measures of common ownership δ, are negative and significant (at the 1% level). Thus we find that common ownership between generic and brand significantly reduces the likelihood of generic entry. The coefficient on common ownership should be interpreted bearing in mind that the unconditional probability of entry for the sample of firms and markets is 2.8% (see Table III). For example, an increase of one standard deviation as measured by δ_S (see also Table III) implies a $0.16 \times 0.027 = 0.0043$ decrease in the probability of entry *ceteris paribus*. This is therefore a $0.0043/0.028 = 15\%$ reduction in the unconditional probability of entry. Similarly, an increase of one standard deviation in δ_C and δ_L imply a 15% and 18% decrease, respectively, in the probability of entry.

For our rank-based measures, column 3 shows that one additional top 5 common investor (equivalent to a 0.2 increase in δ_{R5}) leads to a 0.006 decrease in the probability of entry. Therefore, an additional top 5 common investor leads to a $0.006/0.028 = 21\%$ decline in the probability of entry. The effect of having an additional top 10 common investor is about half: one additional top 10 investor reduces the entry probability by 10%. These findings, therefore, are consistent with the idea that higher ranked investors have a higher incentive and ability to influence decision-making.

Notice further that the effect of common ownership is generally smaller than the effect of being a subsidiary of the brand. For example, if we set δ_S to 1 – that is all shareholders of generic and brand are common owners – then the probability of entry falls by 2.7 percentage points. On the other hand, if the relationship is parent-subsidiary then the probability of entry falls by 5.5 percentage points *ceteris paribus*. This difference, we believe, is intuitive as parent companies most likely have a higher degree of control as compared to common investors.

Furthermore, the control variables carry the expected signs; a larger market size and greater entrant experience all significantly increase the likelihood of entry. Pediatric drugs are also more likely to experience entry. On the other hand, we find that the number of molecular substitutes on and off-patent do not have a significant impact on generic entry. For the sake of avoiding repetition and for space reasons, we do not display the coefficients associated to the control variables in the rest of this section.

[31] There are several therapeutic fields at the ATC2 level which do not experience any entry in our sample, thus the dummy indicators for these ATC2 fields become perfect predictors for a zero outcome. These observations are thus dropped in the logit and probit models.

TABLE VI. Main specification - pairwise analysis

VARIABLES	(1)	(2)	(3)	(4)	(5)
δ_S	-0.0273***				
	(0.00676)				
δ_C		-0.0776***			
		(0.0183)			
δ_{R5}			-0.0292***		
			(0.00712)		
δ_{R10}				-0.0298***	
				(0.00811)	
δ_L					-0.0287***
					(0.00556)
Subsidiary (0/1)	-0.0555***	-0.0540***	-0.0275*	-0.0284*	-0.0546***
	(0.0145)	(0.0145)	(0.0148)	(0.0150)	(0.0145)
Experience Route ÷ 10	0.00837***	0.00838***	0.00833***	0.00837***	0.00841***
	(0.000855)	(0.000856)	(0.000854)	(0.000856)	(0.000857)
Experience ATC2 ÷ 10	0.0609***	0.0611***	0.0611***	0.0611***	0.0609***
	(0.0104)	(0.0104)	(0.0104)	(0.0104)	(0.0104)
Experience New Drug ÷ 10	0.00453	0.00408	0.00385	0.00407	0.00467
	(0.00286)	(0.00283)	(0.00280)	(0.00285)	(0.00285)
Breadth (ATC2) ÷ 10	0.00101	0.00114	0.000670	0.000891	0.000952
	(0.00231)	(0.00231)	(0.00230)	(0.00231)	(0.00229)
Market Size	0.0344***	0.0343***	0.0343***	0.0344***	0.0344***
	(0.00867)	(0.00867)	(0.00866)	(0.00869)	(0.00865)
Authorized Generic (0/1)	0.00647	0.00654	0.00645	0.00646	0.00652
	(0.00409)	(0.00410)	(0.00410)	(0.00410)	(0.00409)
Orphan Drug (0/1)	-0.00104	-0.000929	-0.000961	-0.000963	-0.00104
	(0.00706)	(0.00706)	(0.00706)	(0.00706)	(0.00706)
Pediatric Drug (0/1)	0.0126***	0.0125***	0.0126***	0.0126***	0.0126***
	(0.00477)	(0.00477)	(0.00479)	(0.00479)	(0.00477)
Substitutes on Patent (ATC2) ÷ 10	-0.00416	-0.00407	-0.00394	-0.00406	-0.00408
	(0.00638)	(0.00637)	(0.00638)	(0.00639)	(0.00637)
Substitutes off Patent (ATC2) ÷ 10	-0.00620	-0.00617	-0.00632	-0.00624	-0.00622
	(0.00497)	(0.00498)	(0.00498)	(0.00498)	(0.00496)
Observations	34144	34144	34144	34144	34144
R-squared	0.0855	0.0855	0.0855	0.0854	0.0857
Therapeutic field	Yes	Yes	Yes	Yes	Yes
Drug form	Yes	Yes	Yes	Yes	Yes
Submission type	Yes	Yes	Yes	Yes	Yes
Generic region of origin	Yes	Yes	Yes	Yes	Yes
Year end of exclusivity	Yes	Yes	Yes	Yes	Yes
Drug markets	395	395	395	395	395

Notes: OLS regression. Standard errors in parentheses are clustered at the drug market level. The dependent variable is entry within 6 quarters. The constant term is estimated but not reported. $***p < 0.01, **p < 0.05, *p < 0.1$.

VI.B Instrumental variable estimation

If investors adjust their holdings in response to entry opportunities, common ownership might be endogenous. The direction of the potential bias is a priori not clear. For example, if investors in the brand increase investment in generics with entry plans, common ownership between the generic and brand will increase before entry, causing β to be biased upwards. Alternatively, if investors with shareholdings in generic firms reduce the size of their stakes in brand firms with drugs that face impending generic entry, then common ownership will decrease before entry, causing β to be biased downwards.

To investigate the concern of potential endogeneity we perform IV estimations and instrument for common ownership with financial index membership at the pair level.[32] We use information on the holdings included in the Dow Jones US Select Pharmaceutical Index during the 2006-2014 period. Our data on the composition of the Dow Jones US Select Pharmaceutical Index comes from historical data on the composition of BlackRock's iShares US Pharmaceutical exchange-traded fund (ETF) which tracks the Dow Jones US Select Pharmaceutical Index.

Figure A1 in Appendix A provides a snapshot of the top 10 investments of the fund as of November 2013. As can be seen, both generic and brand firms are present in the fund; e.g., Mylan primarily produces generic drugs whereas Johnson & Johnson is a brand company. On average, the fund has been comprised of 39 pharma holdings over time.[33] Since May 2006, each listed company has been included in the ETF for an average of 4 years. The fund has been marked by various periods of high entrance and exit – for instance, more than 6 companies dropped out and entered the fund in the last quarter of 2013 and the third quarter of 2015, respectively – and periods of no change.

Our instrument, *Index Presence* is an indicator equal to 1 if both firms are listed on the Dow Jones US Select Pharmaceutical Index at the point in time when common ownership is measured. We expect that if both companies in the pair appear in the Index, common ownership will increase by virtue of the fact that investors who track the index, so-called *index investors*, will hold shares in both companies. The identifying assumption is that

[32] A similar approach has been applied by several other articles in the literature. For example, Aghion (2013) use the inclusion of a firm in the S&P 500 as an instrument for institutional ownership. Bena et al. (2017) instrument foreign institutional ownership with stock additions and deletions to the MSCI all country world index. Schmidt and Fahlenbach (2017) instrument passive institutional ownership with switches between the Russel 1000 and Russel 2000 indexes. Scott Morton and Boller (2020) use instances of a stock entering the S&P 500 index to test if an increase in common ownership changes future expected profits of the entering firm and its product market rivals.

[33] A detailed description of how the Dow Jones US Select Pharmaceutical Index is constructed can be found at: https://www.spglobal.com/spdji/en/documents/methodologies/methodology-dj-us-select-sector-specialty.pdf

inclusion in the pharmaceutical index, is exogenous to a particular market entry, except through its effect on common ownership. This is the case provided that the index is not created with potential entry opportunities in mind and that, controlling for other factors, addition to the index does not directly affect entry decisions except through common ownership.

The results of the IV regressions are presented in Table VII. The IV results are very similar to the OLS results in terms of size of the coefficients (although their significance is lower). Furthermore, the first-stage results, reported in Table D1 in Appendix D, indicate that the instrument is highly relevant and positively correlated with all measures of δ (see the F-stats of excluded instruments). However, the Durbin-Wu-Hausman tests show that we cannot reject the hypothesis that δ is exogenous, and this for all our measures of δ. This suggests that in our context the potential endogeneity of common ownership is not a large concern. One possible explanation for this finding is that a large share of common investors in our dataset are index investors and are therefore adjusting their holdings in generic or brand firms, based on their presences in indices like the Dow Jones US Select Pharmaceutical Index, and less due to direct potential entry opportunities. For the remaining of our analysis, we refrain, therefore, from IV estimations and continue with more efficient estimation methods.

TABLE VII. Instrumental variables regression

VARIABLES	(1)	(2)	(3)	(4)	(5)
δ_S	-0.0285*				
	(0.0147)				
δ_C		-0.0636*			
		(0.0328)			
δ_{R5}			-0.0324*		
			(0.0169)		
δ_{R10}				-0.0324*	
				(0.0167)	
δ_L					-0.0239*
					(0.0124)
Observations	34144	34144	34144	34144	34144
All controls	Yes	Yes	Yes	Yes	Yes
Therapeutic field	Yes	Yes	Yes	Yes	Yes
Drug form	Yes	Yes	Yes	Yes	Yes
Submission type	Yes	Yes	Yes	Yes	Yes
Generic region of origin	Yes	Yes	Yes	Yes	Yes
Year end of exclusivity	Yes	Yes	Yes	Yes	Yes
Drug markets	395	395	395	395	395

Notes: 2SLS regression. Standard errors in parentheses are clustered at the drug market level. The dependent variable is entry within 6 quarters. The constant term and control variables are estimated but not reported. The instrument is an indicator equal to 1 if both firms are listed on the Dow Jones US Select Pharmaceutical Index. $***p < 0.01, **p < 0.05, *p < 0.1$.

VI.C Robustness checks

Our main results are robust to a series of different specifications, as can be seen from the tables in Appendix D. Table D2 shows results where we add drug product fixed effects. The significance and magnitude of the coefficients stays virtually the same. Table D3 and Table D4 present probit and logit regressions for our main specification, respectively. Results also show that our five common ownership measures negatively impact entry.

Furthermore, in our main specification we use Medicare reimbursements as a proxy for market size. To check the robustness of results to this measure, in Tables D5 and D6 we use a different proxy for market size based on the total sales volume for the drug in the US. We use publicly available sales data from drugs.com. Drugs.com provides the annual US sales figures for the top 200 drugs for the years 2003 - 2010 (source: Verispan/VONA) and the top 100 drugs for the years 2011 - 2013 (source: IMS Health/Midas). In Table D5

we substitute Medicare reimbursements with an indicator variable for whether or not the drug is in the top 100 in terms of sales. In Table D6 we limit the sample to drugs where we have information on the annual US sales in the year before the market becomes open for entry. Our results are robust to both of these alternative measures of market size.

Another important dimension may be the set of potential entrants. In our main specification, the set of potential entrants is relatively narrowly defined. We exclude generic firms from the potential entrant set that have not previously launched a generic drug of the same form as the relevant brand drug. Doing so, however, means that we drop 51 *actual* entry observations (5% of all actual entry observations). To check the robustness of our results to a broader potential entrant set, we expand the set to also include generics without experience in the relevant drug form. Results in Table D7 show that the effects are qualitatively identical to our main results: for all common ownership measures, the effect is negative and significant at the 1% level.

We also test the robustness of our results to different entry time windows, as entry may be slower or faster than our chosen 6 quarter window. In Table D8 we alter the dependent variable to consider entry within any time period. Findings are qualitatively the same as in our main specification, i.e., entry is significantly negatively influenced by common ownership.[34]

VI.D Correlation among measures

Overall, we find similar effects for our five proposed common ownership measures, both in terms of significance and economic magnitude. This is in fact not surprising as, empirically, the five measures of common ownership are highly correlated with each other (see Table VIII).

TABLE VIII. Cross-correlations between common ownership measures

Variables	δ_S	δ_C	δ_{R5}	δ_{R10}	δ_L
δ_S	1.000				
δ_C	0.890	1.000			
δ_{R5}	0.793	0.763	1.000		
δ_{R10}	0.874	0.828	0.862	1.000	
δ_L	0.894	0.890	0.792	0.805	1.000

Thus, although our measures can conceptually capture different mechanisms of influence, the empirical counterparts are similar across brand-generic pairs. This implies that

[34]We also considered alternative time windows such as entry within a 2 year time period. These results are available on request.

we cannot say that much about which measure of common ownership best captures the *manner* in which common investors' incentives and ability translate into the weight that the generic firm places on joint profits. On the positive side, given the high correlations, we can continue with only one measure for the rest of our analysis.

VI.E Non-linear effects

We now investigate whether greater levels of common ownership have a relatively larger impact, i.e., whether the relationship between common ownership and entry is non-linear. Table IX present results where common ownership is specified in categories, based on our common ownership measure δ_S.

TABLE IX. Categorical specification

	(1)
VARIABLES	
I($0 < \delta_S \leq 0.3$)	0.00186
	(0.00315)
I($0.3 < \delta_S \leq 0.5$)	-0.00785*
	(0.00410)
I($\delta_S > 0.5$)	-0.0149***
	(0.00464)
Observations	34144
R-squared	0.0854
All controls	Yes
Therapeutic field	Yes
Drug form	Yes
Submission type	Yes
Generic region of origin	Yes
Year end of exclusivity	Yes
Drug markets	395

Notes: OLS regression. Standard errors in parentheses are clustered at the drug market level. The dependent variable is entry within 6 quarters. The constant term and control variables are estimated but not reported. $***p < 0.01, **p < 0.05, *p < 0.1$.

The results in Table IX indicate that the effect of common ownership is greater the larger the level of common ownership. The coefficients on each categorical variable increase

in magnitude (become more negative) with higher levels of common ownership. Furthermore, once δ_S is greater than 0.5 the coefficient is significant at the 1% level. A change from zero common ownership to common ownership δ_S greater than 0.5 reduces the entry probability of a generic by 1.5 percentage points on average. This is approximately a 50% decline in the unconditional probability of entry.[35]

These results indicate that common ownership levels have a non-linear impact on entry, where high levels have a much stronger impact than low levels. In particular, common ownership has its strongest and most significant effect when more than half of the total ownership in the pair is in the hands of the common investors. We, therefore, continue the rest of the analysis with $I(\delta_S > 0.5)$, but provide the results for the continuous variable δ_S in Appendix D (other measures yield similar results, given their high correlation).

VI.F Heterogeneous effects by level of experience

In order to obtain further insights on what drives our average results, we explore the effects of common ownership for different types of potential generic entrants. Our main results indicate that experience is an important factor to explain differences in entry probabilities (see Table VI). More experienced generic entrants are significantly more likely to enter. We explore, therefore, the heterogeneous effects of common ownership along this dimension.

We use in particular the variable *Experience Route*, and for several reasons. First, entry relies on the manufacturing capabilities, which differ depending on the drug form (e.g., being able to manufacture injections vs. tablets). Second, this variable provides a measure of experience tailored to the focal market. Third, there is enough variation in this variable across generics, and it is thus suited to explore heterogeneous effects.

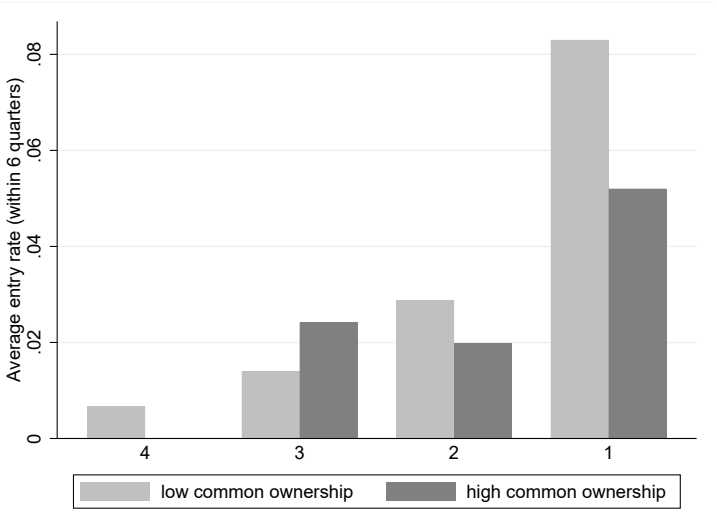
Figure V displays average generic entry rates, split by this measure of experience (in quartiles, with quartile 1 being the most and quartile 4 being the least experienced set of generics) and level of common ownership with the brand. As mentioned before, given that prior analysis in this section has revealed that strong common ownership links are associated with the strongest effects on entry, we separate generic entrants into two groups: those with a strong common ownership link with the brand, i.e., where $\delta_S > 0.5$ (labeled as "high common ownership") and those without a strong link with the brand, i.e., where $\delta_S \leq 0.5$ ("low common ownership").

We first note that more experienced generics are more likely to enter the market, inde-

[35]Note that there are 552 unique generic-brand pairs with a δ_S greater than 0.5 in our sample. This is 5% of all brand-generic pairs.

pendently of the level of common ownership. Especially for the most experienced (quartile 1), entry rates are much higher than for the rest (other quartiles). Secondly, highly experienced generics with high common ownership are significantly less likely to enter than highly experienced generics with low common ownership. In contrast, the existence of a strong common ownership link with the brand, i.e., high versus low common ownership, does not affect significantly the entry rates of less experienced generics.[36]

FIGURE V. Entry rate over level of experience and pairwise common ownership



Notes: High common ownership is defined at the pair level as $\delta_S > 0.5$, whereas low common ownership occurs if $\delta_S \leq 0.5$. Levels of experience are displayed in quartiles, with quartile 1 being the most experienced entrants and quartile 4 being the least experienced set of generics.

We confirm the intuition of the previous figure by performing regressions on split samples (by the four quartiles of generic experience). We use an indicator variable at the pair level for a strong link with the brand ($\delta_S > 0.5$). The rest of the specification is the same as for the pairwise regression that we run in Table VI. The results shown in Table X confirm the conclusions of the graphical analysis. The existence of a strong common ownership link with the brand, i.e., $\delta_S > 0.5$, reduces the likelihood of entry for the most experienced generics (quartile 1) more negatively than for less experienced generics (quartiles 2-4), both in terms of size and significance.[37]

[36]We perform a test of difference of means in each group. For the most experienced generics, the difference is significantly different from zero at the 10% level. For the other quartiles, the difference is insignificant.

[37]In in Table D9 in Appendix D, we show results using the continuous measure of common ownership δ_S.

TABLE X. Split by Experience Level - $I(\delta_S > 0.5)$

VARIABLES	(1) all	(2) quartile 1	(3) quartile 2	(4) quartile 3	(5) quartile 4
I($\delta_S > 0.5$)	-0.0141***	-0.0200**	-0.0110	0.00437	0.00264
	(0.00442)	(0.00838)	(0.00973)	(0.00895)	(0.00379)
Observations	34144	8676	8489	8589	8390
R-squared	0.0852	0.115	0.0342	0.0349	0.0451
All controls	Yes	Yes	Yes	Yes	Yes
Therapeutic field	Yes	Yes	Yes	Yes	Yes
Drug form	Yes	Yes	Yes	Yes	Yes
Submission type	Yes	Yes	Yes	Yes	Yes
Generic region of origin	Yes	Yes	Yes	Yes	Yes
Year end of exclusivity	Yes	Yes	Yes	Yes	Yes

Notes: OLS regression. Standard errors in parentheses are clustered at the drug market level. The dependent variable is entry within 6 quarters. The constant term and control variables are estimated but not reported. $***p < 0.01, **p < 0.05, *p < 0.1$.

VII. Market outcomes

In the previous section we have shown how common ownership between a particular generic firm and the brand affects the entry probability of that specific generic. The next step is to analyse how common ownership has an impact on overall market outcomes. We consider, in this section, the effect of market-level measures of common ownership (between all the potential generic entrants and the brand) on market-level measures of generic entry. While our market-level data is not suited to perform group-level analyses at the market-level, we will also discuss the effects on different types of potential generic entrants.

We first present the dependent and main independent variables, i.e., the market-level generic entry and common ownership variables. As market-level controls we use the same variables as in the pairwise analysis. Subsequently, we describe the empirical implementation and results. We, finally, provide a discussion of the results, making use of the analysis of the conceptual framework, presented in Appendix C.

Market entry. We consider several outcome variables to assess entry at the market level: (i) the number of generic entrants within 6 quarters of the end of exclusivity, (ii) the number of generic entrants ever, i.e., until the end of our dataset (iii) the share of actual generic entrants, out of the total number of potential entrants, within 6 quarters, (iv) the

share of actual generic entrants, out of the total number of potential entrants, ever, (v) the duration of time (in quarters) until the first generic enters, and finally (vi) the probability that there is no generic entry at all.[38]

Market level common ownership. To assess the effects of common ownership at the market level, we need to construct market level measures of common ownership. We build on our preferred measure of common ownership, $I(\delta_S > 0.5)$, and construct the market level measure δ_Z, which captures the fraction of "strong" common ownership links in the same market. For each market, we count the number of strong common ownership links and divide this number by the number of potential generic entrants. Formally,

$$\delta_Z(\text{m}) \equiv \frac{\sum_{g \in S_m} I(\delta_S(g,b) > 0.5)}{S_m}, \tag{6}$$

where $I()$ is again the indicator function which is equal to 1 if the argument is true, and to 0 otherwise, and S_m is the set of potential entrants in market m of the brand firm b.

Descriptive statistics. Table XI presents summary statistics for the market outcomes and the market level measures of common ownership. The average number of generic entrants within 6 quarters for our sample of drug markets is 2.4. This figure increases to 3.8 if we do not limit ourselves to a specific time window and consider all occurrences of entry in the data. On average the share of generic entrants who actually enter, out of the set of potential entrants, is 3.7%. On average, the first generic enters 6 quarters after the market becomes open for entry. For 20% of our markets, there is no generic entry at all. The average level of common ownership at the market level, as measured by δ_Z, is 0.04, with a minimum of 0 and a maximum of 32%.

[38] If there is no generic entry within the sample, the duration is calculated as the time between when the market becomes open for entry and the end date of the dataset.

TABLE XI. Summary statistics of market outcomes and common ownership measure

VARIABLES	(1) N	(2) mean	(3) sd	(4) min	(5) max
No. entrants within 6 quarters	395	2.400	2.978	0	17
No. entrants	395	3.838	4.070	0	23
Entry share within 6 quarters	395	0.0365	0.0603	0	0.500
Entry share	395	0.0564	0.0757	0	0.625
Time until first entry (in quarters)	395	5.954	11.93	0	55
No entry (0/1)	395	0.197	0.399	0	1
δ_Z	395	0.0434	0.0558	0	0.318

Empirical implementation. For each outcome variable we estimate the following linear model:

$$Y_m = \beta_0 + \beta\delta_Z(m) + \eta Z_m + A_m + \mu_t + \epsilon_m,$$

where Y_m is one of the outcome variables mentioned above (number of entrants within 6 quarters, number of entrants overall, entry share withing 6 quarters and overall, time until first entry and no entry at all), δ_Z is our market level measure of common ownership, Z_m is the vector of drug market control variables, A_m is a vector of fixed effects for drug form/route, submission class and therapeutic field (ATC-2 level), and lastly μ_t is a fixed effect for the year of the end of exclusivity.

Results. Table XII presents the coefficient estimates β for the market-wide measure of common ownership δ_Z. Common ownership has a negative effect on the number of entrants within 6 quarters (column 1), a negative effect on the number of entrants ever (column 2), a negative effect on the share of the potential entrants entering within 6 quarters (column 3), a negative effect on the share of the potential entrants entering ever (column 4), a positive impact on the time until the first generic entry (column 5), and a positive impact on the probability that there is no entry at all in the market (column 6). All the estimates are significant (at the 5% or 10% level), which is a strong result, we believe, given the small number of observations (one per market, 395 markets in total). Thus, not only does common ownership result in fewer generic entrants, it also delays the onset of generic competition and makes it more likely that a brand firm will face zero competition from

generic entrants.[39]

We now consider the economic magnitude of these effects. A one standard deviation increase in δ_Z leads to a 15% decrease in the number of entrants within 6 quarters (column 1), a 12% decrease in the number of entrants ever (column 2), a 18% decrease in the average share of potential entrants that actually enter the market in 6 quarters (column 3) and a 16% decrease within any time frame (column 4). A one standard deviation increase in the share of strong links extends the time to first generic entry by 1.3 quarters, which is a 24% increase in the average time until generic entry (column 5). Finally, a one standard deviation increase in the share of strong links increases the probability of no generic entry at all by $0.0558 \times 1.147 = 6.4$ percentage points (column 6) which represents a 32% increase in the unconditional probability of zero entry.

We can further use the estimated coefficients to make predictions. For example, using the results of column 2, we find that when going from the minimum level of δ_Z, i.e., having no major common ownership links at all, to the maximum market level of 0.32, the average number of entrants in a market would go down from about 4.2 to 1.7, keeping all else constant. Thus, we find that common ownership has an economically significant effect on total generic entry as it may reduce the average number of total entrants by more than 50%.

[39] As a second measure of market level common ownership, for robustness, we compute δ_S (market); the average of δ_S for all potential generic entrants for the relevant market. Results with this measures are presented in the Appendix Table D10. Results are similar although less significant, which is in line with the finding in the previous section that common ownership displays non-linear effects, where higher levels of common ownership have a larger and more significant impact.

TABLE XII. Market outcomes

VARIABLES	(1) N-6q	(2) N	(3) Share-6q	(4) Share	(5) Time	(6) No entry
δ_Z	-6.389**	-8.157**	-0.117*	-0.164**	25.48*	1.147**
	(2.641)	(3.636)	(0.0624)	(0.0772)	(13.80)	(0.506)
Market Size	3.643***	4.781***	0.0326**	0.0495***	-4.890**	-0.118*
	(0.901)	(1.088)	(0.0129)	(0.0164)	(2.232)	(0.0657)
Authorized Generic (0/1)	0.543	0.887*	0.0112	0.0158*	-2.486*	-0.108**
	(0.386)	(0.467)	(0.00805)	(0.00925)	(1.376)	(0.0426)
Orphan Drug (0/1)	-0.408	-0.199	0.00639	0.0114	1.792	0.0808
	(0.615)	(0.810)	(0.0167)	(0.0204)	(2.287)	(0.0845)
Pediatric Drug (0/1)	0.932**	1.458***	0.0209**	0.0295**	-2.687*	-0.0730
	(0.440)	(0.548)	(0.0105)	(0.0121)	(1.540)	(0.0504)
Substitutes on Patent (ATC2) ÷ 10	-0.334	-0.0923	-0.00410	-0.00794	0.520	-0.0139
	(0.488)	(0.635)	(0.00915)	(0.0123)	(1.786)	(0.0572)
Substitutes off Patent (ATC2) ÷ 10	-0.152	-0.490	-0.0119	-0.0162	-0.229	-0.00921
	(0.333)	(0.414)	(0.0105)	(0.0123)	(2.082)	(0.0593)
Observations	395	395	395	395	395	395
R-squared	0.393	0.467	0.385	0.449	0.330	0.353
Therapeutic field	Yes	Yes	Yes	Yes	Yes	Yes
Drug form	Yes	Yes	Yes	Yes	Yes	Yes
Submission type	Yes	Yes	Yes	Yes	Yes	Yes
Year end of exclusivity	Yes	Yes	Yes	Yes	Yes	Yes

Notes: OLS. Standard errors in parentheses are robust. The constant term is estimated but not reported. $***p < 0.01, **p < 0.05, *p < 0.1$.

Discussion. Section VI. shows that an increase in common ownership between a particular generic and the brand implies that this particular generic is less likely to enter. The results of this section show that this reduction in entry is not (entirely) filled by the entry of other generics. Indeed, an increase in the market-level average of common ownership (which could be produced from an increase in the common ownership of a particular generic-brand pair) reduces overall entry. Due to the low number of observations at the market level (and high levels of correlation between the group-level variables of common ownership), we cannot go beyond the average reported effects at the market level. However, we can make use our conceptual framework (see Appendix C) to propose a tentative explanation.

As we show in the Appendix, entry decisions between the pool of potential generic

entrants may exhibit strategic complementarities in the presence of common ownership between brand and generics. In other words, a reduction in the likelihood of entry of a given generic may induce a rival generic, if it has common ownership with the brand, to also less likely to enter the market. This happens because the entry of the first generic is more detrimental for the brand than that of additional entrants. Therefore, if a given generic's likelihood of entry goes down, a commonly owned rival generic could optimally respond by refraining from entering, as its entry may be especially harmful for the brand. Common investors may then see their generic gains out-weighted by their brand losses.

This effect allows for an overarching explanation of our pairwise and market results. Following an increase in common ownership between a focal generic and the brand, the focal generic enters less. Rival generics (those with positive levels of common ownership with the brand) might enter less, in reaction. The remaining generics, such as the non-experienced generics (see Section 6), may be non-strategic or have a too high entry cost to fill the gap. This leads to an overall decrease in entry.

VIII. Conclusion

Ownership linkages between firms, which typically arise due to large institutional investors holding shares in multiple firms at once, are a defining feature of firm ownership structures in the present day. Consequently the question of whether these investors influence firm strategies and correspondingly whether common ownership between rival firms has an effect on product markets outcomes have recently attracted significant attention.

In this article we consider the effect of common ownership on market entry decisions in the pharmaceutical industry. Given that generic entry results in substantial revenue losses for the brand firm and relatively lower revenue gains for generic entrants, we argue that higher levels of common ownership reduce generic entry as common owners have both the incentive and ability to push back entry. Our empirical results lend robust support to this proposition. We show that higher common ownership between a potential generic entrant and the brand incumbent firm in a specific drug market has a significant negative effect on the likelihood that the generic firm will enter the market. This is true for several measures of common ownership, different econometric methods, different definitions of the potential entrant set, different time-horizons and different sets of fixed effects. In terms of economic effects, based on our linear probability specifications, we find that a one-standard-deviation increase in common ownership decreases the probability of generic entry by 15-21%.

We further find that common ownership has a non-linear effect on entry, where stronger links have a much higher impact, and that the (average) negative effects of bilateral common ownership on entry are mainly driven by the most experienced generics. Still, compared to the effect of being fully owned by the brand, the effect of any level of common ownership between the generic and the brand is smaller.

In a next step, we find that an increase in market-level measures of common ownership, i.e., between all potential generics and the brand, has a negative effect on the overall number of entrants, as well as on the share of potential entrants that actually enter. We also find that common ownership delays generic entry and increases the probability that the brand will face zero competition from generic entrants. In terms of economic magnitudes, a one-standard- deviation increase in the market level of common ownership decreases the number of generics in that market by 13-15%, extends the time of generic entry by 24% and increases the probability of no generic entry at all by 32% relative to the mean.

Our research contributes to the literature on the product markets effects of common ownership and informs the current debate. We provide evidence that is consistent with the hypothesis that common shareholders indeed influence corporate decision-making. Given the importance of generic entry in terms of reducing drug prices and therefore overall healthcare costs, common ownership in the pharmaceutical industry may thus have the potential to raise the costs to consumers and healthcare payers.

While we believe our paper robustly shows that common ownership reduces entry at the individual and market level, there is room for future work on the topic. First, to make a clear and precise welfare assessment, one needs a structural empirical model, where entry decisions are explicitly modelled and detailed price data is used. Further, much still needs to be done to understand the corporate governance of common ownership, and this in several dimensions. First, how exactly holdings translate into incentives and ability to impact entry could help in opening the "black box" of common owners' influence mechanisms. Second, how preferences of diverse investors are aggregated into firm's decisions is another key aspect in understanding how (common) ownership translates into control.

Finally, US pharmaceutical markets are a clear example where common ownership can impact entry. Indeed, given the large asymmetries between brand and generic profits, incentives to delay entry are high. It would be interesting to identify other markets where both incentives and abilities are high, and to investigate whether common owners exert influence there too. We think these avenues provide for an exciting research agenda.

Appendices

A Common ownership

Anecdotal Evidence

We provide here some anecdotal evidence of common investors' influence in the pharama industry (see also Banal-Estanol et al., 2021). In 2016, a group of representatives of major US mutual funds (Fidelity Investments, T. Rowe Price Group Inc., Wellington Management Co., among others) met up with top biotechnology and pharmaceutical executives and lobbyists to discuss the pricing conditions of the market and the possible steps that could be taken in order to avoid future regulations. This example also illustrates that investor interactions need not be addressed to a particular company but can be extended to a specific industry.[40]

In 2019, BlackRock stated in their annual report that they engaged with a number of pharmaceutical companies including Abbott, Abbvie, Bristol-Myers Squibb, Pfizer, Novartis, Merck, GlaxoSmithKline, Johnson Johnson, Sanofi, Biogen, Allergan, Teva Pharmaceutical and Takeda.[41] Similarly, State Street reported in their 2019 annual report that they engaged with 64 pharmaceutical companies.[42] The head of corporate governance at State Street Global Advisors stated that "Our size, experience, and long term outlook provide us with corporate access and allow us to establish and maintain an open and constructive dialogue with company management and boards."[43]

More recently, in relation to the COVID-19 crisis, institutional investors have pushed for firms to collaborate with rivals and share information. In April 2020, a number of asset managers, including BlackRock and Fidelity, announced that "they want drug companies to put aside any qualms about collaborating with rivals." BlackRock held talks with pharma companies to discuss ways to develop and deploy treatments by "working with industry competitors." Separately, a group of 50 investors with over $2.5 trillion in assets requested that companies share their findings related to the vaccine and agree not to enforce the relevant patents. Since then a number of alliances have formed to collaborate on treatments and vaccines for COVID-19.[44]

Institutional investors have also been involved in merger decisions. BlackRock is reported to have actively pushed for a merger between the pharmaceutical firms AstraZeneca and Pfizer. The largest institutional shareholder in AstraZeneca and also a top five shareholder in Pfizer at the time, "urged the British pharma giant's board to eventually re-engage in talks with Pfizer Inc. over a possible deal."[45]

[40]See Caroline Chen, Mutual Fund Industry to Drugmakers: Stand Up and Defend Yourself, Bloomberg News, 2016, available at https://www.bloomberg.com/news/articles/2016-05-09/ top-funds-said-to-tell-pharma-leaders-to-defend-drug-pricing.

[41]See Investment Stewardship Annual Report, BlackRock, 2019, available at https://www.blackrock.com/corporate/literature/publication/blk-annual-stewardship-report-2019.pdf.

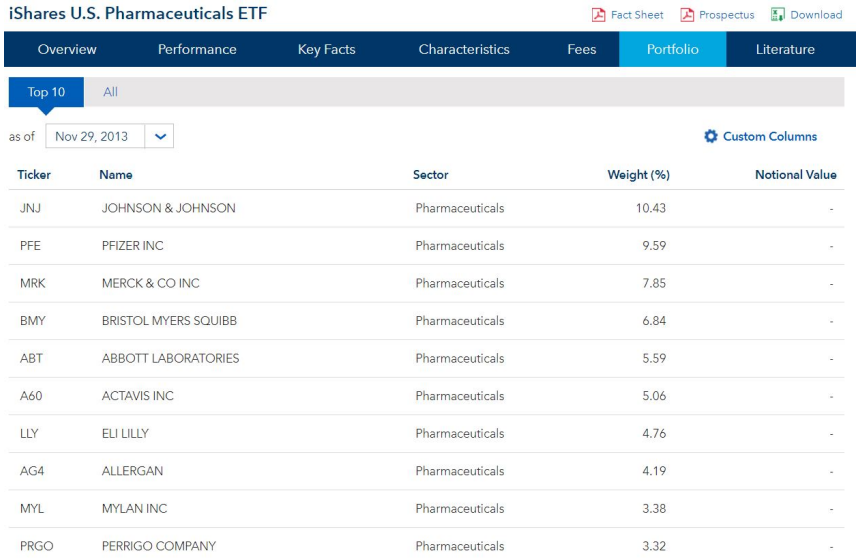
[42]See Stewardship Report, State Street, 2019 available at https://www.ssga.com/library-content/products/esg/annual-asset-stewardship-report-2018-19.pdf

[43]See Rakhi Kumar, Passive investment, active ownership, State Street, 2014, available at https://www.ft.com/content/7c5f8d60-ba91-11e3-b391-00144feabdc0

[44]See Attracta Mooney and Donato Mancini, Drugmakers urged to collaborate on coronavirus vaccine, Finanicial Times, April, 2020, available at https://www.ft.com/content/ b452ceb9-765a-4c25-9876-fb73d736f92a; Matt Levine, Investors Want a Cure, Not a Winner, Bloomberg, April, 2020, available at https: //www.bloomberg.com/opinion/articles/2020-04-24/investors-want-a-cure-not-a-winner

[45]See Hester Plumridge, AstraZeneca Shareholder Backs Board Rejection of Pfizer Bid,

FIGURE A1. iShares U.S. Pharmaceutical ETF (IHE) - Snapshot of Holdings



iShares U.S. Pharmaceuticals ETF

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Top 10 | All

as of Nov 29, 2013

Custom Columns

Ticker	Name	Sector	Weight (%)	Notional Value
JNJ	JOHNSON & JOHNSON	Pharmaceuticals	10.43	-
PFE	PFIZER INC	Pharmaceuticals	9.59	-
MRK	MERCK & CO INC	Pharmaceuticals	7.85	-
BMY	BRISTOL MYERS SQUIBB	Pharmaceuticals	6.84	-
ABT	ABBOTT LABORATORIES	Pharmaceuticals	5.59	-
A60	ACTAVIS INC	Pharmaceuticals	5.06	-
LLY	ELI LILLY	Pharmaceuticals	4.76	-
AG4	ALLERGAN	Pharmaceuticals	4.19	-
MYL	MYLAN INC	Pharmaceuticals	3.38	-
PRGO	PERRIGO COMPANY	Pharmaceuticals	3.32	-

Wall Street Journal, 2014, available at https://www.wsj.com/articles/ astrazeneca-shareholder-blackrock-sides-with-board-on-rejecting-pfizer-bid-1400791061; Phil Serafin Mary Childs, BlackRock Is Said to Encourage Pfizer-AstraZeneca Talks, BLOOMBERG, 2014, available at https://www.bloomberg.com/news/articles/2014-05-22/blackrock-is-said-to-encourage-pfizer-astrazeneca-talks

B Dataset construction

This Appendix contains a detailed description of how the data used for the analysis in this article was constructed. The Orange Book has been downloaded from the FDA website for each year (2001q4, 2002q4,..., 2017q4) using Internet Archive. In the current version of the Orange Book online the names of companies have been partially back-dated to display the current manufacturer of a drug. To establish the company name and drug status at the time of approval, we merged information from multiple versions of the FDA Orange Book.

Duplicate applications in the FDA Orange Book were identified and removed. Where duplicate applications had different approval dates, the earlier date was taken. Thereafter the products in the dataset were merged with historical patent data from the FDA based on the FDA drug application number and product number. The patent data provides a complete list of which patents are associated with the product and their corresponding expiration dates.

In the FDA Orange Book, a drug product can be identified as a unique ingredient-form-strength combination. For example, Cetirizine Hydrochloride in syrup form with a strength of 5mg/5ml. Initially, the FDA Orange Book reports 3964 products at the ingredient-form-strength level that were launched from 1982q1 until 2017q2. For our purposes we restricted the data in multiple ways. First, we consider only drug products that faced generic entry or patent expiry in the time frame 2004q1 to 2014q4 (this is the range where we have data on all variables). This results in a sample of 1080 unique drug products. We then drop drug products which are not linked to any patent (as this study focuses on market entry in markets that are initially protected by patents). This results in 666 unique drug products. Thereafter we drop OTC drugs, keeping only prescription drugs. This results in 640 unique drug products.

On the basis of information contained in the Orange Book we seek to remove drug products where the original brand drug was withdrawn for safety reasons. We identify these products as cases where the original brand has been discontinued, and there is no note in the Orange Book that the discontinuation was not for safety reasons. Dropping these brand products results in 554 unique drug products. We drop two further drug products where generic applications (ANDAs) were approved before the NDA application for the same ingredient-form-strength. This results in 552 drug products.

We then aggregate these drug products to the ingredient-form level. We take the first strength that was approved by the FDA at the ingredient-form level as the relevant brand product. We then identify subsequent ANDAs that were approved at the same ingredient-form level. In cases where a generic enters with multiple strengths, we keep only the earliest entry. This results in 457 unique drug product markets, or brand products, at the ingredient-form level.

A variable is constructed that takes the earlier of either generic entry or the date of the last expiring patent for the relevant product market at the ingredient-form level; called "end of exclusivity."

Each product is linked through exact text matching, based on compound-name, with the ATC/DDD Index 2015.[46] The ATC/DDD Index 2015 is used to identify relevant therapeutic markets and chemical classes for different levels of the ATC classification system. Whereas the ATC3 level is most in line with

[46]The ATC/DDD Index 2015 categorizes all chemical compounds used in any therapeutic field according to a five-level hierarchical system, called the Anatomical Therapeutic Chemical (ATC) Classification System. The highest level (ATC1) consist of 14 anatomical main groups (e.g. Alimentray Tract and Metabolism (A) or Cardiovascular System (C)). The next lower level (ATC2) describes 88 therapeutic main groups (e.g. Drugs used in Diabetes (A10) or Diuretics (C03)). Lower levels make even finer distinctions between products. The lowest level (ATC5) indicates 3709 chemical substances.

market definition in M&A approval procedures in Europe and the United States, through the matching process one drug may be linked with numerous therapeutic classes at the ATC3 level. To ensure that we obtain a unique therapeutic class for each drug, we use the broader market definition of ATC2.

For each drug product market, we identify if the brand firm has launched its own generic in the market (an "authorized generic") using the FDA list of authorized generics. The merge was conducted on the basis of trade name and form. Additional information, such as submission class, is merged in using the FDA application number.[47] We recode the FDA form/route variable to construct five form/route classes namely oral, injection, topical, ophthalmic and inhalation.

The data on firms and their product launches from the FDA Orange book is then matched with the Thomson Reuters ownership dataset based on the name of the pharmaceutical company. We correct for the fact that firms may change their name over the course of the sample period and undergo mergers, on the basis of public information. We record the year-quarters in which each firm is either publicly listed or not. For example, some companies in the sample start out being publicly listed, and then are taken off the stock exchange (e.g., if they experience a leveraged buyout) and then are later made public again. It can occur that a company that is known to have been public in a specific year-quarter, has no ownership information in this year-quarter in the Thomson Reuters dataset. Where we have a public firm in the pair that has missing ownership data we remove this pair from the analysis. A total 6 markets are dropped due to missing ownership data, resulting in 451 drug markets.

We then match the brand drug products in our sample with Medicaid reimbursement data, publicly available from medicaid.gov, at the national level using National Drugs Codes (NDC) which are unique product identifiers for drugs in the US. A drug product in our sample may be matched with multiple NDC codes due to the fact we define drug products at the ingredient-form level, whereas NDC codes are defined at the finest level taking drug strength and package size into account. We aggregate information on the total amount reimbursed per year by summing over NDC codes for a drug product. Due to that fact that some drugs cannot be matched with Medicaid reimbursements, we are left with 395 unique drug product markets.

Subsidiary firms are assigned the ownership structure of the parent firm under the assumption that they are fully controlled by the parent. However in recognition of the fact that the subsidiary is a separate entity from the parent with its own previous experience, we determine all experience variables at the subsidiary level. That is, we do not assign the experience of the parent to the subsidiary.

In the final dataset, there are 93 unique brand companies and 189 unique generic companies operating within the relevant markets and time period. Given that the focus of the article is on links between brand and generic companies, we then make our dataset pairwise; creating brand-generic pairs. There are 10,453 unique pairs.

The common ownership measures are constructed at the pair level using data from Thomson Reuters Global Ownership Database from 2003 to 2014. We calculate common ownership measures in the year of the end of exclusivity (lag 0), one year prior (lag 1) and two years prior (lag 2). When constructing measures of common ownership, we restrict ourselves to the investor holdings that represent at least one percent in the equity of the firms. Investor acquisitions during this period and ultimate owners are identified on the basis of public sources.

[47]The main submission classes include Type 1 New Molecular Entity, Type 2 New Active Ingredient, Type 3 New Dosage Form, Type 4 New Combination, Type 5 New Formulation or Other Differences (e.g., new indication, new applicant, new manufacturer).

C Simple model of strategic interaction

In this Appendix, we characterize the entry decisions of a set of *strategic* entrants, i.e., firms that take the entry decisions of other firms into account, making use of the setting of the conceptual framework, described in Section III. We first use the case of two potential generic entrants to illustrate the type of strategic effects that may appear in this setting. Thereafter we characterize the equilibrium entry decisions of N symmetric generics as a function of their individual (and market) level of common ownership with the brand, δ. All the proofs can be found in the last subsection of this Appendix.

Let us make the following additional assumptions. To make the problem interesting, let us assume that generic profits increase with entry, $\pi_g^k > 0$. This is consistent with the evidence in Figure I. We also assume that generic competition reduces individual generic profits, i.e. π_g^k is decreasing in k, and that the change in the brand firm's profit loss decreases with the number of entrants, i.e. $\left|\Delta\pi_b^k\right|$ is decreasing in k. This is also consistent with the evidence in Figure I: brand revenues decline steadily with the number of entrants, but the marginal loss for an additional entrant is smaller for larger number of entrants.

Strategic effects: complements or substitutes?

For ease of illustration, let us restrict ourselves in this subsection to the case of $N = 2$ potential generic entrants. Neither the analysis nor the notation of this subsection uses the symmetry assumption. This assumption, though, simplifies the notation and the equilibrium analysis of the following subsection.

We investigate if focal generic g is less (or equally) likely to enter as the probability p_1 of having a competing generic increases, and the probability p_0 of having none declines ("strategic substitutes"); or alternatively, if g is more (or equally) likely to enter as p_1 increases ("strategic complements"). Substituting $p_0 = 1 - p_1$ and deriving Π_g in (1) with respect to p_1,

$$\partial\Pi_g(p_0, p_1, \delta)/\partial p_1 = (\pi_g^1 - \pi_g^0) + \delta(\Delta\pi_b^1 - \Delta\pi_b^0),$$

we can identify two effects. The first term is negative, as $\pi_g^0 > \pi_g^1$, and therefore the gains from entry of g are lower if the other is more likely to enter. This is the traditional business stealing effect from competition of other generics. The second term, though, is positive, as $\left|\Delta\pi_b^0\right| > \left|\Delta\pi_b^1\right|$. As the other generic is more likely to enter, the effect of focal generic entry on the brand firm is less detrimental, as the reduction of brand profits in the presence of another competing generic is smaller.

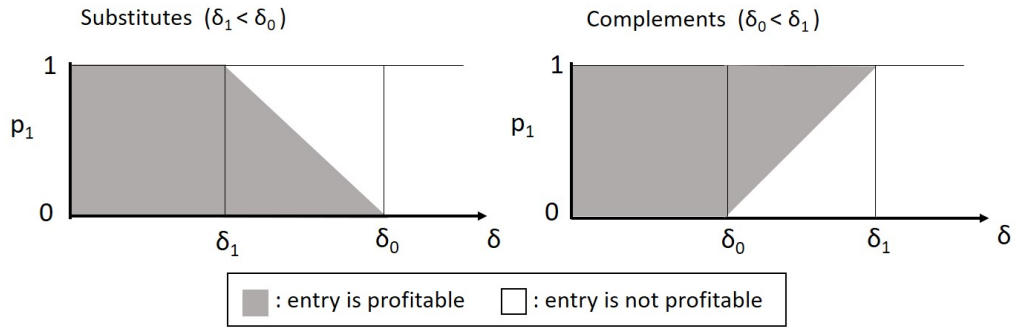
The overall effect depends on which of the two effects, proxied by the profits of generic entrant π_g^k and the loss in profits of the brand $\left|\Delta\pi_b^k\right|$, decreases faster with the entry of others, and thus how the ratio $\bar{\delta}_k \equiv \pi_g^k / \left|\Delta\pi_b^k\right|$ changes with k. If the generic profits decrease faster, and thus the ratios are such that $\bar{\delta}_1 < \bar{\delta}_0$, others entering is more detrimental and entry decisions exhibit strategic substutabilities. Instead, if the brand losses decrease faster, and thus $\bar{\delta}_0 < \bar{\delta}_1$, others entering is less detrimental and entry decisions exhibit strategic complementarities. The results are summarized in the following proposition.

Proposition 1. *(a) If $\bar{\delta}_1 < \bar{\delta}_0$, the generic firm g is less (or equally) likely to enter if the other generic firm is more likely to enter (strategic substitutability).*
(b) If $\bar{\delta}_0 < \bar{\delta}_1$, the generic firm g is more (or equally) likely to enter if the other generic is more likely to enter (strategic complementarity).

Figure C1 depicts the combinations of g's common ownership with the brand, δ, and probability of the

other entering, p_1, for which g's entry is profitable (marked in the darker shade in the figure); where the left panel shows the case of strategic substitutes and the right panel the case for strategic complements. Clearly, for a given p_1, common ownership reduces entry profitability. But the effect of the probability of the other entering, p_1, for a given level of common ownership δ has non-trivial effects on the profitability of entering. An increase in p_1 may mean that entry switches from profitable to unprofitable in the intermediate region of δ in the case of substitutes (the left-hand panel) whereas it may switch from unprofitable to profitable in the intermediate region of δ in the case of complements (the right-hand panel). Still, in both cases, entry is profitable for any p_1 if δ is sufficiently low, i.e. entering is a dominant strategy, whereas entry is unprofitable for any p_1 if δ is sufficiently high, i.e. not entering is a dominant strategy.

FIGURE C1. Profitable entry of g as a function of δ and p_1



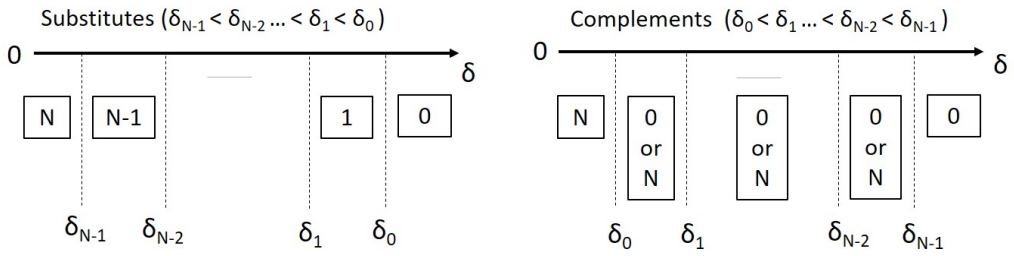
Equilibrium entry decisions

Now let us consider the pure-strategy equilibrium decisions in the general case of N potential entrants as a function of their symmetric level of common ownership with the brand, δ. Note that δ is both the individual and market levels of common ownership of the generics with the brand in this symmetric setting. Considering and distinguishing between the two cases identified in the previous proposition, the next proposition summarizes the overall number of entrants in equilibrium.

Proposition 2. *(a) In the case of strategic substitutes ($\bar{\delta}_{N-1} < \bar{\delta}_{N-2} < ... < \bar{\delta}_0$), the number of entrants in equilibrium is: N if $\delta \leq \bar{\delta}_{N-1}$; $N-k$ if $\bar{\delta}_{N-k} < \delta \leq \bar{\delta}_{N-k-1}$ for $k = 1, ..., N-1$; and 0 if $\bar{\delta}_0 < \delta$.*
(b) In the case of strategic complements ($\bar{\delta}_0 < \bar{\delta}_1 < ... < \bar{\delta}_{N-1}$), the number of entrants in equilibrium is: N if $\delta \leq \bar{\delta}_0$; N or 0 if $\bar{\delta}_0 < \delta \leq \bar{\delta}_{N-1}$; and 0 if $\bar{\delta}_{N-1} < \delta$.

Figure C2 depicts the number of entrants in equilibrium as a function of their symmetric level of common ownership with the brand, δ. In both cases, there exists multiple equilibria in all the intermediate regions. But in the case of strategic substitutes, the equilibrium difference is between the identity of entrants and not how many of the entrants enter. In the case of complementarities, the equilibrium number of entrants is extreme, either none or all of them shall enter. This is because, in the case of substitutes, the entry of another generic makes generic entry less profitable, whereas in the case of complements, it makes it more profitable.

FIGURE C2. Number of entrants in equilibrium as a function of δ



Still, in both cases, the equilibrium number of entrants decreases with the level of common ownership, as long as we assign a fixed probability of selecting one equilibrium over another.

Proof of Proposition 1

We determine the optimal entry decision of focal generic firm g for a given probability of entry of the other generic, p_1, i.e. the best response function.

We first note that whether profits of the focal generic increase if the other is more likely to enter depends on the level of common ownership. Indeed, in the case where $N = 2$, we can write the profits as a function of just p_1,

$$\Pi_g(p_1, \delta) = (1 - p_1)(\pi_g^0 + \delta \Delta \pi_b^0) + p_1(\pi_g^1 + \delta \Delta \pi_b^1)$$

and, as displayed in the text,

$$\partial \Pi_g(p_1, \delta)/\partial p_1 = (\pi_g^1 - \pi_g^0) + \delta(\Delta \pi_b^1 - \Delta \pi_b^0).$$

As this function is strictly increasing in δ ($\partial^2 \Pi_g(p_1, \delta)/\partial p_1 \partial \delta = \Delta \pi_b^1 - \Delta \pi_b^0 > 0$), and it has a negative intercept ($\partial \Pi_g(p_1, 0)/\partial p_1 = \pi_g^1 - \pi_g^0 < 0$), there exists δ^* such that, if $\delta \leq \delta^*$, profits are decreasing in p_1 ($\partial \Pi_g(p_1, \delta)/\partial p_1 \leq 0$) whereas, if $\delta > \delta^*$, profits are increasing in p_1 ($\partial \Pi_g(p_1, \delta)/\partial p_1 > 0$), where

$$\delta^* \equiv -(\pi_g^1 - \pi_g^0)/(\Delta \pi_b^1 - \Delta \pi_b^0).$$

Second, we determine the optimal decision in cases where the other generic uses pure-strategies:

- If $p_1 = 0$ (i.e., it does not enter for sure), g shall it find it optimal to enter if $\delta \leq \bar{\delta}_0$ as $\Pi_g(0, \delta) = \pi_g^0 + \delta \Delta \pi_b^0 \geq 0$ if and only if

$$\delta \leq \pi_g^0 / \left| \Delta \pi_b^0 \right| \equiv \bar{\delta}_0.$$

- Similarly, if $p_1 = 1$ (i.e., it does enter for sure), g shall it find it optimal to enter if $\delta \leq \bar{\delta}_1$ as $\Pi_g(1, \delta) = \pi_g^1 + \delta \Delta \pi_b^1 \geq 0$ if and only if

$$\delta \leq \pi_g^1 / \left| \Delta \pi_b^1 \right| \equiv \bar{\delta}_1.$$

Simple algebra shows that if $\bar{\delta}_1 < \bar{\delta}_0$ then $\bar{\delta}_0 < \delta^*$ whereas if $\bar{\delta}_0 < \bar{\delta}_1$ then $\delta^* < \bar{\delta}_0$. These two cases affect the strategic interaction.

Let us now consider the best response function for different levels of common ownership, δ. We first show that, if $\bar{\delta}_1 < \bar{\delta}_0$ and thus $\bar{\delta}_1 < \bar{\delta}_0 < \delta^*$, focal generic g is less (or equally) likely to enter if p_1 is greater (termed "strategic substitutes"). Still, it may be that the generic's profits increase with the entry of the other, as long as it does not affect the decision.

- If $\delta \leq \bar{\delta}_1$ then entering is a dominant strategy. Indeed, we have that $\delta < \delta^*$ and g is less likely to enter if the probability of entering of the other is greater ($\partial \Pi_g(p_1, \delta)/\partial p_1 < 0$). As $\delta \leq \bar{\delta}_1$, g should enter for any p_1 as $\Pi_g \geq 0$ even in the most adverse case, in which the other does enter for sure, $p_1 = 1$.

- In the case in which $\bar{\delta}_1 < \delta \leq \bar{\delta}_0$, the decision to enter depends on p_1: g should enter if the probability of the other entering is low. In formal terms, $\Pi_g > 0$ if and only if $p_1 < p_1^*$ where p_1^* is such that $\Pi_g(p_1^*, \delta) = 0$. Notice that p_1^* is well defined, as $\Pi_g(0, \delta) > 0$ (as $\delta < \bar{\delta}_0$), $\partial \Pi_g(p_1, \delta)/\partial p_1 < 0$ (as $\delta < \delta^*$) and $\Pi_g(1, \delta) < 0$ (as $\delta > \bar{\delta}_1$). In addition, note that the threshold level of p_1^* is decreasing in the level of common ownership,

$$\partial p_1^* / \partial \delta = -[\partial \Pi_g(p_1, \delta)/\partial \delta] / [\partial \Pi_g(p_1, \delta)/\partial p_1] < 0.$$

- If $\bar{\delta}_0 < \delta \leq \delta^*$, then not entering is a dominant strategy. Indeed, g should not enter for any p_1 as $\Pi_g < 0$ even in the most favorable case, in which the other does not enter for sure, $p_1 = 0$.

- In case the levels of common ownership δ are such that $\delta > \delta^*$ then not entering is dominant. In that case g is more likely to enter if the probability of entering of the other is greater ($\partial \Pi_g(p_1, \delta)/\partial p_1 > 0$), but g should not enter for any p_1 as $\Pi_g < 0$ even in the most favorable case, in which the other enters for sure, $p_1 = 1$ as $\delta > \bar{\delta}_1$.

Second, we show that, if $\bar{\delta}_0 < \bar{\delta}_1$ and thus $\delta^* \leq \bar{\delta}_0 < \bar{\delta}_1$, focal generic g is more (or equally as) likely to enter if p_1 is greater (labeled as "strategic complements").

- In case the levels of common ownership δ are such that $\delta < \delta^*$ then entering is dominant. In that case g is less likely to enter if the probability of entering of the other is greater ($\partial \Pi_g(p_1, \delta)/\partial p_1 < 0$) but g should p_1 as $\Pi_g > 0$ even in the most adverse case, in which the other enters for sure, $p_1 = 1$ as $\delta < \bar{\delta}_1$.

- In the case in which $\delta^* < \delta \leq \bar{\delta}_0$, entering is dominant. Indeed as $\delta > \delta^*$ g is more likely to enter if the probability of entering of the other is greater $\partial \Pi_g(p_1, \delta)/\partial p_1 > 0$). As $\delta < \bar{\delta}_0$ g should enter for any p_1 as $\Pi_g > 0$ even in the most adverse case, in which the other does not enter for sure, $p_1 = 0$.

- In the case in which $\bar{\delta}_0 < \delta \leq \bar{\delta}_1$, the decision to enter depends on p_1: g should enter if the probability of the other entering is high. In formal terms, $\Pi_g > 0$ if and only if $p_1 > p_1^*$ where p_1^* is such that $\Pi_g(p_1^*, \delta) = 0$. Notice that p_1^* is well defined, as $\Pi_g(0, \delta) < 0$ (as $\delta > \bar{\delta}_0$), $\partial \Pi_g(p_1, \delta)/\partial p_1 > 0$ (as $\delta > \delta^*$) and $\Pi_g(1, \delta) > 0$ (as $\delta < \bar{\delta}_1$). In addition, note that the threshold level of p_1^* is decreasing in the level of common ownership,

$$\partial p_1^*/\partial \delta = -[\partial \Pi_g(p_1, \delta)/\partial \delta]/[\partial \Pi_g(p_1, \delta)/\partial p_1] > 0.$$

- If $\delta^* > \bar{\delta}_1$ g then not entering is dominant. Indeed g should not enter for any p_1 as $\Pi_g < 0$ even in the most favorable case, in which the other does enter for sure, $p_1 = 1$.

Proof of Proposition 2

We proceed in two steps. We first determine the optimal entry decision of focal generic firm g for each entry decision of the other $N-1$ generics. That is, we compute, as in the previous proposition, the best response function (which depends again on the level of common ownership). But here, although allowing for N generics, we concentrate on pure strategies. As we assume generics to be symmetric, the key is how many, but not which one, of the others decide to enter. In a second step, we compute the (pure-strategy) Nash equilibria.

As in the previous proposition, in case k of the other entrants enter ($k = 0, ...N-1$, $p_k = 1$ and, for any $j \neq k$, $p_j = 0$), g shall it find it optimal to enter if and only if $\delta \leq \bar{\delta}_k$ as $\Pi_g = \pi_g^k + \delta \Delta \pi_b^k \geq 0$ if and only if

$$\delta \leq \pi_g^k / \left| \Delta \pi_b^k \right| \equiv \bar{\delta}_k.$$

In the case of a single potential entrant ($N = 1$ and $k = 0$), this is the optimal decision: enter if $\delta \leq \bar{\delta}_0$ and do not if $\delta > \bar{\delta}_0$. In this case, parts (a) and (b) in the statement of the proposition are the same. From now on we consider $N > 1$.

Now let us consider the two cases of the statement of the proposition. Suppose first that $\bar{\delta}_{N-1} < \bar{\delta}_{N-2} < ... < \bar{\delta}_0$ ("strategic substitutes"). The best response function of g with respect to the number of other entrants depends, as in the previous proposition, on the level of common ownership.

- If $\delta \leq \bar{\delta}_{N-1}$ entering is a dominant strategy for g, independent of the number of other entrants, as $\delta \leq \bar{\delta}_k$ for any k.

- If $\bar{\delta}_{N-k} < \delta \leq \bar{\delta}_{N-k-1}$ for any $k = 1, ..., N-1$, g shall enter if $N-k-1$ other generics, or less, enter, as $\delta \leq \bar{\delta}_{N-k-1} < ... < \bar{\delta}_0$, but it shall not enter if $N-k$ other generics, or more, do enter, as $\bar{\delta}_{N-1} < ... < \bar{\delta}_{N-k} \leq \delta$.

- Finally, if $\delta > \bar{\delta}_0$ not entering is a dominant strategy, as $\delta > \bar{\delta}_k$ for any k.

For instance in the case of two potential entrants ($N = 2$), g should enter if $\delta \leq \bar{\delta}_1$, enter if and only if the other does not enter if $\bar{\delta}_1 < \delta \leq \bar{\delta}_0$ (as $N = 2$, $k = 1$, $N-k-1 = 0$ and $N-k = 1$) and not enter if $\delta > \bar{\delta}_0$.

The equilibrium number of entrants also depends on the (symmetric) level of common ownership with the brand.

- If $\delta \leq \bar{\delta}_{N-1}$ all should enter in equilibrium, as entering is a dominant strategy.

- If $\bar{\delta}_{N-k} < \delta \leq \bar{\delta}_{N-k-1}$ for any $k = 1, ..., N-1$, $N-k$ generics should enter in equilibrium, as entering is optimal if $N-k-1$ other generics enter and not entering is optimal if $N-k$ do so.

- Finally, if $\delta > \bar{\delta}_0$ none of them should enter as not entering is a dominant strategy.

For instance in the case of two potential entrants ($N = 2$, which implies $k = 1$), the two generics should enter if $\delta \leq \bar{\delta}_1$, one of them should enter if $\bar{\delta}_1 < \delta \leq \bar{\delta}_0$ (as $N = 2$, $k = 1$ and $N-k = 1$) and none of them should enter if $\delta > \bar{\delta}_0$.

Suppose now that $\bar{\delta}_0 < \bar{\delta}_1 < ... < \bar{\delta}_{N-1}$ ("strategic complements"). The best response function of g with respect to the number of other entrants is now as follows:

- If $\delta \leq \bar{\delta}_0$ entering is again a dominant strategy for g, as $\delta < \bar{\delta}_k$ for any k.

- But now, if $\bar{\delta}_{N-k-1} < \delta \leq \bar{\delta}_{N-k}$ for any $k = 1, ..., N-1$, g shall enter if $N-k$ other generics, or more, enter, as $\delta \leq \bar{\delta}_{N-k} < ... < \bar{\delta}_{N-1}$, but it shall not enter if $N-k-1$ other generics, or less, do enter, as $\delta_0 < ... < \bar{\delta}_{N-k-1} < \delta$.

- Similarly, if $\delta > \bar{\delta}_{N-1}$ not entering is again a dominant strategy, as $\delta > \bar{\delta}_k$ for any k.

For instance in the case of two potential entrants ($N = 2$), g should enter if $\delta \leq \bar{\delta}_0$, enter if and only if the other does enter if $\bar{\delta}_0 < \delta \leq \bar{\delta}_1$ and not enter if $\delta > \bar{\delta}_2$.

The equilibrium number of entrants also depends on the (symmetric) level of common ownership with the brand.

- As before, if $\delta \leq \bar{\delta}_0$ all should enter in equilibrium, as entering is a dominant strategy.

- But the equilibria in the intermediate cases $\bar{\delta}_0 < \delta \leq \bar{\delta}_{N-1}$ are different: either all the N generics enter or none of them does. Indeed, if $N-1$ generics enter, it is optimal to enter, as $\delta \leq \bar{\delta}_{N-1}$, and if 0 of them does, it is optimal not to enter either, as $\delta > \bar{\delta}_0$. Moreover, there is no equilibrium within $\bar{\delta}_0 < \delta \leq \bar{\delta}_{N-1}$ in which k generics enter, for k is such that $0 < k < N$. Indeed, if an entrant finds it profitable to enter then it should also be profitable for those that do not enter (and if one of the non-entrants find it profitable not to enter then it should also be non-profitable for one of the entrants).

- Finally, if $\delta > \bar{\delta}_{N-1}$ none of them should enter as not entering is a dominant strategy.

In the case of two potential entrants ($N = 2$, which implies $k = 1$), the two generics should enter if $\delta \leq \bar{\delta}_0$, the two or none of them should enter if $\bar{\delta}_0 < \delta \leq \bar{\delta}_1$ and none of them should enter if $\delta > \bar{\delta}_1$.

D Further tables

TABLE D1. First-stage IV regressions

	(1)	(2)	(3)	(4)	(5)
VARIABLES	δ_S	δ_C	δ_{top5}	δ_{top10}	δ_L
Index Presence	0.337***	0.151***	0.296***	0.297***	0.402***
	(0.00885)	(0.00444)	(0.0127)	(0.00752)	(0.0152)
Constant	0.00990	-0.00263	-0.0273	-0.0217	0.00824
	(0.0328)	(0.0101)	(0.0274)	(0.0253)	(0.0295)
Observations	34,144	34,144	34,144	34,144	34,144
R-squared	0.400	0.487	0.421	0.480	0.404
Fixed Effects	Yes	Yes	Yes	Yes	Yes
Drug markets	395	395	395	395	395
F-stat excl. instruments	1454	1157	540.6	1556	704.7
Endogeneity test (p-val)	0.929	0.593	0.833	0.857	0.649

Notes: For simplicity only the coefficient associated with the excluded instrument is reported. $***p < 0.01, **p < 0.05, *p < 0.1$.

TABLE D2. Robustness - Drug market fixed effects

VARIABLES	(1)	(2)	(3)	(4)	(5)
δ_S	-0.0220***				
	(0.00613)				
δ_C		-0.0649***			
		(0.0176)			
δ_{R5}			-0.0254***		
			(0.00697)		
δ_{R10}				-0.0269***	
				(0.00750)	
δ_L					-0.0240***
					(0.00527)
Subsidiary (0/1)	-0.0481***	-0.0467***	-0.0240	-0.0241	-0.0475***
	(0.0142)	(0.0142)	(0.0150)	(0.0150)	(0.0142)
Experience Route ÷ 10	0.00825***	0.00824***	0.00823***	0.00825***	0.00827***
	(0.000680)	(0.000680)	(0.000680)	(0.000680)	(0.000680)
Experience ATC2 ÷ 10	0.0629***	0.0630***	0.0631***	0.0631***	0.0628***
	(0.00810)	(0.00810)	(0.00809)	(0.00810)	(0.00810)
Experience New Drug ÷ 10	0.00408	0.00375	0.00373	0.00395	0.00426
	(0.00296)	(0.00290)	(0.00288)	(0.00294)	(0.00293)
Breadth (ATC2) ÷ 10	0.00199	0.00202	0.00187	0.00197	0.00191
	(0.00150)	(0.00151)	(0.00150)	(0.00150)	(0.00150)
Observations	34144	34144	34144	34144	34144
R-squared	0.121	0.121	0.121	0.121	0.121
Generic region of origin	Yes	Yes	Yes	Yes	Yes
Drug product fixed effect	Yes	Yes	Yes	Yes	Yes
Drug markets	395	395	395	395	395

Notes: OLS regression. Standard errors in parentheses are robust. The dependent variable is entry within 6 quarters. The constant term is estimated but not reported. $***p < 0.01, **p < 0.05, *p < 0.1$.

TABLE D3. Robustness - Probit

VARIABLES	(1)	(2)	(3)	(4)	(5)
δ_S	-0.426***				
	(0.126)				
δ_C		-1.212***			
		(0.356)			
δ_{R5}			-0.421***		
			(0.145)		
δ_{R10}				-0.462***	
				(0.147)	
δ_L					-0.396***
					(0.125)
Subsidiary (0/1)	-0.918*	-0.891*	-0.478	-0.459	-0.890*
	(0.508)	(0.505)	(0.512)	(0.511)	(0.505)
Experience Route ÷ 10	0.0742***	0.0744***	0.0740***	0.0743***	0.0742***
	(0.00586)	(0.00586)	(0.00591)	(0.00586)	(0.00589)
Experience ATC2 ÷ 10	0.386***	0.389***	0.388***	0.390***	0.386***
	(0.0571)	(0.0571)	(0.0570)	(0.0570)	(0.0571)
Experience New Drug ÷ 10	-0.0874**	-0.0908**	-0.0954***	-0.0926**	-0.0902**
	(0.0376)	(0.0373)	(0.0368)	(0.0374)	(0.0370)
Breadth (ATC2) ÷ 10	0.217***	0.221***	0.211***	0.217***	0.214***
	(0.0275)	(0.0275)	(0.0275)	(0.0276)	(0.0274)
Market Size	0.360***	0.358***	0.357***	0.358***	0.358***
	(0.0885)	(0.0886)	(0.0881)	(0.0887)	(0.0881)
Authorized Generic (0/1)	0.117*	0.118*	0.116*	0.116*	0.118*
	(0.0648)	(0.0649)	(0.0650)	(0.0650)	(0.0649)
Orphan Drug (0/1)	-0.0419	-0.0390	-0.0422	-0.0409	-0.0427
	(0.109)	(0.109)	(0.109)	(0.109)	(0.109)
Pediatric Drug (0/1)	0.199***	0.199***	0.198***	0.201***	0.197***
	(0.0738)	(0.0739)	(0.0744)	(0.0743)	(0.0740)
Substitutes on Patent (ATC2) ÷ 10	-0.0636	-0.0624	-0.0602	-0.0626	-0.0635
	(0.0879)	(0.0875)	(0.0876)	(0.0876)	(0.0875)
Substitutes off Patent (ATC2) ÷ 10	-0.0567	-0.0551	-0.0596	-0.0575	-0.0576
	(0.0758)	(0.0761)	(0.0761)	(0.0762)	(0.0757)
Observations	32994	32994	32994	32994	32994
Therapeutic field	Yes	Yes	Yes	Yes	Yes
Drug form	Yes	Yes	Yes	Yes	Yes
Submission type	Yes	Yes	Yes	Yes	Yes
Generic region of origin	Yes	Yes	Yes	Yes	Yes
Year end of exclusivity	Yes	Yes	Yes	Yes	Yes
Drug markets	395	395	395	395	395

Notes: Probit regression. Standard errors in parentheses are clustered at the drug market level. The dependent variable is entry within 6 quarters. The constant term is estimated but not reported. $***p < 0.01, **p < 0.05, *p < 0.1$.

TABLE D4. Robustness - Logit

VARIABLES	(1)	(2)	(3)	(4)	(5)
δ_S	-0.893***				
	(0.267)				
δ_C		-2.691***			
		(0.744)			
δ_{R5}			-0.911***		
			(0.307)		
δ_{R10}				-0.965***	
				(0.308)	
δ_L					-0.957***
					(0.266)
Subsidiary (0/1)	-2.232**	-2.160*	-1.270	-1.264	-2.170*
	(1.116)	(1.113)	(1.135)	(1.133)	(1.113)
Experience Route ÷ 10	0.149***	0.150***	0.149***	0.149***	0.150***
	(0.0119)	(0.0120)	(0.0121)	(0.0120)	(0.0121)
Experience ATC2 ÷ 10	0.685***	0.690***	0.690***	0.692***	0.685***
	(0.119)	(0.119)	(0.118)	(0.118)	(0.119)
Experience New Drug ÷ 10	-0.187**	-0.190**	-0.202**	-0.198**	-0.184**
	(0.0815)	(0.0810)	(0.0802)	(0.0812)	(0.0804)
Breadth (ATC2) ÷ 10	0.528***	0.536***	0.518***	0.527***	0.522***
	(0.0588)	(0.0586)	(0.0589)	(0.0588)	(0.0586)
Market Size	0.778***	0.775***	0.772***	0.773***	0.778***
	(0.191)	(0.191)	(0.190)	(0.191)	(0.190)
Authorized Generic (0/1)	0.251*	0.251*	0.247*	0.246*	0.251*
	(0.140)	(0.140)	(0.140)	(0.140)	(0.140)
Orphan Drug (0/1)	-0.0628	-0.0523	-0.0639	-0.0605	-0.0645
	(0.235)	(0.235)	(0.236)	(0.235)	(0.236)
Pediatric Drug (0/1)	0.462***	0.461***	0.459***	0.465***	0.459***
	(0.163)	(0.163)	(0.164)	(0.164)	(0.163)
Substitutes on Patent (ATC2) ÷ 10	-0.125	-0.121	-0.120	-0.123	-0.126
	(0.192)	(0.192)	(0.191)	(0.191)	(0.191)
Substitutes off Patent (ATC2) ÷ 10	-0.146	-0.144	-0.153	-0.148	-0.148
	(0.169)	(0.170)	(0.170)	(0.171)	(0.169)
Observations	32994	32994	32994	32994	32994
Therapeutic field	Yes	Yes	Yes	Yes	Yes
Drug form	Yes	Yes	Yes	Yes	Yes
Submission type	Yes	Yes	Yes	Yes	Yes
Generic region of origin	Yes	Yes	Yes	Yes	Yes
Year end of exclusivity	Yes	Yes	Yes	Yes	Yes
Drug markets	395	395	395	395	395

Notes: Logit regression. Standard errors in parentheses are clustered at the drug market level. The dependent variable is entry within 6 quarters. The constant term is estimated but not reported. $***p < 0.01, **p < 0.05, *p < 0.1$.

TABLE D5. Robustness - Indicator for top 100 sales

VARIABLES	(1)	(2)	(3)	(4)	(5)
δ_S	-0.0276***				
	(0.00678)				
δ_C		-0.0789***			
		(0.0184)			
δ_{R5}			-0.0290***		
			(0.00712)		
δ_{R10}				-0.0301***	
				(0.00811)	
δ_L					-0.0286***
					(0.00560)
Subsidiary (0/1)	-0.0549***	-0.0535***	-0.0271*	-0.0276*	-0.0540***
	(0.0145)	(0.0145)	(0.0148)	(0.0149)	(0.0144)
Experience Route ÷ 10	0.00838***	0.00839***	0.00834***	0.00838***	0.00842***
	(0.000856)	(0.000856)	(0.000854)	(0.000857)	(0.000857)
Experience ATC2 ÷ 10	0.0608***	0.0609***	0.0609***	0.0610***	0.0608***
	(0.0104)	(0.0104)	(0.0104)	(0.0104)	(0.0104)
Experience New Drug ÷ 10	0.00457	0.00413	0.00384	0.00410	0.00466
	(0.00287)	(0.00283)	(0.00280)	(0.00285)	(0.00285)
Breadth (ATC2) ÷ 10	0.00101	0.00116	0.000664	0.000898	0.000948
	(0.00231)	(0.00230)	(0.00230)	(0.00230)	(0.00229)
Authorized Generic (0/1)	0.00260	0.00268	0.00261	0.00260	0.00267
	(0.00401)	(0.00402)	(0.00402)	(0.00402)	(0.00401)
Orphan Drug (0/1)	-0.00417	-0.00405	-0.00407	-0.00408	-0.00416
	(0.00703)	(0.00701)	(0.00703)	(0.00703)	(0.00704)
Pediatric Drug (0/1)	0.0129***	0.0128***	0.0129***	0.0129***	0.0129***
	(0.00481)	(0.00481)	(0.00483)	(0.00483)	(0.00481)
Substitutes on Patent (ATC2) ÷ 10	-0.00800	-0.00790	-0.00774	-0.00788	-0.00789
	(0.00616)	(0.00615)	(0.00616)	(0.00617)	(0.00615)
Substitutes off Patent (ATC2) ÷ 10	-0.00421	-0.00418	-0.00436	-0.00426	-0.00425
	(0.00498)	(0.00499)	(0.00500)	(0.00500)	(0.00498)
Top 100 in Sales (0/1)	0.0208***	0.0208***	0.0206***	0.0208***	0.0207***
	(0.00557)	(0.00556)	(0.00558)	(0.00558)	(0.00557)
Observations	34144	34144	34144	34144	34144
R-squared	0.0854	0.0854	0.0853	0.0852	0.0855
Therapeutic field	Yes	Yes	Yes	Yes	Yes
Drug form	Yes	Yes	Yes	Yes	Yes
Submission type	Yes	Yes	Yes	Yes	Yes
Generic region of origin	Yes	Yes	Yes	Yes	Yes
Year end of exclusivity	Yes	Yes	Yes	Yes	Yes
Drug markets	395	395	395	395	395

Notes: OLS regression. Standard errors in parentheses are clustered at the drug market level. The dependent variable is entry within 6 quarters. The constant term is estimated but not reported. $***p < 0.01, **p < 0.05, *p < 0.1$.

TABLE D6. Robustness - Using total US sales for drugs in top 100

VARIABLES	(1)	(2)	(3)	(4)	(5)
δ_S	-0.0902***				
	(0.0140)				
δ_C		-0.229***			
		(0.0396)			
δ_{R5}			-0.0974***		
			(0.0165)		
δ_{R10}				-0.112***	
				(0.0176)	
δ_L					-0.0829***
					(0.0121)
Subsidiary (0/1)	-0.121***	-0.114***	-0.0371	-0.0251	-0.117***
	(0.0382)	(0.0382)	(0.0354)	(0.0380)	(0.0378)
Experience Route ÷ 10	0.0143***	0.0144***	0.0143***	0.0144***	0.0145***
	(0.00220)	(0.00221)	(0.00220)	(0.00221)	(0.00221)
Experience ATC2 ÷ 10	0.0669**	0.0681**	0.0679**	0.0674**	0.0670**
	(0.0266)	(0.0266)	(0.0267)	(0.0266)	(0.0267)
Experience New Drug ÷ 10	0.0268***	0.0241***	0.0236***	0.0262***	0.0259***
	(0.00802)	(0.00783)	(0.00772)	(0.00793)	(0.00794)
Breadth (ATC2) ÷ 10	-0.00623	-0.00582	-0.00705	-0.00620	-0.00656
	(0.00570)	(0.00581)	(0.00573)	(0.00570)	(0.00571)
Authorized Generic (0/1)	0.00741	0.00682	0.00749	0.00700	0.00790
	(0.00850)	(0.00859)	(0.00862)	(0.00850)	(0.00857)
Orphan Drug (0/1)	0.0110	0.0127	0.0101	0.0110	0.0103
	(0.0125)	(0.0126)	(0.0128)	(0.0126)	(0.0127)
Pediatric Drug (0/1)	0.0309***	0.0317***	0.0314***	0.0320***	0.0310***
	(0.0112)	(0.0113)	(0.0115)	(0.0112)	(0.0114)
Substitutes on Patent (ATC2) ÷ 10	0.00306	0.00440	0.00303	0.00280	0.00277
	(0.0101)	(0.0102)	(0.0102)	(0.0101)	(0.0102)
Substitutes off Patent (ATC2) ÷ 10	0.0321	0.0319	0.0333	0.0320	0.0327
	(0.0219)	(0.0220)	(0.0224)	(0.0219)	(0.0222)
Brand Sales USD bn.	0.0121**	0.0117**	0.0123**	0.0121**	0.0123**
	(0.00562)	(0.00562)	(0.00562)	(0.00565)	(0.00565)
Observations	8600	8600	8600	8600	8600
R-squared	0.152	0.152	0.152	0.153	0.152
Therapeutic field	Yes	Yes	Yes	Yes	Yes
Drug form	Yes	Yes	Yes	Yes	Yes
Submission type	Yes	Yes	Yes	Yes	Yes
Generic region of origin	Yes	Yes	Yes	Yes	Yes
Year end of exclusivity	Yes	Yes	Yes	Yes	Yes
Drug markets	93	93	93	93	93

Notes: OLS regression. Standard errors in parentheses are clustered at the drug market level. The dependent variable is entry within 6 quarters. The constant term is estimated but not reported. $***p < 0.01, **p < 0.05, *p < 0.1$.

TABLE D7. Robustness - Broader entrant set

VARIABLES	(1)	(2)	(3)	(4)	(5)
δ_S	-0.0143***				
	(0.00439)				
δ_C		-0.0443***			
		(0.0127)			
δ_{R5}			-0.0189***		
			(0.00479)		
δ_{R10}				-0.0173***	
				(0.00552)	
δ_L					-0.0179***
					(0.00390)
Subsidiary (0/1)	-0.0337***	-0.0332***	-0.0157*	-0.0176*	-0.0336***
	(0.00885)	(0.00883)	(0.00925)	(0.00955)	(0.00884)
Experience Route ÷ 10	0.00837***	0.00838***	0.00836***	0.00837***	0.00839***
	(0.000791)	(0.000792)	(0.000790)	(0.000792)	(0.000792)
Experience ATC2 ÷ 10	0.0559***	0.0560***	0.0559***	0.0560***	0.0559***
	(0.00950)	(0.00950)	(0.00951)	(0.00951)	(0.00950)
Experience New Drug ÷ 10	0.00447**	0.00429**	0.00437**	0.00439**	0.00474**
	(0.00202)	(0.00198)	(0.00196)	(0.00201)	(0.00199)
Breadth (ATC2) ÷ 10	1.06e-05	0.000133	-6.88e-05	1.74e-05	9.73e-05
	(0.00168)	(0.00169)	(0.00169)	(0.00169)	(0.00168)
Market Size	0.0282***	0.0282***	0.0282***	0.0282***	0.0282***
	(0.00653)	(0.00652)	(0.00652)	(0.00654)	(0.00652)
Authorized Generic (0/1)	0.00419	0.00421*	0.00419	0.00419	0.00421*
	(0.00254)	(0.00255)	(0.00255)	(0.00255)	(0.00254)
Orphan Drug (0/1)	-0.00263	-0.00257	-0.00259	-0.00260	-0.00262
	(0.00399)	(0.00399)	(0.00399)	(0.00399)	(0.00399)
Pediatric Drug (0/1)	0.00790***	0.00787***	0.00792***	0.00793***	0.00792***
	(0.00298)	(0.00298)	(0.00299)	(0.00299)	(0.00298)
Substitutes on Patent (ATC2) ÷ 10	-0.00245	-0.00242	-0.00235	-0.00242	-0.00242
	(0.00346)	(0.00346)	(0.00346)	(0.00346)	(0.00346)
Substitutes off Patent (ATC2) ÷ 10	-0.00264	-0.00262	-0.00270	-0.00264	-0.00266
	(0.00254)	(0.00255)	(0.00255)	(0.00255)	(0.00254)
Observations	55769	55769	55769	55769	55769
R-squared	0.0817	0.0818	0.0818	0.0817	0.0819
Therapeutic field	Yes	Yes	Yes	Yes	Yes
Drug form	Yes	Yes	Yes	Yes	Yes
Submission type	Yes	Yes	Yes	Yes	Yes
Generic region of origin	Yes	Yes	Yes	Yes	Yes
Year end of exclusivity	Yes	Yes	Yes	Yes	Yes
Drug markets	395	395	395	395	395

Notes: OLS regression. Standard errors in parentheses are clustered at the drug market level. The dependent variable is entry within 6 quarters. The constant term is estimated but not reported. The sample of potential generic entrants includes all pharmaceutical companies that launched at least one generic product in our drug markets. $***p < 0.01, **p < 0.05, *p < 0.1$.

TABLE D8. Robustness - Entry ever

VARIABLES	(1)	(2)	(3)	(4)	(5)
δ_S	-0.0407***				
	(0.00848)				
δ_C		-0.122***			
		(0.0232)			
δ_{R5}			-0.0448***		
			(0.00849)		
δ_{R10}				-0.0526***	
				(0.0101)	
δ_L					-0.0424***
					(0.00688)
Subsidiary (0/1)	-0.0783***	-0.0764***	-0.0356**	-0.0316*	-0.0770***
	(0.0163)	(0.0164)	(0.0166)	(0.0168)	(0.0163)
Experience Route ÷ 10	0.00998***	0.0100***	0.00993***	0.00999***	0.0100***
	(0.00101)	(0.00101)	(0.00101)	(0.00101)	(0.00101)
Experience ATC2 ÷ 10	0.0840***	0.0842***	0.0842***	0.0843***	0.0839***
	(0.0119)	(0.0119)	(0.0119)	(0.0119)	(0.0118)
Experience New Drug ÷ 10	0.00768**	0.00723**	0.00677**	0.00770**	0.00785**
	(0.00331)	(0.00328)	(0.00325)	(0.00331)	(0.00328)
Breadth (ATC2) ÷ 10	0.00542**	0.00572**	0.00495*	0.00551**	0.00533**
	(0.00255)	(0.00255)	(0.00254)	(0.00255)	(0.00253)
Market Size	0.0465***	0.0464***	0.0464***	0.0465***	0.0465***
	(0.0117)	(0.0117)	(0.0116)	(0.0117)	(0.0116)
Authorized Generic (0/1)	0.0111**	0.0112**	0.0110**	0.0110**	0.0111**
	(0.00500)	(0.00501)	(0.00501)	(0.00501)	(0.00501)
Orphan Drug (0/1)	0.00319	0.00339	0.00333	0.00340	0.00319
	(0.00918)	(0.00915)	(0.00917)	(0.00918)	(0.00918)
Pediatric Drug (0/1)	0.0182***	0.0181***	0.0182***	0.0184***	0.0181***
	(0.00598)	(0.00597)	(0.00600)	(0.00600)	(0.00598)
Substitutes on Patent (ATC2) ÷ 10	-0.00136	-0.00122	-0.00102	-0.00120	-0.00123
	(0.00836)	(0.00836)	(0.00837)	(0.00838)	(0.00835)
Substitutes off Patent (ATC2) ÷ 10	-0.0143**	-0.0142**	-0.0145**	-0.0143**	-0.0143**
	(0.00604)	(0.00604)	(0.00604)	(0.00605)	(0.00602)
Observations	34144	34144	34144	34144	34144
R-squared	0.102	0.102	0.102	0.102	0.102
Therapeutic field	Yes	Yes	Yes	Yes	Yes
Drug form	Yes	Yes	Yes	Yes	Yes
Submission type	Yes	Yes	Yes	Yes	Yes
Generic region of origin	Yes	Yes	Yes	Yes	Yes
Year end of exclusivity	Yes	Yes	Yes	Yes	Yes
Drug markets	395	395	395	395	395

Notes: OLS regression. Standard errors in parentheses are clustered at the drug market level. The dependent variable is entry (within any time period). The constant term is estimated but not reported. $***p < 0.01, **p < 0.05, *p < 0.1$.

TABLE D9. Robustness - Split by Experience Level - δ_S

VARIABLES	(1) all	(2) quartile 1	(3) quartile 2	(4) quartile 3	(5) quartile 4
δ_S	-0.0273***	-0.0348**	-0.0387***	-0.00260	0.00682
	(0.00676)	(0.0142)	(0.0122)	(0.0116)	(0.00524)
Observations	34144	8676	8489	8589	8390
R-squared	0.0855	0.115	0.0351	0.0349	0.0453
All controls	Yes	Yes	Yes	Yes	Yes
Therapeutic field	Yes	Yes	Yes	Yes	Yes
Drug form	Yes	Yes	Yes	Yes	Yes
Submission type	Yes	Yes	Yes	Yes	Yes
Generic region of origin	Yes	Yes	Yes	Yes	Yes
Year end of exclusivity	Yes	Yes	Yes	Yes	Yes

Notes: OLS regression. Standard errors in parentheses are clustered at the drug market level. The dependent variable is entry within 6 quarters. The constant term is estimated but not reported. $***p < 0.01, **p < 0.05, *p < 0.1$.

TABLE D10. Robustness - Market outcomes - δ_S (market)

VARIABLES	(1) N-6q	(2) N	(3) Share-6q	(4) Share	(5) Time	(6) No entry
δ_S (market)	-5.821*	-8.231**	-0.0818	-0.136*	20.57	0.957**
	(3.006)	(3.956)	(0.0605)	(0.0773)	(14.47)	(0.470)
Market Size	3.622***	4.762***	0.0320**	0.0488***	-4.779**	-0.114*
	(0.914)	(1.089)	(0.0129)	(0.0163)	(2.197)	(0.0655)
Authorized Generic (0/1)	0.471	0.789*	0.0101	0.0141	-2.223	-0.0958**
	(0.380)	(0.460)	(0.00800)	(0.00920)	(1.380)	(0.0426)
Orphan Drug (0/1)	-0.403	-0.193	0.00649	0.0116	1.772	0.0799
	(0.611)	(0.808)	(0.0168)	(0.0207)	(2.277)	(0.0838)
Pediatric Drug (0/1)	0.990**	1.545***	0.0216**	0.0308**	-2.879*	-0.0821
	(0.442)	(0.548)	(0.0106)	(0.0122)	(1.588)	(0.0523)
Substitutes on Patent (ATC2) ÷ 10	-0.414	-0.200	-0.00543	-0.00994	0.827	7.57e-05
	(0.486)	(0.631)	(0.00900)	(0.0120)	(1.756)	(0.0577)
Substitutes off Patent (ATC2) ÷ 10	-0.106	-0.428	-0.0112	-0.0151	-0.403	-0.0172
	(0.336)	(0.419)	(0.0105)	(0.0123)	(2.086)	(0.0596)
Observations	395	395	395	395	395	395
R-squared	0.391	0.467	0.381	0.446	0.326	0.348
Therapeutic field	Yes	Yes	Yes	Yes	Yes	Yes
Drug form	Yes	Yes	Yes	Yes	Yes	Yes
Submission type	Yes	Yes	Yes	Yes	Yes	Yes
Year end of exclusivity	Yes	Yes	Yes	Yes	Yes	Yes

Notes: OLS. Standard errors in parentheses are robust. The constant term is estimated but not reported. $***p < 0.01, **p < 0.05, *p < 0.1$.

References

Aghion, P., J. Van Reenen, and L. Zingales (2013). Innovation and institutional ownership. *American Economic Review 103*(1), 277–304.

Antón, M., F. Ederer, M. Gine, and M. C. Schmalz (2021). Innovation: The bright side of common ownership? Working paper. Available at SSRN 3099578.

Antón, M., F. Ederer, M. Giné, and M. C. Schmalz (2022). Common ownership, competition, and top management incentives. Working paper.

Appel, I. R., T. A. Gormley, and D. B. Keim (2016). Passive investors, not passive owners. *Journal of Financial Economics 121*(1), 111–141.

Appelt, S. (2015). Authorized generic entry prior to patent expiry: Reassessing incentives for independent generic entry. *Review of Economics and Statistics 97*(3), 654–666.

Azar, J. (2017). Portfolio diversification, market power, and the theory of the firm. Working Paper, IESE Business School, Universidad de Navarra, 2017.

Azar, J., M. C. Schmalz, and I. Tecu (2018). Anticompetitive effects of common ownership. *The Journal of Finance 73*(4), 1513–1565.

Backus, M., C. Conlon, and M. Sinkinson (2019). The common ownership hypothesis: Theory and evidence. Brookings Working Paper.

Backus, M., C. Conlon, and M. Sinkinson (2021a). Common ownership and competition in the ready-to-eat cereal industry. Working paper, National Bureau of Economic Research.

Backus, M., C. Conlon, and M. Sinkinson (2021b). Common ownership in America: 1980–2017. *American Economic Journal: Microeconomics 13*(3), 273–308.

Banal-Estañol, A., J. Seldeslachts, and X. Vives (2020). Diversification, common ownership, and strategic incentives. In *AEA Papers and Proceedings*, Volume 110, pp. 561–64.

Bena, J., M. A. Ferreira, P. Matos, and P. Pires (2017). Are foreign investors locusts? the long-term effects of foreign institutional ownership. *Journal of Financial Economics 126*(1), 122–146.

Boller, L. and F. S. Morton (2020). Testing the theory of common stock ownership. Working Paper, National Bureau of Economic Research.

Branstetter, L., C. Chatterjee, and M. J. Higgins (2016). Regulation and welfare: Evidence from Paragraph IV generic entry in the pharmaceutical industry. *The RAND Journal of Economics 47*(4), 857–890.

Brav, A., W. Jiang, S. Ma, and X. Tian (2018). How does hedge fund activism reshape corporate innovation? *Journal of Financial Economics 130*(2), 237–264.

Duggan, M. and F. Scott Morton (2010). The effect of Medicare Part D on pharmaceutical prices and utilization. *American Economic Review 100*(1), 590–607.

Eldar, O., J. Grennan, and K. Waldock (2020). Common ownership and startup growth. *Duke Law School Public Law & Legal Theory Series* (2019-42).

FDA (2019). Statement from fda commissioner scott gottlieb, m.d., on new policy to improve access and foster price competition for drugs that face inadequate generic competition. Press release. February 19. Online. Available at: https://www.fda.gov/NewsEvents/Newsroom/PressAnnouncements/ucm631456.htm (Accessed: 20 February 2019).

Fichtner, J., E. M. Heemskerk, and J. Garcia-Bernardo (2017). Hidden power of the big three? passive index funds, re-concentration of corporate ownership, and new financial risk. *Business and Politics 19*(2), 298–326.

Geng, H., H. Hau, and S. Lai (2016). Technological progress and ownership structure. Working Paper, CEPR Discussion Paper No. DP11064.

Helland, E. and S. A. Seabury (2016). Are settlements in patent litigation collusive? evidence from Paragraph IV challenges. National Bureau of Economic Research Working Paper.

Hemphill, C. S. and M. Kahan (2019). The strategies of anticompetitive common ownership. *Yale Law Journal 129*, 1392.

Hovenkamp, E. and J. Lemus (2018). Delayed entry settlements at the patent office. *International Review of Law and Economics 54*, 30–38.

Jacobo-Rubio, R., J. L. Turner, and J. W. Williams (2020). The distribution of surplus in the US pharmaceutical industry: Evidence from Paragraph IV patent-litigation decisions. *The Journal of Law and Economics 63*(2), 203–238.

Kyle, M. K. (2006). The role of firm characteristics in pharmaceutical product launches. *The RAND Journal of Economics 37*(3), 602–618.

López, Á. L. and X. Vives (2019). Overlapping ownership, R&D spillovers, and antitrust policy. *Journal of Political Economy 127*(5), 2394–2437.

Malenko, N. and Y. Shen (2016). The role of proxy advisory firms: Evidence from a regression-discontinuity design. *The Review of Financial Studies 29*(12), 3394–3427.

Moreno-Torres, I., J. Puig-Junoy, and J.-R. Borrell (2009). Generic entry into the regulated Spanish pharmaceutical market. *Review of Industrial Organization 34*(4), 373–388.

O'Brien, D. P. and S. C. Salop (1999). Competitive effects of partial ownership: Financial interest and corporate control. *Antitrust Law Journal 67*, 559.

O'Brien, D. P. and K. Waehrer (2017). The competitive effects of common ownership: We know less than we think. *Antitrust Law Journal 81*, 729.

Posner, E. A., F. M. Scott Morton, and E. G. Weyl (2017). A proposal to limit the anti-competitive power of institutional investors. *Antitrust Law Journal*.

Regan, T. L. (2008). Generic entry, price competition, and market segmentation in the prescription drug market. *International Journal of Industrial Organization 26*(4), 930–948.

Reiffen, D. and M. R. Ward (2005). Generic drug industry dynamics. *Review of Economics and Statistics 87*(1), 37–49.

Schmalz, M. (2015). How passive funds prevent competition. Online. Available: http://ericposner.com/martin-schmalz-how-passive-funds-prevent-competition/.

Schmalz, M. C. (2018). Common-ownership concentration and corporate conduct. *Annual Review of Financial Economics 10*, 413–448.

Schmalz, M. C. (2021). Recent studies on common ownership, firm behavior, and market outcomes. *The Antitrust Bulletin 66*(1), 12–38.

Schmidt, C. and R. Fahlenbrach (2017). Do exogenous changes in passive institutional ownership affect corporate governance and firm value? *Journal of Financial Economics 124*(2), 285–306.

Scott Morton, F. M. (1999). Entry decisions in the generic pharmaceutical industry. *The RAND Journal of Economics 30*, 421–440.

Scott Morton, F. M. (2002). Horizontal integration between brand and generic firms in the pharmaceutical industry. *Journal of Economics & Management Strategy 11*(1), 135–168.

Seldeslachts, J., M. Newham, and A. Banal-Estanol (2017). Common ownership of german companies. DIW Economic Bulletin 30.

Shekita, N. (2022). Interventions by common owners. *Journal of Competition Law & Economics 18*(1), 99–134.

Wang, Y. I., J. Li, and R. Anupindi (2022). Manufacturing and regulatory barriers to generic drug competition: A structural model approach. Working paper. Available at SSRN 3145635.

Xie, J. and J. Gerakos (2020). The anticompetitive effects of common ownership: the case of paragraph iv generic entry. In *AEA Papers and Proceedings*, Volume 110, pp. 569–72.