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Common Ownership and Market Entry: Evidence from the Pharmaceutical Industry*

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Abstract

Common ownership - where two firms are partially owned by the same investor - and its impact on product markets has recently drawn attention. This paper focuses on implications for entry. We consider the entry decisions of generic pharmaceutical firms into drug markets opened up by the end of regulatory protection in the US. We provide a framework that shows that greater common ownership between the brand firm and a potential generic entrant reduces the likelihood that this generic enters. We then extend this prediction to show that higher overall common ownership between the brand and all potential generic entrants at the market level leads to fewer generic entrants. We find robust evidence for these predictions: a one-standard-deviation increase in common ownership decreases the probability of individual entry by 9-13%, whereas a one-standard-deviation increase in market-level common ownership decreases the total number of entrants by 11-13% in that market.

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

Key words: Market Entry, Ownership Structure, Pharma

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1 Introduction

The top two shareholders in Johnson & Johnson, Pfizer, Abbott Laboratories, Perrigo and Allergan, which are among the largest brand or generic companies in US pharmaceutical markets, were BlackRock and Vanguard in 2015 (Thomson Reuters Global Ownership Database, 2015). BlackRock and Vanguard are amongst the world's largest institutional investors.[1] Investors' holdings in multiple firms gives rise to what is known as "common ownership." A controversial question is if, and if so in which way, firms' strategic decisions are altered by the presence of common ownership.[2]

The focus of this paper is to investigate the effect of common ownership on one of the most important strategic decisions firms make: market entry. Specifically, we analyze generic firms' entry decisions into pharmaceutical markets opened up by the end of regulatory protection. Monopolized markets are a vital source of revenue for brand firms. With the event of generic entry, revenues can decline by as much as 90% (Branstetter et al., 2016). Moreover, losses to the brand and gains to the generic are highly asymmetric. According to one estimate, brand firms value deterring entry on average at about $4.6 billion (Jacobo-Rubio et al., 2017). In contrast, generic firms value the right to enter at about $236.8 million. Thus, entry decisions may crucially depend on whether owners of generic firms also have an interest in brand firms.

We investigate whether a higher level of common ownership between potential generic entrants and the market's incumbent brand reduces the likelihood of entry, both at the level of an individual potential entrant and at the market level for all potential entrants. To do so we combine 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 down healthcare costs. Indeed, promoting generic entry has become an important goal for the FDA in recent years, and there are still several hundred off-patent branded drugs which not face any generic competition (FDA, 2019).

We first present a theoretical framework to understand the effects of common own-

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

[2] Rather than maximizing their own value, commonly-owned firms may maximize shareholders' *portfolio* values. See Backus et al. (2019) and Schmalz (2018) for reviews of the available academic evidence.

ership between an incumbent and the potential entrants. We model, in particular, the simultaneous entry decisions of a set of generic firms, where we take into consideration both individual profits and levels of common ownership with the incumbent brand firm. We find that, in response to a higher level of common ownership with the brand, an individual generic should find entry less profitable, for any belief concerning the entry decisions of the other generics. We then solve for equilibrium and show that there will be fewer entrants in markets characterized by higher levels of common ownership with the brand.

Thereafter we empirically test and corroborate the proposition that higher common ownership reduces individual generic entry. This result is robust to several measures of common ownership, different econometric methods, different definitions of the set of potential entrants, different time-horizons for the decision-making process and different definitions of market size. Our regressions include the controls used in previous literature including pre-entry brand sales, molecular substitutes, entrant experience and the presence of an authorized generic. The average effect is large: a one-standard-deviation increase in common ownership decreases the probability of entry by that generic firm by 9-13%. Furthermore, our results indicate a non-linear impact of common ownership on entry, where high levels have a much stronger impact than low levels. Our results hold if we instrument common ownership with stock market index membership or company headquarters location.

Going to the market level, we find that a one-standard-deviation increase in overall common ownership between the brand and all potential entrants decreases the total number of generics in that market by 11-13%. Our findings are robust to different potential sets of entrants, estimation methods and time windows. Thus, we find that common ownership has an economically significant effect on total generic entry.

Common ownership is a pervasive feature not only of pharmaceutical companies, but of many industries in the US as well as in Europe (Fichtner et al., 2017; Seldeslachts et al., 2017). While large institutional investors may own 5-8% of a single company, this is normally 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' long-term strategies (e.g., McCahery, 2016; Fichtner and Garcia-Bernardo, 2017).[3] However, institutional investors need not actively influence companies to have an impact on firm strategies. They may employ "selective omission";

[3]We present some anecdotal evidence in Appendix A that investors confirm this view, both in general and for pharma markets.

encouraging actions that increase both firm value and portfolio profits and remaining silent when this is not the case (Hemphill and Kahan, 2018). They may have an effect by crowding out and occasionally voting against other investors (Antón et al., 2018). Moreover, 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 –rather than maximizing their own profits– to maximize the return of their shareholders' portfolios (Azar, 2017). In our theoretical framework, we present different measures of common ownership that to some extent reflect these different channels on how common ownership might influence firms' behavior.

The ongoing concentration of ownership in the hands of a few large investors and the corresponding escalation in common ownership is unprecedented. Dubbed "an economic blockbuster" and "the major new antitrust challenge of our time," common ownership is undoubtedly an important, new topic in economics (Elhauge, 2016; Posner et al., 2017).[4] But empirical research on the topic is still in its infancy. For a large sample of US public firms, He and Huang (2017) find that common ownership by institutional investors facilitates explicit forms of product market coordination which in turn improves innovation productivity and operating profitability. Azar et al. (2018), on the other hand, provide empirical evidence that common ownership in the airline industry is linked to higher prices. The results of these studies have been subject to ongoing debate (see e.g., O'Brien and Waehrer, 2017). There is, however, a resounding agreement that more research is required to understand the implications of common ownership (Patel, 2017; OECD, 2017).

This paper 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. Another advantage of the current paper over previous empirical studies is the fact that we do not only look at market-level common ownership, but also at ownership links at the pair level; between individual generics and the incumbent brand. Recent simultaneous research by Xie and Gerakos (2018) consider how ownership linkages through institutional holdings affect patent settlements between brand and generic firms. They find that common holdings between a brand and a generic firm are positively associated with the likelihood that the two parties will enter into a settlement agreement. Their study, thus, is complementary to this paper as it showcases a plausible channel of how entry can be deterred.

[4]The issue has also received significant media attention and instigated public debate; see e.g. The Economist (2015), The New York Times (2016), Handelsblatt Global (2016) and OECD (2017).

The rest of the paper is organized as follows. Section 2 provides a literature overview of entry in pharmaceutical markets and common ownership. Section 3 introduces the theoretical framework. Section 4 presents the data. Section 5 presents the empirical analysis and results of the effect of common ownership on individual entry. Section 6 deals with the effect of common ownership on market outcomes. Section 7 concludes. We include Appendices on (i) anecdotal evidence on how institutional investors influence firms' decisions, (ii) data construction, (iii) empirical robustness checks and (iv) mathematical proofs.

2 Literature

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

2.1 Generic entry

Several papers 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 pharma 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 highlights the role of the characteristics of the drugs. 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.

Scott Morton (2002) reviews 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. Xie and Genakos (2018) 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. Additionally, through positive brands' abnormal stock market returns around the settlement date, they conclude that these settlements have facilitated collusion between brand and generics. Helland and Seabury (2016) investigate the link between Paragraph IV challenges, settlements and entry. They find that a Paragraph IV challenge increases generic entry, while 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.

2.2 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) 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 (2018F) 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 mainly focused on price effects. In an empirical study 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. (2016) focus on 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. Further studies that look at the effect of common ownership on prices in airlines (Kennedy et al, 2017) and banking (Gramlich and Grundl, 2017), using different methodologies, measures and samples, find mixed effects.

Some recent empirical studies highlight the positive effects that common ownership can have on innovation and vertical relations. Antón et al. (2017) examine how common ownership affects R&D investments and innovation output. Geng et al. (2017) find that vertical common-ownership links can mitigate hold-up problems arising from patent com-

plementarities, which in turn is correlated with more innovation. Cici et al. (2015) and Freeman (2016) find that common ownership between vertically connected firms can help strengthen business relationships.

Finally, there is a small but growing 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., 2016). 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.

3 Theoretical framework

We now present a simple framework to understand the effects of common ownership on market entry. We model, in particular, the decisions of a set of symmetric "generic" firms that have the possibility to produce a generic drug and enter a market currently dominated by the branded product of a "brand" firm. We first analyse how an increase in common ownership between a brand and a generic affects this individual generic's entry decision, taking as given the decisions of other generics. We thereafter characterize the overall number of entrants in equilibrium as a function of the level of common ownership of all the generics with the brand. Finally, we propose several measures of common ownership between brand and generic firms. All proofs can be found in Appendix D.

3.1 Common ownership and individual entry

Consider N (≥ 1) symmetric generic firms that can simultaneously enter the market of the product of a brand firm B.[5] In this subsection, we shall focus on the decision of a *focal* generic G as a function of its beliefs about the entry decisions of the other generics. In other words, we compute the best-reply function.

Denote by p_i the probability, assigned by this (risk-neutral) focal generic, to the event that a number i of the *other* generic firms enter the market, where $i = 0, ..., N-1$ and $\sum_{i=0}^{N-1} p_i = 1$. Denote by $\pi_G^i (> 0)$ the focal generic's profits in a market that also includes i *other* generic firms (and thus the market contains in total $i+2$ firms, when also counting the brand firm). Profits π_G^i may include fixed costs of entry, and are thus net of these entry costs. Denote by $\Delta\pi_B^i (< 0)$ the loss in profits of the brand firm B due to an increase from i to $i+1$ in the total number of generic entrants in the market.

Let us make the following assumptions. Naturally, we shall assume that generic competition reduces individual generic profits, i.e. π_G^i is decreasing in i, and that the change in the brand firm's profit loss decreases with the number of entrants, i.e. $|\Delta\pi_B^i|$ is decreasing in i. We also posit that the gains of the generic are lower than the losses of the brand, as generic competition reduces a brand firm's profits significantly (Branstetter, 2016).[6] As a result, although generic firm profits increase, $\pi_G^i > 0$, joint profits decrease with entry, $\pi_G^i + \Delta\pi_B^i < 0$. We furthermore assume away collusion between the potential entrants.

Common ownership between the generic and the brand makes the entry decision non-trivial. Indeed, shareholders of the generic that also own shares in the brand should care not only about the profits of the generic, but also about the reduction of joint profits, i.e. they care about what we term the "net gains from entry." Let us denote the weight placed by the decision-makers of G on joint profits with the brand firm B, rather than on individual generic firm profits, by δ. An increase in common ownership between G and B will increase δ. Thus, δ can be viewed as our "measure of common ownership." We discuss

[5] Our main empirical specification specifies an entry window of 6 quarters. During this time frame, entry decisions should be considered as simultaneous. This is because the entire application process for generic drugs takes about 6 quarters on average, depending on the application's quality and unexpected FDA delays. Information on ANDA's received by the FDA is kept secret until approval and manufacturers do not reveal their entry plans due to strategic business considerations.

[6] We thus assume that the business stealing effects caused by generic entry on the brand firm are larger than any market expansion effect. This holds true for markets with low demand elasticity of which pharma markets are a primary example (Duggan and Scott Morton, 2010). Note we do not need this assumption for the comparative static results, but only to ensure that for some level of common ownership, δ, entry is unprofitable. Furthermore, we focus on entry rather than pricing decisions. We consider prices to be set outside the model as, in any case, in the pharmaceutical industry prices of brand products are always substantially higher than those of generics.

possible common ownership measures at the end of the theory section.

In this framework, generic firm G shall enter the market as long as its expected net gains from entry are positive, i.e., when $\Pi_G \geq 0$, where

$$\Pi_G(p_0, ..., p_{N-1}, \delta) \equiv \sum_{i=0}^{N-1} p_i[(1-\delta)\pi_G^i + \delta(\pi_G^i + \Delta\pi_B^i)]. \quad (1)$$

In the absence of common ownership between G and B, $\delta = 0$, and therefore generic G should place no weight on joint profits and entry will occur, as $\pi_G^i > 0$ for any number i of other generic entrants. At the other extreme, in the case where common ownership is so high that joint profits are as important as individual generic profits, $\delta = 1$ and entry will not occur, as $\pi_G^i + \Delta\pi_B^i < 0$ for any i. More in general, the gains from entry of a generic G decrease in its level of common ownership with the brand, as

$$\partial\Pi_G(p_0, ..., p_{N-1}, \delta)/\partial\delta = \sum_{i=0}^{N-1} p_i \Delta\pi_B^i < 0 \text{ for any } p_0, ..., p_{N-1}.$$

This leads us to the first key prediction:

Prediction 1: An increase in the level of common ownership between an individual generic and the brand reduces entry by this generic.

3.2 Common ownership and market entry

In this part, we characterize the equilibrium entry decisions of the N potential entrants, as a function of their symmetric "market-level" common ownership with the brand, δ. To this end, we first analyse the strategic interaction between generics' entry decisions.

3.2.1 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.

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,

$$\partial\Pi_G(p_0, p_1, \delta)/\partial p_1 = (\pi_G^1 - \pi_G^0) + \delta(\Delta\pi_B^1 - \Delta\pi_B^0),$$

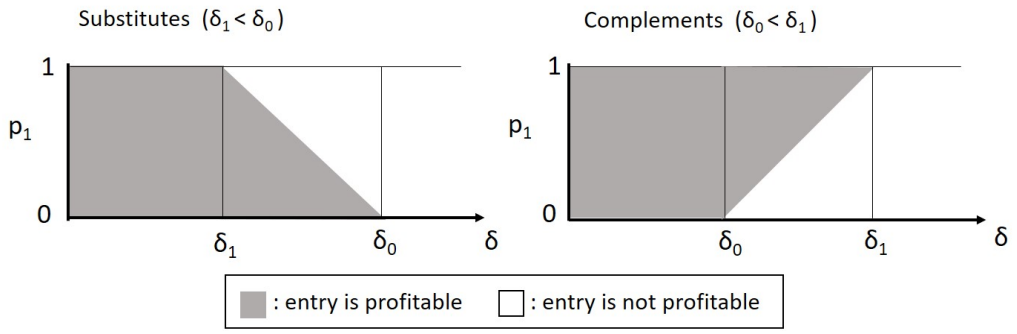
we can identify two effects. The first term is negative, as $\pi_G^0 > \pi_G^1$, and therefore the gains from entry of G are lower if the other is more likely to enter. This is the traditional business stealing effect from competition of other generics. The second term, though, is positive, as $|\Delta\pi_B^0| > |\Delta\pi_B^1|$. 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^i and the loss in profits of the brand $|\Delta\pi_B^i|$, decreases faster with the entry of others, and thus how the ratio $\delta_i \equiv \pi_G^i / |\Delta\pi_B^i|$ changes with i. If the generic profits decrease faster, and thus the ratios are such that $\delta_1 < \delta_0$, others entering is more detrimental and entry decisions exhibit strategic substutabilities. Instead, if the brand losses decrease faster, and thus $\delta_0 < \delta_1$, others entering is less detrimental and entry decisions exhibit strategic complementarities. The results are summarized in the following lemma.

Proposition 1. *(a) If $\delta_1 < \delta_0$, 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 $\delta_0 < \delta_1$, the generic firm G is more (or equally) likely to enter if the other generic is more likely to enter (strategic complementarity).

Figure 1 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 1: Profitable entry of G as a function of δ and p_1



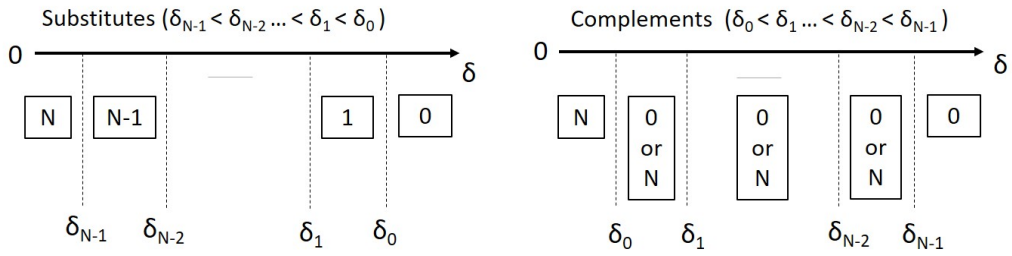
3.2.2 Equilibrium entry decisions

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. Considering and distinguishing between the two cases identified in the previous proposition, the proposition summarizes the overall number of entrants in equilibrium.

Proposition 2. *(a) In the case of strategic substitutes ($\delta_{N-1} < \delta_{N-2} < ... < \delta_0$), the number of entrants in equilibrium is: N if $\delta \leq \delta_{N-1}$; $N-i$ if $\delta_{N-i} < \delta \leq \delta_{N-i-1}$ for $i = 1, ..., N-1$; and 0 if $\delta_0 < \delta$.*
(b) In the case of strategic complements ($\delta_0 < \delta_1 < ... < \delta_{N-1}$), the number of entrants in equilibrium is: N if $\delta \leq \delta_0$; N or 0 if $\delta_0 < \delta \leq \delta_{N-1}$; and 0 if $\delta_{N-1} < \delta$.

Figure 2 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 2: 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 allow ourselves to assign a fixed probability of selecting one equilibrium over another. This leads us to the second key prediction:

Prediction 2: An increase in the market-level common ownership between the brand and generics reduces entry by generics in this market.

3.3 Common ownership measures

We now 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 places on joint rather than on individual firm profits. We posit that shareholdings in the brand provide common investors with *incentives* to steer decisions towards joint profits and shareholdings in the generic provide investors 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 two approaches that to some extent cover different channels of investor influence. In broad terms, the first approach has some flavor of investors actively engaging with decision-making, as it parametrizes the effect of shareholders' interests into an index of decision-making influence. The second approach assumes that the generic firm's decision-makers are aware of and take shareholders' portfolio interests into account, and hence investors do not need to explicitly engage.

Production function approach This approach assumes that there exists a "production function" that transforms each common investor's shareholdings in the two firms (inputs) into a "joint profit steering index" (output). This index increases with the size of the investor's shareholdings in the brand because this increases her concerns about the reduction of joint profits (incentives). The index also increases with the size of the investor's

shareholdings in the generic because larger shareholdings naturally imply a greater ability to influence the generic firm's decisions (ability). For simplification, assuming perfect coordination among common investors, the weight that the generic firm places on joint, rather than on individual, profits is the sum of joint profit steering indices across common investors.[7] In formal terms, there exists a function f such that

$$\delta = \sum_j f(\gamma_{jG}, \gamma_{jB}),$$

where γ_{jG} and γ_{jB} are the shareholdings of a common shareholder j that owns shares 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 (Gilje et al., 2018). First, the two shareholdings can be "perfect substitutes,"i.e., $f(\gamma_{jG}, \gamma_{jB}) = (\gamma_{jG} + \gamma_{jB})/2$, and thus:

$$\delta_S \equiv \sum_j (\gamma_{jG} + \gamma_{jB})/2. \tag{2}$$

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

$$\delta_C \equiv \sum_j \min\{\gamma_{jG}, \gamma_{jB}\}. \tag{3}$$

Note that both functions are assumed to be symmetric with respect to the two inputs. Moreover, the scale is such that both measures range between zero and one. In both cases, 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.

In terms of interpretation, perfect substitutes (equation (2)) assumes that the marginal effect of an increase in incentives does not depend on ability, and vice versa. On the other hand, perfect complements (equation (3)) 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

[7] 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).

same contribution to δ 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 common investors in the brand and generic are similar.[8]

Weighted sum of interests approach This approach, following O'Brien and Salop (2000), assumes that the decision makers of the generic firm maximize a weighted sum of the interests of all investors in the firm, where (i) the interests of an investor are given by her shareholdings in the two firms and (ii) the weights are given by the investor's degree of control of the firm. The *interests* of any (common or non-common) shareholder i who has holdings γ_{iG} and γ_{iB} are given by $\gamma_{iG}\pi_G + \gamma_{iB}\pi_B$. Assuming that control is proportional to financial interest, the degree of control of the generic firm is given by γ_{iG} (*ability*). Decision-makers of the generic firm should maximize

$$\sum_i \gamma_{iG} \left[\gamma_{iG}\pi_G + \gamma_{iB}\pi_B\right],$$

where γ_{iG} and γ_{iB} are the shareholdings of any shareholder i that owns shares in either or both of the two firms. Straightforward algebra shows that maximizing this function is equivalent to maximizing

$$\pi_G + \frac{\sum_i \gamma_{iG}\gamma_{iB}}{\sum_i \gamma_{iG}^2}\pi_B$$

and thus

$$\delta_L \equiv \frac{\sum_i \gamma_{iG}\gamma_{iB}}{\sum_i \gamma_{iG}^2}$$

can be thought of a measure of common ownership. 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. See O'Brien and Waehrer (2017) and Backus et al. (2019) for a thorough discussion of this measure, often called "lambda".

[8]Both functions are examples of the classic constant elasticity of substitution (CES) production functions. A constant elasticity of substitution implies that the production technology has a constant percentage change in factor proportions due to a percentage change in marginal rate of technical substitution. In the case of perfect substitutes, the elasticity of substitution is infinity. In the case of perfect complements, the elasticity of substitution is zero.

4 Data

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

4.1 Entry in the pharmaceutical industry

Broadly speaking, pharmaceutical firms can be categorized as brand firms or generic firms.[9] 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, 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, for instance 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 3.

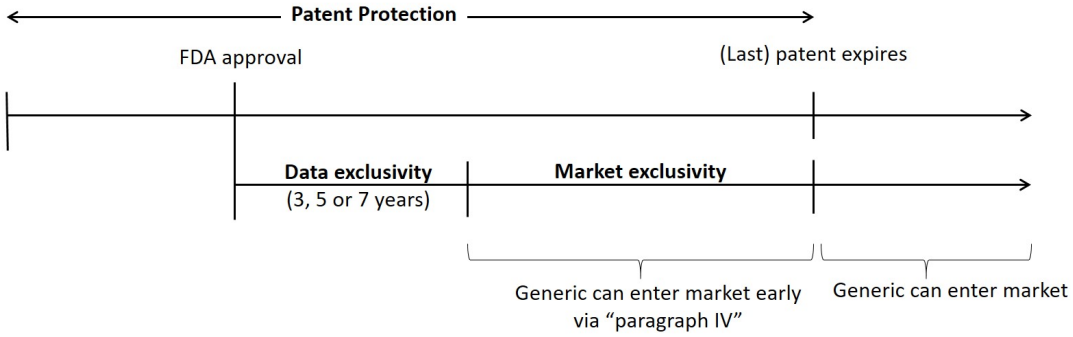
We use FDA approval as an indicator of generic entry, in line with several papers on the topic (e.g., Helland and Seabury, 2016; Hovenkamp and Lemus, 2018; Scott Morton, 1999, 2000). We consider a market to be open for generic entry at the earlier of either the date of first generic entry or the end of the market exclusivity period. 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.[10] We term this point in time the "end of exclusivity."

We focus on entry that occurs within 6 quarters after the end of exclusivity, as generics prefer to enter a market as early as possible (Wang et al., 2018, Scott Morton, 1999) and it

[9]Note that we define firms as being a "brand" or a "generic" on a 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.

[10]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).

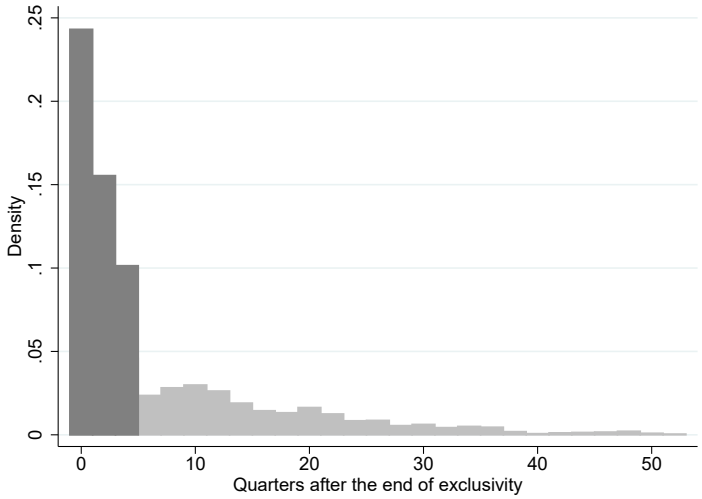
Figure 3: Exclusivities and patent protection in pharmaceuticals



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."

indeed captures most of the actual generic entries in our sample (see Figure 4); see further below on the details of our sample. However, given the potential sensitivity of results to our time window, we will show that results are robust to other entry period definitions.

Figure 4: Histogram of entry



Notes: This figure illustrates the entry patterns in our data after the "end of exclusivity." The dark gray area shows the probability that entry occurs within 6 quarters after the end of exclusivity.

4.2 Pharma data sources and variables

We obtain NDA and ANDA information 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, dosage form, 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; see also Helland and Seabury (2016) and Hovenkamp and Lemus (2018) for more details on this data source. Data concerning sales of brand drugs is taken from the website drugs.com, which provides the annual US sales figures for the top 200 drugs for the years 2003 -2010 and the top 100 drugs for the years 2011- 2013. Additionally, products are linked to their relevant therapeutic field using the ATC/DDD Index 2015 and applying exact text matching, based on compound-name.[11]

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 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 full sample of potential generic entrants to form a brand product-generic observation. The sample of potential generic entrants includes all pharmaceutical companies that launched at least one generic product in our drug markets. Results are robust to a set of different definitions of the entrant set, as we will show when discussing the results.

Following prior literature, we construct variables used to control for relevant drug market and generic firm 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). The drug market characteristics include an indicator for the pre-market-entry sales of the brand product: *Sales Top 100* takes the value 1 if the

[11]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.

brand drug ranks in the top 100 drugs in terms of US sales in the year before the end of exclusivity. In a robustness check in Table C3, we show that our main results do not change when including Medicaid reimbursement data as a measure of market size. The indicator variable *Authorized Generic* takes on the value 1 if the brand firm has launched an authorized generic in that particular market.[12]

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 dosage form/route and the year of the end of exclusivity.[13]

Generic firm characteristics aim to capture the prior experience of the generic in the relevant market. Controlling for generic firm characteristics has shown to be crucial in previous studies (Scott Morton, 1999; Scott Morton, 2002; Kyle, 2006). *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 identical route of administration 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 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. The variables concerning generic firm experience and substitutes are 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.

[12]Note that our dependent 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.

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

4.3 Common ownership data

We use the Thomson Reuters Global Ownership Database, which includes holdings by each shareholder in each publicly listed firm 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.

The advantages with regard to datasets used by other papers on common ownership are considerable. Most recent papers on common ownership use Thomson's Spectrum database (e.g., Azar et al., 2017; He and Huang, 2017; Xi and Genakos, 2018). This 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.

For each firm for each quarter in the period 2003-2014 we extracted data on the shareholders that own at least 1% of the shares, and computed yearly ownership averages. Table 1 gives an example of the top 5 investors for the brand-generic pair Johnson & Johnson-Mylan in 2013. As shown, in this pair common shareholders account for the lion's share of the ownership of the top 5 investors.

Table 1: Top 5 Largest Investors (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

5 Individual entry

In this section, we empirically investigate the impact of pairwise common ownership linkages between brand and generic on that particular generic's entry decisions, i.e. our first prediction, for a variety of different empirical specifications.

5.1 Common ownership variables

Our measures of common ownership aim to capture the weight that the generic firm G places on the joint profits of the pair G-B. The empirical counterparts of the three measures introduced in the theory section are as follows. Firstly we use the production function measure that assumes that the shareholdings of the common investors in the two firms are perfect substitutes in the joint profit steering index:

$$\delta_S = \frac{\sum_j(\gamma_{jB} + \gamma_{jG})}{\sum_i(\gamma_{iB} + \gamma_{iG})}, \tag{4}$$

where the numerator runs over the investors j that G and B have in common and the denominator runs over all the investors i in our database. As there are other investors that own less than 1%, the denominator may be smaller than the theoretical 2. We also use the production function measure that assumes that the shareholdings are perfect complements in the joint profit steering:

$$\delta_C = \sum_j \min\{\gamma_{jB}, \gamma_{jG}\}. \tag{5}$$

Lastly, we use the measure that assumes that the generic firm maximizes a weighted sum of (common and non-common) shareholder interests i:

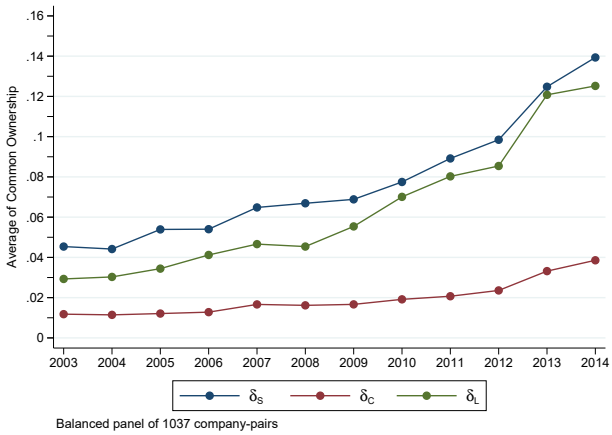
$$\delta_L = \frac{\sum_i \gamma_{iB}\gamma_{iG}}{\sum_i \gamma_{iG}^2}. \tag{6}$$

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). In a robustness check we include an indicator variable set to 1 for private companies.

We pay particular attention to the case in which the brand has a share in the potential generic entrant, i.e. when there is "cross-ownership" in the market. We create an indicator variable that takes on the value 1 if the potential generic entrant is (partially) cross-owned

by the brand and 0 if it is not, where stakes of the brand can go from 1% to 100% in the generic.

Figure 5: Evolution of common ownership



We report results using 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. About one to two years before filing an ANDA application, the generic firm starts preparing to enter (Reiffen and Ward, 2005). However, since it is unclear at exactly what point time the final entry decision of the generic firm is made, we also check that our results are robust to the use of common ownership measured two and zero years prior to the end of exclusivity. Results are not included in the paper, but they are similar to the current analysis and available upon request.

Figure 3 shows the evolution of the common ownership measures over time.[14] It is evident that common ownership has increased significantly from 2003 to 2014. The growth of common ownership was relatively small until the beginning of 2010. The average level of common ownership almost doubled in the last four years of the sample.

5.2 Sample and descriptive statistics

Our final sample consists of 451 drug product markets and 58,737 drug product-brand-generic observations. We consider only 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

[14]We only include the company-pairs that are observed for the entire period, as this provides a robust overview of how the degree of connectedness between brand and generic pairs has changed over time.

variables. In total there are 102 unique brand companies. Companies may enter (by incorporation) or exit the sample (by acquisition or bankruptcy). There are 13,954 unique generic-brand pairs. On average there are 131 potential generic entrants per market.

Table 2 gives an example of the structure of our data in terms of drug market, brand firm, potential generic entrants, entry and common ownership measures. The example relates to the drug Natrecor which is used for the treatment of heart failure and is produced by Johnson & Johnson. The relevant market is defined by the ingredients (nestiritide recombinant) and dosage form (solution; intravenous). The patent associated with Natrecor expired in 2014q2. Entry is defined within 6 quarters of the end of market exclusivity, in this case between 2014q2 and 2015q4. According to this definition no generics have entered the market. Indeed, the drug is currently on the FDA List of off-patent, off-exclusivity drugs without an approved generic.[15] The common ownership measures correspond to those of the year 2013.

Table 2: Example data structure

obs.	trade name	ingredients	dosage form	brand	generic entrant	entry	δ_S	δ_C	δ_L
1	natrecor	nestiritide recombinant	solution; intravenous	JOHNSON & JOHNSON	MYLAN	0	0.67	0.23	0.90
2	natrecor	nestiritide recombinant	solution; intravenous	JOHNSON & JOHNSON	BARR	0	0.51	0.02	0.25
3	natrecor	nestiritide recombinant	solution; intravenous	JOHNSON & JOHNSON	RANBAXY	0	0.05	0.01	0.00
4	natrecor	nestiritide recombinant	solution; intravenous	JOHNSON & JOHNSON	SANDOZ	0	0.45	0.09	0.33
5	natrecor	nestiritide recombinant	solution; intravenous	JOHNSON & JOHNSON	AMNEAL	0	0	0	0
6	natrecor	nestiritide recombinant	solution; intravenous	JOHNSON & JOHNSON	APOTEX	0	0	0	0
.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.

Table 3 outlines the key characteristics for the 451 entry opportunities. The unconditional probability of entry is 2%.[16] For 111 out of 451 markets (25%), there is no entry within 6 quarters. In 26% of the markets the brand has launched a generic itself, i.e. started selling an authorized generic. In terms of brand revenues, 16% of drug markets are ranked in the top 100 drugs in terms of sales in the year prior to the end of exclusivity. On average a potential generic entrant has launched 13 generic products of the same route/form as the brand and is active in 11 therapeutic fields.

[15] https://www.fda.gov/downloads/Drugs/ResourcesForYou/Consumers/BuyingUsingMedicineSafely/UnderstandingGenericDrugs/UCM564441.pdf

[16] Both number of entrants and realized entry opportunities are comparable with previous studies: 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.

Table 3: Summary statistics

Variable	Obs.	Mean	Std. Dev.	Min	Max
Entry (0/1)	58737	0.02	0.14	0	1
δ_S	58737	0.074	0.15	0	0.868
δ_C	58737	0.021	0.051	0	0.366
δ_L	58737	0.062	0.16	0	1.365
Cross Ownership (0/1)	58737	0.002	0.046	0	1
Sales Top 100 (0/1)	58737	0.158	0.365	0	1
Authorized Generic (0/1)	58737	0.26	0.439	0	1
Substitutes on Patent ÷10	58737	2.325	1.669	0	7.3
Substitutes off Patent ÷10	58737	1.6	1.31	0	6.1
Experience Route ÷10	58737	1.305	3.086	0	29.9
Experience ATC2 ÷10	58737	0.07	0.223	0	3.2
Experience New Drug ÷10	58737	0.179	0.424	0	2.8
Breadth of Experience ÷10	58737	1.135	1.204	0	6.1

5.3 Empirical implementation

We determine which individual generic firms are more likely to enter a given drug market. As our main variable of interest –common ownership between a potential generic entrant and the brand– is firm-specific, our regressions in this section are based on the individual probability of entering (as in e.g. Scott Morton, 1999), rather than on the market-level number of entrants (as in e.g. Scott Morton, 2000). However, it is important to remember that –as in our theory section on individual entry– other potential generic entrants are part of the analysis through their inclusion in the set of potential entrants.

The binary dependent variable thus contains the market entry decision of the generic firm. The resulting equation to be estimated is:

$$Pr[Entry_{Gm} = 1] = \beta_0 + \beta\delta_{Gm} + \eta Z_m + \gamma X_{Gm} + A_m + \mu_t + \epsilon_{Gm}.$$

$Entry_{Gm}$ takes on the value 1 when generic G enters market m within 6 quarters after the end of exclusivity. δ_{Gm} is one of the measures of common ownership between the generic firm and the brand for the market, where δ_{Gm} can be δ_S, δ_C or δ_L. Z_m is a vector of market characteristics, including market size as measured by pre-generic-entry sales, an indicator for the presence of an authorized generic and the number of on- and off-patent inter-molecular substitutes in same therapeutic field. X_{Gm} is a vector of generic-market characteristics, including generic's previous experience with drug from/route, generic's

previous experience with the therapeutic class, generic's previous experience with new drugs, number of therapeutic fields in which the generic has experience and region of generic's company headquarters.[17] A vector of fixed effects A_m is included for drug dosage form, submission class and therapeutic field (ATC-2 level), as well as a fixed effect μ_t for the year of the end of exclusivity.

We first estimate a linear probability model (LPM), as in our case a LPM model is able to estimate more parameters than a probit or logit model. In the case of the probit and logit models certain dummy variables perfectly predict the outcome; hence, these observations are dropped.[18,19] However, coefficients for the probit and logit models are also reported in Appendix C.

The coefficient β measures the impact of common ownership between the brand and the generic on the generic's entry decision. If investors adjust their holdings in response to entry opportunities, common ownership might be endogenous. For example if investors in the brand increase investment in generics with entry plans, common ownership between the brand and generic will increase before entry, causing β to be biased upwards. To address these endogeneity concerns, we therefore also perform IV estimations and instrument for common ownership with financial index membership at the pair level.[20] We use the holdings included in the iShares US Pharmaceutical exchange-traded fund (ETF) during the 2006-2014 period (with symbol *IHE*). The IHE fund, launched in 2006 and managed by BlackRock, tracks the Dow Jones US Select Pharmaceutical Index, which in turn is designed to measure the performance of the pharmaceutical sector of the US equity market. According to BlackRock (2017), the IHE fund generally invests at least 90% of its assets in securities or other financial instruments related to the Dow Jones US Select Pharmaceutical Index.

[17] Regions are defined as Australasia, Eastern Asia, Eastern Europe, Northern America, Northern Europe, South-eastern Europe, Southern Asia, Southern Europe, Western Asia, Western Europe.

[18] As noted by Caudill (1988), if the model contains a dummy variable for membership in some group, and every member of the group has the same value for the dependent variable, the coefficient of the group dummy variable cannot be estimated in logit or probit models but can be estimated in the linear probability model.

[19] 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. The therapeutic fields are as follows: A16 for which there are 4 drug products (4 drug markets, 525 obs. are dropped); D04 (1 drug market, 118 obs. are dropped), D09 (1 drug market, 122 obs. are dropped), R02 (1 drug market, 137 obs. are dropped).

[20] A similar approach has been applied by several other papers 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.

Appendix A provides a snapshot of the top 10 investments of the fund as of November 2013. As can be seen, both brand and generic firms are present in the fund; e.g. Johnson & Johnson is a brand company, whereas Mylan primarily produces generic drugs. On average, the fund has been comprised of 39 holdings over time, each allocated a specific weight that changes over time. These relative weightings are computed using the market-cap methodology whereby the securities are valued according to their total market capitalization. Since May 2006, each listed company has been included in the ETF for an average of 4 years. This evidences the pattern of entry and exit of the fund that 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.

We construct a first instrumental variable, based on the IHE fund, *Index Periods*. *Index Periods* is constructed by adding up the number of quarters that both firms have appeared in the index up until one year prior to the end of exclusivity.[21] We expect that the longer both companies are present in the IHE index, the more investment in both companies will increase by investors that track the Dow Jones US Select Pharmaceutical Index, leading to higher common ownership levels. The identifying assumption is that inclusion in the ETF, which mirrors 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.

We further construct an additional instrument based on the pharmaceutical companies' headquarters. In particular, the instrument *Same Region* takes on the value 1 when both companies in the pair have headquarters located in the same geographic region and 0 when the regions differ. We expect that companies with headquarters in the same region will have higher common ownership due to regionally focused investors. That is, if both companies are located in Southern Asia, the pair is likely to have higher common ownership than if one company was located in Southern Asia and the other in Northern America.

[21]Similar instrumental variables that were constructed include *Index Presence* which is an indicator variable that is 1 if one or both companies are included in the ETF, and *Index Weights* which sums the weights of each pair of companies and indicates their relative financial importance for every period. Results are robust to using these alternative instruments.

5.4 Results

We present the results for the OLS and IV estimations with our three common ownership measures in table 4. The coefficient on δ across all measures is negative and significant. Thus we find that common ownership between the brand and generic indeed reduces the likelihood of generic entry. The coefficient on common ownership should be interpreted bearing in mind the unconditional probability of entry for the sample. The unconditional probability of entry for the sample of firms and markets is 2%. Focusing on the OLS estimations in columns (1) - (3), an increase of one standard deviation as measured by δ_S implies a $0.15 \times 0.012 = 0.0018$ percentage point decrease in the probability of entry, *ceteris paribus*. This is therefore a $0.0018/0.02 = 9\%$ reduction in the unconditional probability of entry. Similarly, an increase of one standard deviation in δ_C and δ_L imply an 11% and 13% decrease, respectively, in the probability of entry.

The IV results in columns (4) - (6) suggest an even more negative effect of common ownership on entry. The first-stage results, reported in table 6, indicate that both instruments are highly relevant and positively correlated with δ, as the significance of the instruments and the F-test show. However, the Durbin-Wu-Hausman test shows that we cannot reject the hypothesis that δ is exogenous for all measures of δ.

The control variables carry the expected signs; higher pre-entry brand sales, fewer on-patent molecular substitutes and greater entrant experience all significantly increase the likelihood of entry. On the other hand, we find that the launch of an authorized generic and the number of molecular substitutes off-patent do not have a significant impact on generic entry.

Directly relevant for the topic of the study, the effect of common ownership is smaller than the effect of being (partly) being cross-owned by the brand. For example, if δ_S in the OLS estimation is 1 –that is the brand and generic share all the same common owners– then the probability of entry falls by 1.2 percentage points. On the other hand, if the relationship is cross-ownership then the probability of entry falls by 4 percentage points.

Table 4: Main specification

	OLS			IV		
	(1)	(2)	(3)	(4)	(5)	(6)
δ_S	-0.0120***			-0.0230**		
	(0.00437)			(0.0116)		
δ_C		-0.0422***			-0.0591**	
		(0.0130)			(0.0290)	
δ_L			-0.0165***			-0.0183*
			(0.00400)			(0.00949)
Cross Ownership (0/1)	-0.0405***	-0.0401***	-0.0405***	-0.0420***	-0.0406***	-0.0406***
	(0.0101)	(0.0101)	(0.0101)	(0.0102)	(0.0101)	(0.0101)
Sales Top 100 (0/1)	0.0200***	0.0201***	0.0201***	0.0202***	0.0201***	0.0201***
	(0.00231)	(0.00231)	(0.00231)	(0.00232)	(0.00232)	(0.00232)
Authorized Generic (0/1)	0.00103	0.00103	0.00103	0.000978	0.00101	0.00103
	(0.00151)	(0.00151)	(0.00151)	(0.00151)	(0.00151)	(0.00151)
Substitutes on Patent	-0.00429**	-0.00433**	-0.00428**	-0.00438**	-0.00438**	-0.00429**
	(0.00182)	(0.00182)	(0.00182)	(0.00182)	(0.00182)	(0.00182)
Substitutes off Patent	-0.000956	-0.000927	-0.000968	-0.000910	-0.000895	-0.000964
	(0.00153)	(0.00153)	(0.00153)	(0.00153)	(0.00153)	(0.00153)
Experience Route	0.00835***	0.00834***	0.00836***	0.00834***	0.00834***	0.00836***
	(0.000564)	(0.000564)	(0.000564)	(0.000564)	(0.000564)	(0.000564)
Experience ATC2	0.0602***	0.0602***	0.0601***	0.0601***	0.0601***	0.0601***
	(0.00699)	(0.00699)	(0.00699)	(0.00699)	(0.00699)	(0.00699)
Experience New Drug	0.00434*	0.00432**	0.00475**	0.00546**	0.00481**	0.00493**
	(0.00222)	(0.00217)	(0.00219)	(0.00233)	(0.00221)	(0.00224)
Breadth of Experience	0.00325***	0.00333***	0.00329***	0.00342***	0.00344***	0.00332***
	(0.000920)	(0.000924)	(0.000920)	(0.000946)	(0.000947)	(0.000935)
Therapeutic field	Yes	Yes	Yes	Yes	Yes	Yes
Drug form	Yes	Yes	Yes	Yes	Yes	Yes
Submission type	Yes	Yes	Yes	Yes	Yes	Yes
Generic region of origin	Yes	Yes	Yes	Yes	Yes	Yes
Year end of exclusivity	Yes	Yes	Yes	Yes	Yes	Yes
Constant	0.0290***	0.0286***	0.0285***	0.0292***	0.0286***	0.0285***
	(0.00671)	(0.00671)	(0.00670)	(0.00672)	(0.00670)	(0.00670)
Observations	58,737	58,737	58,737	58,737	58,737	58,737
Drug Markets	451	451	451	451	451	451
R-squared	0.079	0.079	0.079			

Notes: Standard errors in parentheses are robust. The dependent variable is entry within 6 quarters. The instruments are the number of periods listed in the ETF iShares U.S. Pharmaceutical and an indicator for both headquarters located in the same region. $***p < 0.01, **p < 0.05, *p < 0.1$.

Table 5: First-stage IV regressions

	(1) δ_S	(2) δ_C	(3) δ_L
Index Periods	0.0527***	0.0207***	0.0652***
	(0.000822)	(0.000331)	(0.00101)
Same Region	0.0104***	0.00636***	0.00621***
	(0.00143)	(0.000495)	(0.00157)
Constant	0.0782***	0.0205***	0.0551***
	(0.00700)	(0.00218)	(0.00676)
Observations	58,737	58,737	58,737
Drug markets	451	451	451
R-squared	0.285	0.298	0.293
Fixed Effects	Yes	Yes	Yes
F-Test	159.7	112.8	117.3
F-Test (p-val)	0	0	0
Weak Instrument	2286	2250	2213
Endogeneity test (p-val)	0.288	0.469	0.779

Notes: For simplicity only the coefficients associated with the excluded instruments are reported. Weak instrument presents the Kleibergen-Paap rk Wald statistic. $***p < 0.01, **p < 0.05, *p < 0.1$.

The fact that we find a significant effect across all measures of common ownership, and similar effects in terms of economic magnitude implies that we cannot say 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. This is in fact no surprise since empirically we find that the three measures of common ownership are highly correlated with each other: corr(δ_S, δ_C)= 0.8, corr(δ_S, δ_L)= 0.84 and corr(δ_C, δ_L)= 0.83. Thus, while in theory our measures capture quite different mechanisms of influence, the empirical counterparts are quite similar and the variation across brand-generic pairs is small.

5.5 Robustness checks

Our results are robust to a series of different specifications, as can be seen from the tables in Appendix C. So far, we have constructed common ownership measures on the base of percentage holdings. However, another class of measures could be based on investors' *rankings* within a company in terms of holdings. We re-do the same estimations as our main specification but with measures based in investors' rank. In particular, we construct counts based on the number investors that are ranked in the top 5 or top 10, respectively,

in both the brand and generic companies. Table C1 shows the results of estimations with the new ranking measures. Column 1 shows that one additional top 5 common investor leads to a -0.003 percentage point decrease in the probability of entry, and this decrease is significant at the 1% level. Remember that that the unconditional entry rate is 0.02. Therefore, an additional top 5 common investor leads to a $0.003/0.02 = 15\%$ decline in the probability of entry. The effect of having an additional top 10 common investor is also highly significant and negative (see column 2), although the size effect is about half. These findings, therefore, are consistent with the idea that higher ranked investors have more power, and effectively use this this power to reduce entry.

In table C2 we present results where common ownership is specified as a categorical variable. We specify common ownership as a categorical variable in order to investigate whether greater levels of common ownership have a larger impact; i.e., whether the relationship between common ownership and entry is non-linear. We focus on the measure δ_S. This measure can be interpreted as the fraction of total ownership in the pair held by common investors, and hence presents natural thresholds. We construct three categorical variables based on the value of δ_S: $\delta_S(0 < \delta \leq 0.3)$ takes on the value 1 if $\delta_S \in (0; 0.3]$, $\delta_S(0.3 < \delta \leq 0.5)$ takes on the value 1 if $\delta_S \in (0.3; 0.5]$, and $\delta_S(0.5 < \delta \leq 1)$ takes on the value 1 if $\delta_S \in (0.5; 1]$.

The results in table C2 indicate that the effect of common ownership increases the greater the level of common ownership. The coefficients on each categorical variable increase in magnitude (become more negative) with higher common ownership. Furthermore, once δ_S is greater than 0.5 coefficients are significant at the 1% level. A change from zero common ownership to common ownership of greater than 0.5 reduces the entry probability of a generic by 0.9 percentage points on average. This is a 50% decline in the unconditional probability of entry. In our sample, there are 669 unique brand-generic pairs with a δ_S of greater than 0.5 at some point in time. This is 5% of all brand-generic pairs. In sum, 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.

We further show results with a different measure for market size in table C3. We use data on total reimbursements by Medicaid for the brand drug in the two years preceding the end of exclusivity as a proxy for market size. Medicaid is a joint federal and state program that helps with medical costs for people with limited income and resources in the US. We match the brand drug products in our sample with Medicaid data using National Drugs Codes (NDC), which are unique product identifiers for drugs in the US. This provides us with a sample of 395 drug products (out of a possible 451). Table C3

shows that with this alternative measure for market size, our results stay qualitative the same.

Table C4 presents logit and probit regressions for our main specification. Results show that our three common ownership measures negatively impact entry. Table C5 shows results for different entry time windows, as entry may be slower or faster than our chosen 6 quarter window. In particular, we show specifications for three additional windows after the end of exclusivity: one year, two years and *all years*, which means that we do not restrict the time window of entry in our sample. Findings are qualitatively the same as in our main specification, i.e., entry is significantly negatively influenced by common ownership and this holds for different time windows.

Another issue may be the set of potential entrants, which we so far have specified to be as large as possible. In table C6, we provide results for the case where we restrict the set of potential entrants to only those with experience in the relevant drug form/route. Doing so, however, means that we drop 61 *actual* entry observations, or 5% all actual entry observations. Results in table C6 show that while effects are larger in size, qualitatively they are identical to our main results: for all three common ownership measures, the effect is negative and significant at the 1% level.

Furthermore, while we checked for the private companies that also operate in the UK that these do not have common ownership, for other companies we cannot be 100% sure that this is the case. We, therefore, re-run our main specification and include dummies for private generics, private brand companies and private brand-generic pairs. As can be seen in table C7, results are fully in line with our main specification.

Tables C8 and C9 show results where we add drug product fixed effects and brand fixed effects, respectively. Again, our main results stay virtually the same.

6 Market outcomes

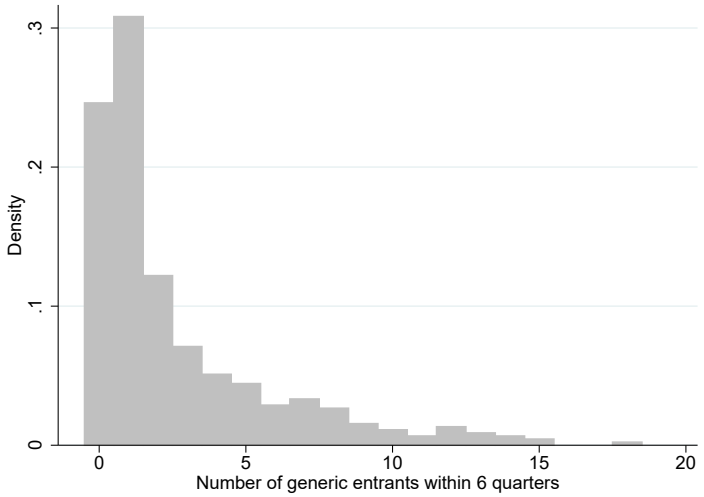
Until this point, we have empirically established that a higher level of common ownership between a brand and a particular generic reduces the entry probability of that specific generic firm. However, it is relevant to consider if, as a result of this, common ownership actually leads to a reduction in the total number of generics in a market. This is especially important from a policy perspective because average drug prices decline steeply with a higher number of generics in a market.[22] In this section we consider the effect of common

[22]See: https://www.fda.gov/aboutfda/centersoffices/officeofmedicalproductsandtobacco/cder/ucm12-9385.htm

ownership at the market level.

Prediction 2 from our theoretical framework states that a higher overall level of common ownership between the brand on the one hand and the set of potential entrants on the other hand, should lead to less entry overall. To test this prediction, we develop a count model where the outcome variable is the total number of generic entrants in a market within 6 quarters after the end of exclusivity, N_m. Figure 6 shows the distribution of our dependent variable. Notably 25% of the drug products in our sample face no entry within 6 quarters after the end of exclusivity.

Figure 6: Histogram of total number of entrants



To measure common ownership at the market level we propose a simple and straightforward approach: we calculate the mean value of δ_S for each market m across the set of potential generic entrants, defined as Set_m. We use the same set of potential generic entrants as in the individual analysis, i.e., all generics in our sample. However, due to the fact that common ownership with the most experienced generics may matter more than common ownership with all potential generic entrants, we also re-do the analysis by defining Set_m as the top 50 and top 20 most experienced generics at the drug form/route level. Thus, our market-level common ownership measure is defined as:

$$\delta_m = \frac{\sum_{Set_m} \delta_S}{\#(Set_m)}, \tag{7}$$

where Set_m is the set of potential entrants in market m (which can be all generics, top 50 or top 20 most experienced generics). As can be seen from Table 6, on average, δ_m is

larger when restricting the set to more experienced generic entrants.

Table 6: Summary statistics at the market-level

Variable	Obs.	Mean	Std. Dev.	Min	Max
N_m	451	2.608	3.249	0	18
$\delta_m - all$	451	0.074	0.044	0	0.176
$\delta_m - top50$	451	0.112	0.069	0	0.307
$\delta_m - top20$	451	0.138	0.085	0	0.325

Our dependent variable is a count of number of entrants into each market after regulatory protections have expired. A commonly used specification for count data is the Poisson model. However, the Poisson model makes the limiting assumption that the variance of the dependent variable equals its mean. In contrast, our data displays overdispersion. As can be seen in Table 6 and Figure 6, the mean number of entrants over our 451 markets is 2.6. However, the distribution is quite dispersed relative to the mean, going from a minimum of zero to a maximum of 18 entrants. The standard parametric model to account for overdispersion is the negative binomial. We estimate the most frequently implemented version of the negative binomial model, which is termed the NB2 model by Cameron and Trivedi (2013); see also this work for a detailed derivation.The negative binomial model introduces unobserved heterogeneity, ν_m, into the conditional mean of the Poisson model. Thus we specify:

$$E(N_m|\mathbf{X_m}, \nu_m) = exp(\beta_0 + \beta\delta_m + \eta Z_m + A_m + \mu_t + \nu_m),$$

where e^{ν_m} follows a gamma distribution with mean 1 and variance α. N_m is the total number of generic entrants within 6 quarters after the end of exclusivity in market m, δ_m is the average level of common ownership in that market between the brand and the set of potential entrants, Z_m is a vector of market level control variables, A_m is a vector of fixed effects for drug dosage form, submission class and therapeutic field (ATC-2 level), and lastly μ_t is a fixed effect for the year of the end of exclusivity.[23] Maximum likelihood estimation of the parameters of the model, including α, is straightforward.

[23]While we focus on 6 quarter windows, averages of δ_S and negative binomial estimates, it is important to note at this stage that our results are robust to taking a 2-year time window, using averages of δ_C and δ_L, and Poisson and OLS specifications. For the sake of brevity, these results are not shown in the paper, but they are available on request.

Table 7: Market-level specification

	All		Top 50		Top 20	
	(1)	(2)	(3)	(4)	(5)	(6)
		$\partial y/\partial x$		$\partial y/\partial x$		$\partial y/\partial x$
δ_m	-2.479*	-6.479*	-1.968**	-5.149**	-1.515**	-3.962**
	(1.285)	(3.388)	(0.825)	(2.184)	(0.652)	(1.724)
Sales Top 100 (0/1)	0.615***	1.608***	0.620***	1.621***	0.621***	1.623***
	(0.121)	(0.323)	(0.121)	(0.323)	(0.121)	(0.322)
Authorized Generic (0/1)	0.167	0.438	0.163	0.427	0.167	0.437
	(0.117)	(0.310)	(0.117)	(0.309)	(0.117)	(0.308)
Substitutes on Patent	-0.221	-0.577	-0.219	-0.573	-0.222	-0.581
	(0.150)	(0.394)	(0.150)	(0.393)	(0.148)	(0.390)
Substitutes off Patent	0.0786	0.205	0.0745	0.195	0.0701	0.183
	(0.138)	(0.360)	(0.137)	(0.358)	(0.130)	(0.356)
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
Constant	0.970*		0.994*		1.010*	
	(0.550)		(0.130)		(0.548)	
Observations	451		451		451	
$\ln(\alpha)$	-0.857***		-0.865***		-0.866***	
R^2_{corr}	0.404		0.403		0.406	
R^2_{pseudo}	0.122		0.123		0.123	

Notes: Negative Binomial Regression. Standard errors in parentheses are robust. The dependent variable is total number of entrants within 6 quarters. $***p < 0.01, **p < 0.05, *p < 0.1$.

Table 7 presents both the coefficient estimates and the average marginal effect of δ_m on total entry, and this for our three sets of potential entrants. First off, it can be seen that for all sets of potential entrants, the effect of δ_m on number of entrants is negative and significant at the 10% level (for $\delta_m - all$) or at the 5% level (for $\delta_m - top$ 50 and $\delta_m - top$ 20). Given the low number of observations (one per market) and the fact that common ownership has been aggregated to the market level –which provides much less precision than the pairwise measures – we interpret this as robust evidence that there is a negative relationship between the overall level of common ownership and entry in a market.

When taking, as example, the impact of $\delta_m - all$ on N_m (columns 1 and 2), the size of the coefficients tells us the following story; an increase in one standard deviation in $\delta_m - all$ leads to a decrease in total entry of 10.9% (0.044 x -2.479) or, equivalently, to a decrease of 0.28 (0.044 X -6.479) entrants. The impact of a one standard deviation increase in $\delta_m - top50$ and $\delta_m - top20$ is to reduce the total number of entrants by 13.5%

and 12.8% respectively. Using our estimates to calculate the average predicted number of generic firms for certain levels of common ownership, we find that when going from the minimum level of $\delta_m - all$, i.e., having no common ownership at all, to the maximum level of 0.176, the average number of entrants in a market would go down from about 3.14 to about 2.11 all else constant. Thus, we find that common ownership has an economically significant effect on total generic entry.

7 Conclusion

Ownership linkages between firms, which typically arise due to large investors that invest in multiple firms in an industry, 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 has recently attracted significant attention.

In this paper 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 that can be much higher than the generic's gains from entry, a simple theory model shows that higher common ownership reduces generic entry as common owners have both the incentive and ability to push back entry. Empirical results lend robust support to this proposition. We show that higher common ownership between a potential generic entrant and the brand firm (incumbent) in a specific drug market has a significant negative effect on the likelihood that the generic firm will enter the market. Based on a linear probability model that relates generic entry to several measures of common ownership with the brand, we find that a one-standard-deviation increase in common ownership decreases the probability of generic entry by 9-13%. Moreover, we show that common ownership has an effect on the overall number of generic firms in a market. A one-standard-deviation increase in common ownership at the market level decreases total entry by 11-13%. Still, it is perhaps important to stress that, as compared to the effect of being cross-owned by the brand, the effect of any level of common ownership between the generic and the brand is smaller.

This 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 strategic decisions of companies. Given the importance of generic entry in terms of reducing drug prices and therefore overall healthcare costs, common ownership in the pharmaceutical industry may have the

potential to raise the costs to consumers and healthcare payers.

There is room for future work on the topic in several dimensions. First, to make a clear welfare assessment on the link between common ownership and welfare, a more structural empirical model is needed where entry, pricing and innovation decisions are explicitly modelled.

Further, much still needs to be done to understand the corporate governance of common ownership, both how holdings translate into influence and how preferences of diverse investors are aggregated into firm's decisions.

Finally, US pharma markets are a clear example where common ownership can impact entry. Indeed, given the large asymmetries between brand and generic profits, incentives are high. Moreover, there exists at least one clear channel how generics and brand companies can make deals, i.e. through Paragraph IV settlements. It would be interesting to identify other markets where both incentives are high and clear channels exist to impact entry, and to investigate whether common owners have an influence therein.

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Appendix A: Common ownership

Anecdotal Evidence

We provide some anecdotal evidence that institutional investors are interested in influencing governance, policies and strategic decisions of firms. Evidence in Appel et al. (2016) suggests that informal discussions between institutions and managers, backed with the threat of voice (i.e., voting in shareholding meetings), are often used to exert influence. Glenn Booraem, controller of Vanguard funds, notes that engagement with directors and management of companies is a key component and that Vanguard has "found through hundreds of discussions every year" that it is "frequently able to accomplish as much -or much more through dialogue" as through voting (Booraem, 2014).

Furthermore, Vanguard's chairman recently stated that Vanguard seeks active interactions with firms they invest in: "In the past, some have mistakenly assumed that our predominantly passive management style suggests a passive attitude with respect to corporate governance. Nothing could be further from the truth."[24] A similar message emerges from BlackRock's chairman Larry Fink, "We are an active voice, we work with companies, we need to work for the long-term interest."[25]

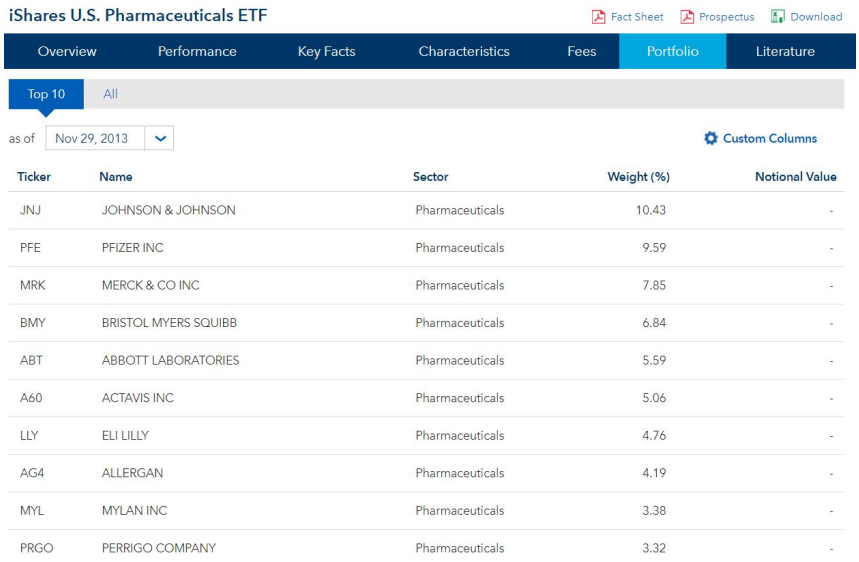
Specifically in pharmaceutical markets, institutional investors can be seen to take an active interest in the strategic decisions of companies. In 2016, a group of representatives of major US mutual funds (Fidelity Investments, T. Rowe Price Group Inc., Wellington Management Co., among others) met up 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.[26]

[24]Letter sent by F. William McNabb III, Vanguard's Chairman and CEO, to the independent leaders of the boards of directors of the Vanguard funds' largest portfolio holdings, dated 27 February 2015, available at https://about.vanguard.com/vanguard-proxy-voting/CEO Letter 03 02 ext.pdf.

[25]Wall Street Journal, 'BlackRock's Larry Fink: typical activists are too short-term', dated 16 January 2014, available at http://blogs.wsj.com/moneybeat/2014/01/16/blackRocks-larry-fink-typical-activists-are-too- short-term/

[26]Chen, C. (2016). Mutual fund industry to drug makers: stand up and defend yourself. Bloomberg News. Retrieved from https://www.bostonglobe.com/business/2016/05/10/mutual-fund-

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	-

industry-drugmakers-stand-and-defend-yourself/REKxLITGDeQR2oVmUZaTIP/story.html

Appendix B: Dataset construction

This Appendix contains a detailed description of how the data used for the analysis in this paper 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 (since 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."

We then merge annual drug sales data from one year before the end of exclusivity. The sales data is obtained 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). The sales data is matched with the FDA Orange book on the basis of trade name. Whereas in some cases the trade name provides an indication of which dosage form the sales refer to, in most cases we have just the trade name of the product. Hence for drugs which are offered in different forms, the different forms are each matched with the total sales of the product.

Each product is linked through exact text matching, based on compound-name, with the ATC/DDD Index 2015.[27] 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 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 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.[28] 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

[27]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.

[28]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).

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.

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.

We define a cross-ownership link as existing when the relationship between the generic and the brand is that of subsidiary and parent, or when one firm has an ownership stake in the other firm. There are 63 unique pairs where there exists cross-ownership, as we define it, between the brand and a potential generic entrant.

In total there are 102 unique brand companies (77 of which are publicly listed at some point in time) and 145 unique generic companies (69 of which are publicly listed at some point in time) operating within the relevant markets and time period. Given that the focus of the paper is on links between brand and generic companies, we then make our dataset pairwise: brand-generic pair. There are 13,954 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.

Appendix C: Robustness

Table C1: Robustness - Rank Measures

	(1)	(2)
No. of common investors in top 5	-0.00309***	
	(0.000991)	
No. of common investors in top 10		-0.00147***
		(0.000545)
Cross Ownership (0/1)	-0.0262**	-0.0273**
	(0.0107)	(0.0107)
Sales Top 100 (0/1)	0.0200***	0.0200***
	(0.00231)	(0.00231)
Authorized Generic (0/1)	0.000986	0.00102
	(0.00151)	(0.00151)
Substitutes on Patent	-0.00423**	-0.00429**
	(0.00182)	(0.00182)
Substitutes off Patent	-0.000993	-0.000939
	(0.00153)	(0.00153)
Experience Route	0.00835***	0.00834***
	(0.000564)	(0.000564)
Experience ATC2	0.0602***	0.0603***
	(0.00699)	(0.00699)
Experience New Drug	0.00437**	0.00432*
	(0.00217)	(0.00221)
Breadth of Experience	0.00322***	0.00324***
	(0.000921)	(0.000921)
Therapeutic field	Yes	Yes
Drug form	Yes	Yes
Submission type	Yes	Yes
Generic region of origin	Yes	Yes
Year end of exclusivity	Yes	Yes
Constant	0.0285***	0.0287***
	(0.00670)	(0.00671)
Observations	58,737	58,737
Drug Markets	451	451
R-squared	0.079	0.079

Notes: Standard errors in parentheses are robust. The dependent variable is entry within 6 quarters. $***p < 0.01, **p < 0.05, *p < 0.1$.

Table C2: Robustness - Categorical Variables Specification

	OLS	IV
δ_S $(0 < \delta \leq 0.3)$	0.00318*	-0.00323
	(0.00180)	(0.00312)
δ_S $(0.3 < \delta \leq 0.5)$	-0.00317	-0.00623*
	(0.00288)	(0.00361)
δ_S $(\delta > 0.5)$	-0.00915***	-0.0126***
	(0.00335)	(0.00372)
Cross Ownership (0/1)	-0.0388***	-0.0414***
	(0.0101)	(0.0102)
Sales Top 100 (0/1)	0.0200***	0.0201***
	(0.00231)	(0.00231)
Authorized Generic (0/1)	0.00114	0.00103
	(0.00151)	(0.00151)
Substitutes on Patent	-0.00418**	-0.00435**
	(0.00182)	(0.00182)
Substitutes off Patent	-0.00105	-0.000958
	(0.00153)	(0.00153)
Experience Route	0.00838***	0.00835***
	(0.000564)	(0.000564)
Experience ATC2	0.0603***	0.0602***
	(0.00698)	(0.00698)
Experience New Drug	0.00365	0.00501**
	(0.00224)	(0.00227)
Breadth of Experience	0.00292***	0.00337***
	(0.000927)	(0.000953)
Therapeutic field	Yes	Yes
Drug form	Yes	Yes
Submission type	Yes	Yes
Generic region of origin	Yes	Yes
Year end of exclusivity	Yes	Yes
Constant	0.0274***	0.0297***
	(0.00676)	(0.00685)
Observations	58,737	58,737
Drug markets	451	451
R-squared	0.079	

Notes: Standard errors in parentheses are robust. The dependent variable is entry within 6 quarters. The instruments are the number of periods listed in the ETF iShares U.S. Pharmaceutical and an indicator for both headquarters located in the same region. $***p < 0.01, **p < 0.05, *p < 0.1$.

Table C3: Robustness - Medicaid Reimbursements Pre-patent Expiry

	(1)	(2)	(3)
δ_S	-0.0123***		
	(0.00449)		
δ_C		-0.0435***	
		(0.0133)	
δ_L			-0.0169***
			(0.00410)
Cross Ownership (0/1)	-0.0359***	-0.0355***	-0.0359***
	(0.0108)	(0.0108)	(0.0108)
Medicaid Reimbursements	0.0322***	0.0322***	0.0322***
	(0.00462)	(0.00462)	(0.00462)
Authorized Generic (0/1)	0.00440***	0.00441***	0.00440***
	(0.00156)	(0.00156)	(0.00156)
Substitutes on Patent	-0.00293	-0.00292	-0.00292
	(0.00202)	(0.00202)	(0.00202)
Substitutes off Patent	-0.00338**	-0.00334**	-0.00339**
	(0.00158)	(0.00158)	(0.00158)
Experience Route	0.00848***	0.00848***	0.00849***
	(0.000591)	(0.000591)	(0.000591)
Experience ATC2	0.0567***	0.0567***	0.0566***
	(0.00714)	(0.00714)	(0.00714)
Experience New Drug	0.00380*	0.00381*	0.00425*
	(0.00229)	(0.00225)	(0.00226)
Breadth of Experience	0.00251***	0.00260***	0.00256***
	(0.000968)	(0.000972)	(0.000969)
Therapeutic field	Yes	Yes	Yes
Drug form	Yes	Yes	Yes
Submission type	Yes	Yes	Yes
Generic region of origin	Yes	Yes	Yes
Year end of exclusivity	Yes	Yes	Yes
Constant	0.0157**	0.0152**	0.0152**
	(0.00721)	(0.00720)	(0.00720)
Observations	51,604	51,604	51,604
Drug Markets	395	395	395
R-squared	0.078	0.078	0.078

Notes: OLS estimation. Standard errors in parentheses are robust.
The dependent variable is entry within 6 quarters.

Table C4: Robustness - Probit and Logit

	Probit			Logit		
	(1)	(2)	(3)	(4)	(5)	(6)
δ_S	-0.257**			-0.568**		
	(0.100)			(0.223)		
δ_C		-0.773***			-1.871***	
		(0.298)			(0.665)	
δ_L			-0.270***			-0.693***
			(0.104)			(0.230)
Cross Ownership (0/1)	-0.948*	-0.935*	-0.937*	-2.297**	-2.259**	-2.271**
	(0.490)	(0.488)	(0.488)	(1.088)	(1.086)	(1.086)
Sales Top 100 (0/1)	0.321***	0.322***	0.321***	0.754***	0.755***	0.755***
	(0.0380)	(0.0380)	(0.0380)	(0.0864)	(0.0863)	(0.0864)
Authorized Generic (0/1)	0.0558	0.0559	0.0563	0.0980	0.0973	0.0981
	(0.0345)	(0.0345)	(0.0345)	(0.0787)	(0.0786)	(0.0787)
Substitutes on Patent	-0.0932**	-0.0936**	-0.0927**	-0.182**	-0.183**	-0.181**
	(0.0401)	(0.0401)	(0.0401)	(0.0892)	(0.0892)	(0.0891)
Substitutes off Patent	-0.0126	-0.0112	-0.0126	-0.0464	-0.0441	-0.0473
	(0.0434)	(0.0435)	(0.0434)	(0.102)	(0.103)	(0.102)
Experience Route	0.0532***	0.0530***	0.0533***	0.0977***	0.0975***	0.0984***
	(0.00421)	(0.00420)	(0.00423)	(0.00904)	(0.00902)	(0.00913)
Experience ATC2	0.419***	0.419***	0.419***	0.735***	0.736***	0.735***
	(0.0462)	(0.0461)	(0.0461)	(0.101)	(0.101)	(0.101)
Experience New Drug	-0.0825**	-0.0840**	-0.0800**	-0.212***	-0.210***	-0.198**
	(0.0359)	(0.0356)	(0.0358)	(0.0796)	(0.0792)	(0.0795)
Breadth of Experience	0.237***	0.237***	0.236***	0.615***	0.616***	0.613***
	(0.0156)	(0.0156)	(0.0155)	(0.0358)	(0.0359)	(0.0358)
Therapeutic field	Yes	Yes	Yes	Yes	Yes	Yes
Drug form	Yes	Yes	Yes	Yes	Yes	Yes
Submission type	Yes	Yes	Yes	Yes	Yes	Yes
Generic region of origin	Yes	Yes	Yes	Yes	Yes	Yes
Year end of exclusivity	Yes	Yes	Yes	Yes	Yes	Yes
Constant	-2.275***	-2.281***	-2.284***	-4.524***	-4.529***	-4.537***
	(0.226)	(0.226)	(0.226)	(0.562)	(0.562)	(0.562)
Observations	57,835	57,835	57,835	57,835	57,835	57,835
Drug Markets	451	451	451	451	451	451

Notes: Standard errors in parentheses are robust. The dependent variable is entry within 6 quarters.

Table C5: Robustness - Entry within 1, 2 and All Years

	Entry within 1 year			Entry within 2 years			All entry		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
δ_S	-0.0102**			-0.00937**			-0.00914**		
	(0.00424)			(0.00439)			(0.00462)		
δ_C		-0.0343***			-0.0351***			-0.0459***	
		(0.0127)			(0.0128)			(0.0135)	
δ_L			-0.0143***			-0.0135***			-0.0192***
			(0.00391)			(0.00404)			(0.00428)
Cross Ownership (0/1)	-0.0373***	-0.0370***	-0.0374***	-0.0442***	-0.0439***	-0.0442***	-0.0563***	-0.0565***	-0.0570***
	(0.00984)	(0.00983)	(0.00983)	(0.0102)	(0.0102)	(0.0102)	(0.0111)	(0.0111)	(0.0111)
Sales Top 100 (0/1)	0.0187***	0.0188***	0.0187***	0.0210***	0.0211***	0.0211***	0.0217***	0.0218***	0.0218***
	(0.00224)	(0.00224)	(0.00224)	(0.00228)	(0.00229)	(0.00228)	(0.00202)	(0.00202)	(0.00201)
Authorized Generic (0/1)	-0.000111	-0.000104	-0.000105	0.00119	0.00119	0.00119	0.00357***	0.00356***	0.00356***
	(0.00145)	(0.00145)	(0.00145)	(0.00151)	(0.00151)	(0.00151)	(0.00137)	(0.00137)	(0.00137)
Substitutes on Patent	-0.00367**	-0.00369**	-0.00366**	-0.00442**	-0.00445**	-0.00441**	-0.00490***	-0.00495***	-0.00492***
	(0.00171)	(0.00171)	(0.00171)	(0.00185)	(0.00185)	(0.00185)	(0.00174)	(0.00174)	(0.00174)
Substitutes off Patent	-0.00111	-0.00109	-0.00112	-0.000731	-0.000706	-0.000739	-0.00272**	-0.00269**	-0.00272**
	(0.00146)	(0.00146)	(0.00146)	(0.00151)	(0.00151)	(0.00151)	(0.00135)	(0.00135)	(0.00135)
Experience Route	0.00795***	0.00795***	0.00796***	0.00854***	0.00854***	0.00855***	0.0103***	0.0103***	0.0103***
	(0.000550)	(0.000550)	(0.000550)	(0.000571)	(0.000571)	(0.000571)	(0.000613)	(0.000613)	(0.000613)
Experience ATC2	0.0561***	0.0561***	0.0560***	0.0696***	0.0696***	0.0695***	0.0814***	0.0813***	0.0812***
	(0.00678)	(0.00678)	(0.00678)	(0.00725)	(0.00725)	(0.00725)	(0.00769)	(0.00769)	(0.00769)
Experience New Drug	0.00462**	0.00456**	0.00500**	0.00354	0.00359	0.00394*	0.00582**	0.00622**	0.00683***
	(0.00217)	(0.00212)	(0.00214)	(0.00225)	(0.00220)	(0.00221)	(0.00248)	(0.00244)	(0.00245)
Breadth of Experience	0.00281***	0.00287***	0.00285***	0.00328***	0.00335***	0.00330***	0.00564***	0.00578***	0.00576***
	(0.000894)	(0.000898)	(0.000894)	(0.000927)	(0.000930)	(0.000928)	(0.000981)	(0.000983)	(0.000980)
Therapeutic field	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Drug form	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Submission type	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Generic region of origin	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year end of exclusivity	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	0.0285***	0.0282***	0.0281***	0.0300***	0.00335***	0.0298***	0.0324***	0.0322***	0.0320***
	(0.00644)	(0.00644)	(0.00644)	(0.00656)	(0.000930)	(0.00655)	(0.00642)	(0.00642)	(0.00641)
Observations	58,737	58,737	58,737	61,662	61,662	61,662	86,732	86,732	86,732
Drug Markets	451	451	451	451	451	451	451	451	451
R-squared	0.076	0.076	0.076	0.082	0.082	0.082	0.086	0.086	0.086

Notes: OLS Estimation. Standard errors in parentheses are robust. $***p < 0.01, **p < 0.05, *p < 0.1$.

Table C6: Robustness - Potential Entrants with Experience in Drug Form

	(1)	(2)	(3)
δ_S	-0.0247***		
	(0.00583)		
δ_C		-0.0736***	
		(0.0167)	
δ_L			-0.0273***
			(0.00496)
Cross Ownership (0/1)	-0.0619***	-0.0608***	-0.0614***
	(0.0133)	(0.0132)	(0.0132)
Sales Top 100 (0/1)	0.0233***	0.0233***	0.0233***
	(0.00299)	(0.00299)	(0.00299)
Authorized Generic (0/1)	0.00179	0.00184	0.00182
	(0.00215)	(0.00215)	(0.00215)
Substitutes on Patent	-0.00632**	-0.00635**	-0.00625**
	(0.00299)	(0.00299)	(0.00299)
Substitutes off Patent	-0.00314	-0.00310	-0.00315
	(0.00268)	(0.00268)	(0.00268)
Experience Route	0.00813***	0.00812***	0.00815***
	(0.000661)	(0.000660)	(0.000661)
Experience ATC2	0.0642***	0.0643***	0.0641***
	(0.00812)	(0.00812)	(0.00812)
Experience New Drug	0.00477*	0.00444	0.00511*
	(0.00283)	(0.00279)	(0.00281)
Breadth of Experience	0.00297**	0.00299**	0.00291**
	(0.00145)	(0.00145)	(0.00144)
Therapeutic field	Yes	Yes	Yes
Drug form	Yes	Yes	Yes
Submission type	Yes	Yes	Yes
Generic region of origin	Yes	Yes	Yes
Year end of exclusivity	Yes	Yes	Yes
Constant	0.0595***	0.0591***	0.0588***
	(0.0126)	(0.0126)	(0.0126)
Observations	39,478	39,478	39,478
Drug Markets	451	451	451
R-squared	0.086	0.086	0.087

Notes: OLS estimation. Standard errors in parentheses are robust. The dependent variable is entry within 6 quarters.

Table C7: Robustness - Private Firm Dummies

	(1)	(2)	(3)
δ_S	-0.0163***		
	(0.00592)		
δ_C		-0.0526***	
		(0.0161)	
δ_L			-0.0201***
			(0.00475)
Cross Ownership (0/1)	-0.0420***	-0.0412***	-0.0418***
	(0.0101)	(0.0101)	(0.0101)
Sales Top 100 (0/1)	0.0202***	0.0202***	0.0202***
	(0.00232)	(0.00232)	(0.00231)
Authorized Generic (0/1)	0.000821	0.000825	0.000843
	(0.00151)	(0.00151)	(0.00151)
Substitutes on Patent	-0.00454**	-0.00458**	-0.00451**
	(0.00184)	(0.00184)	(0.00184)
Substitutes off Patent	-0.000852	-0.000818	-0.000877
	(0.00153)	(0.00153)	(0.00153)
Experience Route	0.00836***	0.00835***	0.00838***
	(0.000564)	(0.000564)	(0.000564)
Experience ATC2	0.0602***	0.0601***	0.0600***
	(0.00699)	(0.00699)	(0.00699)
Experience New Drug	0.00401*	0.00388*	0.00426*
	(0.00228)	(0.00227)	(0.00227)
Breadth of Experience	0.00307***	0.00316***	0.00307***
	(0.000929)	(0.000928)	(0.000928)
Generic Private (0/1)	-0.00295	-0.00286	-0.00322*
	(0.00192)	(0.00176)	(0.00168)
Brand Private (0/1)	0.000003	0.000301	-0.00003
	(0.00362)	(0.00354)	(0.00350)
Generic and Brand Private (0/1)	0.00513	0.00489	0.00521
	(0.00379)	(0.00371)	(0.00367)
Therapeutic field	Yes	Yes	Yes
Drug form	Yes	Yes	Yes
Submission type	Yes	Yes	Yes
Generic region of origin	Yes	Yes	Yes
Year end of exclusivity	Yes	Yes	Yes
Constant	0.0299***	0.0294***	0.0294***
	(0.00674)	(0.00672)	(0.00671)
Observations	58,737	58,737	58,737
Drug Markets	451	451	451
R-squared	0.079	0.079	0.079

Notes: OLS estimation. Standard errors in parentheses are robust.
The dependent variable is entry within 6 quarters.

Table C8: Robustness - Drug Product Fixed Effects

	(1)	(2)	(3)
δ_S	-0.00988**		
	(0.00438)		
δ_C		-0.0348***	
		(0.0132)	
δ_L			-0.0150***
			(0.00403)
Cross Ownership (0/1)	-0.0395***	-0.0390***	-0.0396***
	(0.0101)	(0.0101)	(0.0101)
Experience Route	0.00836***	0.00836***	0.00837***
	(0.000560)	(0.000559)	(0.000560)
Experience ATC2	0.0610***	0.0609***	0.0609***
	(0.00690)	(0.00690)	(0.00690)
Experience New Drug	0.00404*	0.00402*	0.00452**
	(0.00220)	(0.00216)	(0.00217)
Breadth of Experience	0.00313***	0.00320***	0.00318***
	(0.000912)	(0.000916)	(0.000912)
Generic region of origin	Yes	Yes	Yes
Drug product fixed effect	Yes	Yes	Yes
Constant	-0.0243***	-0.0248***	-0.0241***
	(0.00829)	(0.00830)	(0.00829)
Observations	58,737	58,737	58,737
Drug Markets	451	451	451
R-squared	0.099	0.099	0.099

Notes: OLS estimation. Standard errors in parentheses are robust. The dependent variable is entry within 6 quarters.

Table C9: Robustness - Brand Firm Fixed Effects

	(1)	(2)	(3)
δ_S	-0.0104**		
	(0.00438)		
δ_C		-0.0351***	
		(0.0132)	
δ_L			-0.0153***
			(0.00402)
Cross Ownership (0/1)	-0.0384***	-0.0378***	-0.0384***
	(0.0102)	(0.0102)	(0.0102)
Sales Top 100 (0/1)	0.0198***	0.0198***	0.0198***
	(0.00254)	(0.00254)	(0.00254)
Authorized Generic (0/1)	0.00201	0.00204	0.00204
	(0.00184)	(0.00184)	(0.00184)
Substitutes on Patent	-0.00702***	-0.00701***	-0.00699***
	(0.00219)	(0.00219)	(0.00219)
Substitutes off Patent	-0.000480	-0.000503	-0.000483
	(0.00180)	(0.00180)	(0.00180)
Experience Route	0.00835***	0.00835***	0.00836***
	(0.000563)	(0.000563)	(0.000563)
Experience ATC2	0.0604***	0.0604***	0.0603***
	(0.00696)	(0.00696)	(0.00696)
Experience New Drug	0.00412*	0.00406*	0.00458**
	(0.00222)	(0.00217)	(0.00218)
Breadth of Experience	0.00320***	0.00327***	0.00326***
	(0.000919)	(0.000923)	(0.000919)
Brand	Yes	Yes	Yes
Therapeutic field	Yes	Yes	Yes
Drug form	Yes	Yes	Yes
Submission type	Yes	Yes	Yes
Generic region of origin	Yes	Yes	Yes
Year end of exclusivity	Yes	Yes	Yes
Constant	0.00324	0.00312	0.00290
	(0.00880)	(0.00880)	(0.00879)
Observations	58,737	58,737	58,737
Drug Markets	451	451	451
R-squared	0.083	0.083	0.084

Notes: OLS estimation. Standard errors in parentheses are robust.
The dependent variable is entry within 6 quarters.

Appendix D: Proofs

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 $\delta \leq \delta_0$ as $\Pi_G(0, \delta) = \pi_G^0 + \delta\Delta\pi_B^0 \geq 0$ if and only if

$$\delta \leq \pi_G^0 / \left|\Delta\pi_B^0\right| \equiv \delta_0.$$

- Similarly, if $p_1 = 1$ (i.e., it does enter for sure), G shall it find it optimal to enter if $\delta \leq \delta_1$ as $\Pi_G(1, \delta) = \pi_G^1 + \delta\Delta\pi_B^1 \geq 0$ if and only if

$$\delta \leq \pi_G^1 / \left|\Delta\pi_B^1\right| \equiv \delta_1.$$

Simple algebra shows that if $\delta_1 < \delta_0$ then $\delta_0 < \delta^*$ whereas if $\delta_0 < \delta_1$ then $\delta^* < \delta_0$. 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 $\delta_1 < \delta_0$ and thus $\delta_1 < \delta_0 < \delta^*$, 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 $\delta \leq \delta_1$ 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 $\delta \leq \delta_1$, 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 $\delta_1 < \delta \leq \delta_0$, 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 $\delta < \delta_0$), $\partial \Pi_G(p_1, \delta)/\partial p_1 < 0$ (as $\delta < \delta^*$) and $\Pi_G(1, \delta) < 0$ (as $\delta > \delta_1$). 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 $\delta_0 < \delta \leq \delta^*$, 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 $\delta > \delta_1$.

Second, we show that, if $\delta_0 < \delta_1$ and thus $\delta^* \leq \delta_0 < \delta_1$, 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 $\delta < \delta_1$.

- In the case in which $\delta^* < \delta \leq \delta_0$, 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 $\delta < \delta_0 G$ 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 $\delta_0 < \delta \leq \delta_1$, 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 $\delta > \delta_0$), $\partial \Pi_G(p_1, \delta)/\partial p_1 > 0$ (as $\delta > \delta^*$) and $\Pi_G(1, \delta) > 0$ (as $\delta < \delta_1$). 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 $\delta^* > \delta_1$ 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, while 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 i of the other entrants enter ($i = 0, ...N-1$, $p_i = 1$ and, for any $j \neq i$, $p_j = 0$), G shall it find it optimal to enter if and only if $\delta \leq \delta_i$ as $\Pi_G = \pi_G^i + \delta \Delta \pi_B^i \geq 0$ if and only if

$$\delta \leq \pi_G^i / \left| \Delta \pi_B^i \right| \equiv \delta_i.$$

In the case of a single potential entrant ($N = 1$ and $i = 0$), this is the optimal decision: enter if $\delta \leq \delta_0$ and do not if $\delta > \delta_0$. 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 $\delta_{N-1} < \delta_{N-2} < ... < \delta_0$ ("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 $\delta \leq \delta_{N-1}$ entering is a dominant strategy for G, independent of the number of other entrants, as $\delta \leq \delta_i$ for any i.
- If $\delta_{N-i} < \delta \leq \delta_{N-i-1}$ for any $i = 1, ..., N-1$, G shall enter if $N-i-1$ other generics, or less, enter, as $\delta \leq \delta_{N-i-1} < ... < \delta_0$, but it shall not enter if $N-i$ other generics, or more, do enter, as $\delta_{N-1} < ... < \delta_{N-i} \leq \delta$.
- Finally, if $\delta > \delta_0$ not entering is a dominant strategy, as $\delta > \delta_i$ for any i.

For instance in the case of two potential entrants ($N = 2$), G should enter if $\delta \leq \delta_1$, enter if and only if the other does not enter if $\delta_1 < \delta \leq \delta_0$ (as $N = 2$, $i = 1$, $N - i - 1 = 0$ and $N - i = 1$) and not enter if $\delta > \delta_0$.

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

- If $\delta \leq \delta_{N-1}$ all should enter in equilibrium, as entering is a dominant strategy.
- If $\delta_{N-i} < \delta \leq \delta_{N-i-1}$ for any $i = 1, ..., N-1$, $N-i$ generics should enter in equilibrium, as entering is optimal if $N-i-1$ other generics enter and not entering is optimal if $N-i$ do so.
- Finally, if $\delta > \delta_0$ 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 $i = 1$), the two generics should enter if $\delta \leq \delta_1$, one of them should enter if $\delta_1 < \delta \leq \delta_0$ (as $N = 2$, $i = 1$ and $N - i = 1$) and none of them should enter if $\delta > \delta_0$.

Suppose now that $\delta_0 < \delta_1 < ... < \delta_{N-1}$ ("strategic complements"). The best response function of G with respect to the number of other entrants is now as follows:

- If $\delta \leq \delta_0$ entering is again a dominant strategy for G, as $\delta < \delta_i$ for any i.
- But now, if $\delta_{N-i-1} < \delta \leq \delta_{N-i}$ for any $i = 1, ..., N-1$, G shall enter if $N-i$ other generics, or more, enter, as $\delta \leq \delta_{N-i} < ... < \delta_{N-1}$, but it shall not enter if $N-i-1$ other generics, or less, do enter, as $\delta_0 < ... < \delta_{N-i-1} < \delta$.
- Similarly, if $\delta > \delta_{N-1}$ not entering is again a dominant strategy, as $\delta > \delta_i$ for any i.

For instance in the case of two potential entrants ($N = 2$), G should enter if $\delta \leq \delta_0$, enter if and only if the other does enter if $\delta_0 < \delta \leq \delta_1$ and not enter if $\delta > \delta_2$.

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

- As before, if $\delta \leq \delta_0$ all should enter in equilibrium, as entering is a dominant strategy.
- But the equilibria in the intermediate cases $\delta_0 < \delta \leq \delta_{N-1}$ 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 $\delta \leq \delta_{N-1}$, and if 0 of them does, it is optimal not to enter either, as $\delta > \delta_0$. Moreover, there is no equilibrium within $\delta_0 < \delta \leq \delta_{N-1}$ in which i generics enter, for i is such that $0 < i < N$. 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 $\delta > \delta_{N-1}$ none of them should enter as not entering is a dominant strategy.

In the case of two potential entrants ($N = 2$, which implies $i = 1$), the two generics should enter if $\delta \leq \delta_0$, the two or none of them should enter if $\delta_0 < \delta \leq \delta_1$ and none of them should enter if $\delta > \delta_1$.