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Abstract

Common ownership - where two firms are at least partially owned by the same investor - and its impact on product market outcomes has recently drawn attention from scholars and practitioners. Previous research links common ownership with higher prices. This paper focuses on implications for market entry. In particular, 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 theoretical framework that shows that greater common ownership between the brand firm (incumbent) and a potential generic entrant reduces the likelihood that the generic enters. We find robust evidence for this prediction. The negative effect of common ownership on entry is large: a one-standard-deviation increase in common ownership decreases the probability of generic entry by 9-13%. We extend our basic framework to allow for strategic interaction between generics' entry decisions, and show that our main prediction still holds. Further, our model shows that the classical idea of entry decisions being strategic substitutes can be reversed into being strategic complements for sufficiently high levels of common ownership between the brand and potential generic entrants. We find some empirical support for this prediction.

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

BlackRock and Vanguard, the world's largest institutional investors, were the top two shareholders in Johnson & Johnson, Pfizer, Abbott Laboratories, Perrigo and Allergan in 2015. These firms are among the largest brand or generic companies in US pharmaceutical markets (Thomson Reuters Global Ownership Database, 2015).[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% (Bransetter 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 a potential generic entrant and the market's incumbent brand reduces the likelihood that the generic firm will enter. 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.

We first present a simple theoretical framework to understand the effects of common ownership between an incumbent and potential entrants. Thereafter we empirically test and corroborate the proposition that higher common ownership reduces the probability to enter. This result is robust to several measures of common ownership, different econometric methods, different definitions of the set of potential entrants and different time-horizons for the decision-making process. Our regressions include the controls used in previous literature including pre-entry brand sales, molecular substitutes, entrant experience and the presence

[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 Schmalz (2018) for a review of the available academic evidence.

of an authorized generic. The average effect is large: a one-standard-deviation increase in common ownership decreases the probability of generic entry 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. Still, as compared to the effect of being a subsidiary of the brand, the effect of any level of common ownership between the generic and the brand is smaller.

We then extend our basic framework to allow for strategic interaction between generics' entry decisions. We show that the classical result of entry decisions being strategic substitutes may be reversed in the presence of common ownership. Entry decisions become strategic complements –i.e. a generic firm's entry is less likely when another generic's probability of entry decreases– when the levels of common ownership between all potential generic entrants with the brand are high. This is because the profits of the brand firm, and therefore joint profits, are harmed the most by the first entrant. Once other generics enter (or are more likely to enter) the same market, the entry of any given generic is less detrimental.

As an illustration, we employ our empirical framework to infer the strategic interaction between two generics' entries. In the case of strategic complementarities, entry of a focal generic should be reduced through a higher level of common ownership of another generic with the brand, as this reduces the likelihood of entry of this other firm. For strategic substitutabilities, the opposite prediction holds. Based on our theoretical framework we find some evidence that, on average, entry decisions are characterized by strategic substitutability. However, entry decisions might be characterized by strategic complementarities for high levels of common ownership between generics and brand.

Common ownership linkages 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 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

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

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 look at pair-level common ownership links between firms, as opposed to industry-level common ownership. Hence, and consistent with the results of the paper, we expect a more robust and prevalent effect of pair-level common ownership on entry. 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.

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 basic theoretical framework. Section 4 presents data and variable construction. Section 5 describes the empirical implementation. Section 6 presents and discusses the results. Section 7 extends the framework to multiple entrants. Section 8 concludes. We further include Appendices on (i) anecdotal evidence on how institutional investors influence firms' decisions, (ii) data

[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).

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 (2017) 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 the price effects of common ownership. 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 complementarities, 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 generic firms that have the possibility to manufacture and sell a generic drug and thus enter a market currently dominated by a brand firm that manufactures and sells the branded drug. This section takes the strategy of the other potential entrants as given, but section 7 shows that the main result of this section holds when they are endogenized. We proceed in two steps. We first describe how an increase in the level of common ownership affects a generic's entry decision. Thereafter, we propose several measures of common ownership between generic and brand.

3.1 Entry in the presence of common ownership

Two symmetric (risk-neutral) generic firms, G and G', can simultaneously enter the market of the product of a brand firm B.[5] Denote by π_k^m the profits of the generic firm $k = \{G, G'\}$ in a market structure $m = \{D, T\}$, denoting duopoly and triopoly, and by $\Delta\pi_B^{MD} \equiv \pi_B^D - \pi_B^M$ and $\Delta\pi_B^{DT} \equiv \pi_B^T - \pi_B^D$ the change in profits of the brand firm B from monopoly to duopoly and from duopoly to triopoly, respectively.

We make the following assumptions on market profits. Entry increases the expected profits of the generic firm k from zero to $\pi_k^m > 0$, where π_k^m may include fixed costs of entry. On the other hand, any additional entry reduces the expected profits of the brand firm, i.e., $\Delta\pi_B^{MD} < 0$ and $\Delta\pi_B^{DT} < 0$. As the reduction of profits decreases with the number of entrants,

[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.

we also assume that $\left|\Delta\pi_B^{MD}\right| > \left|\Delta\pi_B^{DT}\right|$. We furthermore assume away collusion between the potential entrants. We posit that the gains obtained by the generic firm are lower than the losses incurred by the brand firm, as generic competition reduces a brand firm's profits enormously (Branstetter, 2016).[6] As a result, although generic firm profits increase, $\pi_k^m > 0$, joint profits decrease with entry, $\pi_k^D + \Delta\pi_B^{MD} < 0$ and $\pi_k^T + \Delta\pi_B^{DT} < 0$ for $k = \{G, G'\}$.

Common ownership between a generic and the brand makes the entry decision non-trivial. Indeed, shareholders of a 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. Let us denote the weight placed by the decision-makers of the generic firms G and G' on joint profits with the brand firm B rather than on individual generic firm profits by δ and δ', respectively. An increase in common ownership between G and B will increase δ, thus δ can also be viewed as a "measure of common ownership." We further discuss common ownership measures in more detail in the next subsection.

In this framework, the (expected) net gains of entry for a given generic depend on the likelihood it assigns that the competitor generic firm enters. Denoting the probability that G' enters as $p \in [0, 1]$, generic firm G should enter the market as long as its net gains of entry are positive, i.e, $\Pi_G > 0$, where

$$\Pi_G(p, \delta) \equiv (1-p)[(1-\delta)\pi_G^D + \delta(\pi_G^D + \Delta\pi_B^{MD})] + p[(1-\delta)\pi_G^T + \delta(\pi_G^T + \Delta\pi_B^{DT})]. \quad (1)$$

In the absence of common ownership between G and B ($\delta = 0$), generic G should place no weight on joint profits and entry will occur, as $\pi_G^D > 0$ and $\pi_G^T > 0$. At the other extreme, in the case where common ownership is so high that joint profits are as important as individual generic profits ($\delta = 1$), entry will not occur, as $\pi_G^D + \Delta\pi_B^{MD} < 0$ and $\pi_G^T + \Delta\pi_B^{DT} < 0$. More in general, it is easy to see that entry of a generic G is reduced by an increase in its level of common ownership with the brand,

$$\partial\Pi_G(p, \delta)/\partial\delta = (1-p)\Delta\pi_B^{MD} + p\Delta\pi_B^{DT} < 0,$$

independently of the likelihood that it assigns to the other generic's entry (p). The same reasoning holds of course for generic G', taking as given the entry probability of G. This leads us to the key result of this subsection:

Proposition 1. *An increase in the level of common ownership between a generic and the*

[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). Furthermore, we focus on entry rather than pricing decisions. We consider prices to be set outside the model as in pharma industries prices of brand products are substantially higher than those of generics.

brand reduces entry by this generic.

3.2 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 flavour 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

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

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

[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).

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 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

[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. In between, with an elasticity of substitution of one, we have the Cobb-Douglas production function which is functionally similar to our next measure although the approach followed to derive this measure is different.

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) for a thorough discussion of this measure, often also called "lambda."

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

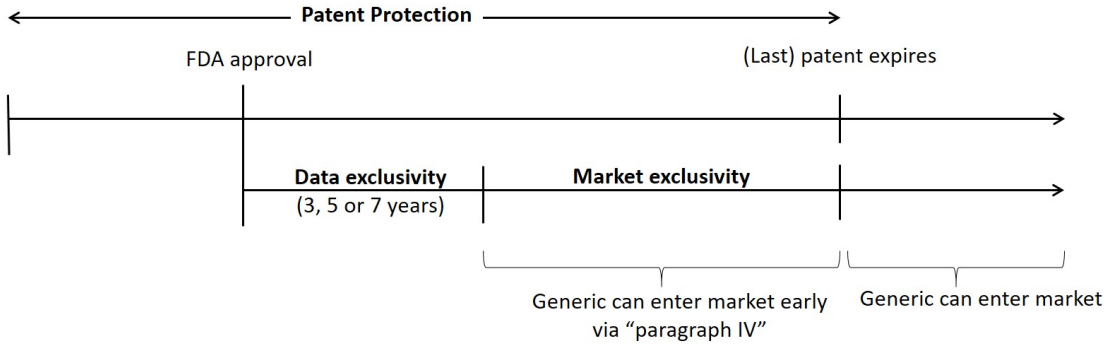
Broadly speaking, pharmaceutical firms can be categorized as brand firms or generic firms.[9] Brand firms undertake costly research and development to discover new medications and bring them to market, and must apply for FDA approval through the new drug application (NDA) procedure. Once a brand has 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 biologically identical 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

[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.

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 1.

Figure 1: Exclusivities and Patent Protection in Pharmaceuticals



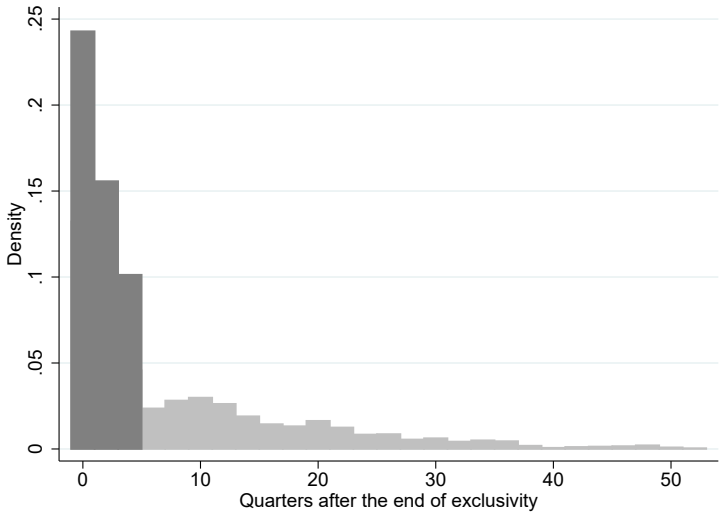
Notes: This figure illustrates the two types of protection awarded to new drugs. Data exclusivity protects the underlying clinical data and runs concurrently with patent protection. At the end of data exclusivity, a drug is protected only by its patents until they expire, a period termed "market exclusivity."

We use 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 and it indeed captures most of the actual generic entries in our sample (see Figure 2); see further below on the details of our sample. Similarly, Wang et al. (2018) and Scott Morton (1999) also limit their analysis to a specific early entry time window. However, given the potential sensitivity of results to our time window, we will show that results are robust to other entry period definitions.

[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 2: 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 product 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 product market as Zyrtec in syrup form with 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.

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 a set of indicator variables for the pre-market-entry sales of the brand product. *Sales Rank (1-10)* takes the value 1 if the brand drug ranks in the top 10 drugs in terms of US sales in the year before the end of exclusivity. *Sales Rank (11-50)* and *Sales Rank (51-100)* are defined in a similar manner. The indicator variable *Authorized Generic* takes on the value 1 if the brand firm has launched an authorized generic in that particular market. We also take into account the intensity of inter-molecular competition in the therapeutic field (Appelt, 2015; Regan, 2008). *Substitutes on Patent (ATC2)* 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 (ATC2)* 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.[12]

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

[12]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.

entrants that are also active in producing new drugs may hold some patents that ease entry. *Breadth (ATC2)* 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.

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

4.4 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 potential generic entrant is a subsidiary of the brand firm. We create an indicator variable that takes on the value 1 if the potential generic entrant is a subsidiary of the brand and 0 if it is not. In the former, the common ownership variables are set to zero. Subsidiaries of other firms are assigned the ownership structure of their parent firm. We consider a firm X to be subsidiary of a firm Y if firm Y has a direct ownership stake of more than 50% in firm X.

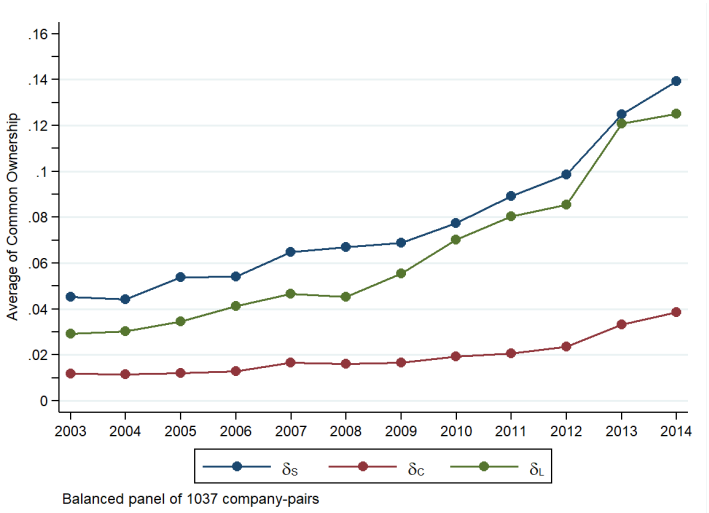
We can also identify minority shareholdings, i.e., when one firm has an ownership stake of less than 50% in another firm. However there are only three pairs in the dataset where the brand has a stake-holding in the potential generic entrant (Daiichi-Ranbaxy, Galderma-Alcon and Novartis-Alcon) and only one pair where the potential generic entrant has a stake-holding in the brand (Taro-Sun). As this ends up being too few observations to draw meaningful statistical conclusions, we do not consider these links in the analysis.

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.[13] 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.

[13]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.

Figure 3: Evolution of Common Ownership



4.5 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 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.[14] The common ownership measures correspond to those of the year 2013.

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

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%.[15] 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, 2% of drug markets are ranked in the top 10 drugs in terms of sales in the year prior to the end of exclusivity, 7% are ranked in the top 11-50, and 7% are in the top 51-100 drugs. 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.

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
Subsidiary (0/1)	58737	0.002	0.045	0	1
Sales Rank (1-10) (0/1)	58737	0.022	0.146	0	1
Sales Rank (11-50) (0/1)	58737	0.069	0.253	0	1
Sales Rank (51-100) (0/1)	58737	0.067	0.251	0	1
Authorised Generic (0/1)	58737	0.26	0.439	0	1
Substitutes on Patent (ATC2) ÷10	58737	2.325	1.669	0	7.3
Substitutes off Patent (ATC2) ÷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 (ATC2) ÷10	58737	1.135	1.204	0	6.1

[15]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 realised, in Kyle (2006) 2.5% of entry opportunities are realized, and in Appelt (2015) 10% of entry opportunities are realized.

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

$$Pr[Entry_{Gm} = 1] = \beta_0 + \beta\delta_{Gm} + \eta Z_m + \gamma X_{Gm} + A_m + \alpha_t + \epsilon_{Gm}. \quad (7)$$

$Entry_{Gm}$ 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 product 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.[16] 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 α_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.[17] 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

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

[17] 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.

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.[18] 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.

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.[19] 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.

[18] 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.

[19] 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.

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. Table 4 indeed indicates that different regions have different top common owners (it provides a snapshot for the year 2009). The identifying assumption is that whether or not the brand and generic headquarters are in the same region does not directly affect the entry decision.

Table 4: Top common owners in each region for pharmaceutical firms and their number of blockholdings >1% (2009)

Southern Asia		**Eastern Asia**		**Northern Europe**	
Life Insurance of India	12	Bank of Tokyo-Mitsubishi	7	BlackRock	6
Citigroup	7	Nomura Holdings	6	Invesco	5
La Caixa	7	Nippon Life Insurance	6	Aviva	5
fil investment management	7	Sumitomo Life Insurance	4	NBIM	5
HDFC Asset Mgmt	6	Nikko Asset Mgmt	4	HarbourVest Partners	5

Western Europe		**Northern America**	
BlackRock	10	BlackRock	65
Fidelity Investments	9	Vanguard Group	59
NBIM	8	State Street Global	57
HarbourVest Partners	6	Northern Trust Global	45
Franklin Templeton	6	Fidelity Investments	42

6 Results

We present the results for the OLS and IV estimations with our three common ownership measures in table 5. 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.

Table 5: Main Specification

	OLS			IV		
	(1)	(2)	(3)	(4)	(5)	(6)
δ_S	-0.0121***			-0.0234**		
	(0.00437)			(0.0116)		
δ_C		-0.0422***			-0.0601**	
		(0.0130)			(0.0291)	
δ_L			-0.0166***			-0.0187**
			(0.00400)			(0.00952)
Subsidiary (0/1)	-0.0411***	-0.0406***	-0.0411***	-0.0427***	-0.0412***	-0.0413***
	(0.0102)	(0.0102)	(0.0102)	(0.0103)	(0.0102)	(0.0102)
Sales Rank (1-10) (0/1)	0.0219***	0.0219***	0.0218***	0.0221***	0.0220***	0.0218***
	(0.00619)	(0.00619)	(0.00619)	(0.00620)	(0.00620)	(0.00619)
Sales Rank (11-50) (0/1)	0.0223***	0.0223***	0.0224***	0.0225***	0.0224***	0.0224***
	(0.00364)	(0.00364)	(0.00364)	(0.00366)	(0.00365)	(0.00365)
Sales Rank (51-100) (0/1)	0.0177***	0.0178***	0.0177***	0.0178***	0.0179***	0.0177***
	(0.00308)	(0.00308)	(0.00308)	(0.00308)	(0.00308)	(0.00308)
Authorized Generic (0/1)	0.000922	0.000928	0.000930	0.000870	0.000907	0.000924
	(0.00152)	(0.00152)	(0.00152)	(0.00151)	(0.00151)	(0.00151)
Substitutes on Patent (ATC2)	-0.00445**	-0.00448**	-0.00444**	-0.00454**	-0.00453**	-0.00445**
	(0.00183)	(0.00183)	(0.00183)	(0.00184)	(0.00183)	(0.00183)
Substitutes off Patent (ATC2)	-0.000814	-0.000788	-0.000827	-0.000762	-0.000753	-0.000821
	(0.00152)	(0.00152)	(0.00152)	(0.00152)	(0.00152)	(0.00152)
Experience Route	0.00835***	0.00834***	0.00836***	0.00835***	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*	0.00431**	0.00475**	0.00549**	0.00483**	0.00496**
	(0.00222)	(0.00217)	(0.00219)	(0.00233)	(0.00221)	(0.00224)
Breadth (ATC2)	0.00325***	0.00333***	0.00329***	0.00343***	0.00345***	0.00332***
	(0.000920)	(0.000924)	(0.000920)	(0.000946)	(0.000947)	(0.000935)
Therapeutic field (0/1)	Yes	Yes	Yes	Yes	Yes	Yes
Drug form (0/1)	Yes	Yes	Yes	Yes	Yes	Yes
Submission type (0/1)	Yes	Yes	Yes	Yes	Yes	Yes
Generic region of origin (0/1)	Yes	Yes	Yes	Yes	Yes	Yes
Year end of exclusivity (0/1)	Yes	Yes	Yes	Yes	Yes	Yes
Constant	0.0296***	0.0293***	0.0292***	0.0299***	0.0293***	0.0292***
	(0.00674)	(0.00674)	(0.00674)	(0.00676)	(0.00673)	(0.00673)
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 number of periods listed in the ETF iShares U.S. Pharmaceutical and an indicator for both headquarters located in the same region. $***p < 0.01, **p < 0.05, *p < 0.1$.

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.

Table 6: 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	0.0103***	0.00635***	0.00614***
	(0.00143)	(0.000495)	(0.00157)
Constant	0.0776***	0.0197***	0.0547***
	(0.00701)	(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	156.7	110.7	115
F-Test (p-val)	0	0	0
Weak Instrument	2289	2253	2215
Endogeneity test (p-val)	0.276	0.445	0.757

Notes: Standard errors in parentheses are robust. 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 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 a subsidiary of 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 parent-subsidiary then the probability of entry falls by 4 percentage points. This finding suggests that, while in theory complete common ownership by multiple shareholders is identical to full ownership, this is not the case in the data.

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.

In table 7 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 $\delta_S \in (0.5; 1]$.

Table 7: Categorical Variables Specification

	OLS	IV
δ_S $(0 < \delta \leq 0.3)$	0.00320*	-0.00323
	(0.00180)	(0.00312)
δ_S $(0.3 < \delta \leq 0.5)$	-0.00322	-0.00629*
	(0.00288)	(0.00361)
δ_S $(\delta > 0.5)$	-0.00919***	-0.0126***
	(0.00335)	(0.00372)
Subsidiary (0/1)	-0.0394***	-0.0421***
	(0.0102)	(0.0103)
Sales Rank (1-10) (0/1)	0.0218***	0.0220***
	(0.00619)	(0.00619)
Sales Rank (11-50) (0/1)	0.0224***	0.0224***
	(0.00364)	(0.00364)
Sales Rank (51-100) (0/1)	0.0176***	0.0178***
	(0.00308)	(0.00308)
Authorized Generic (0/1)	0.00104	0.000923
	(0.00151)	(0.00151)
Substitutes on Patent (ATC2)	-0.00434**	-0.00451**
	(0.00183)	(0.00183)
Substitutes off Patent (ATC2)	-0.000906	-0.000815
	(0.00152)	(0.00151)
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 (ATC2)	0.00292***	0.00337***
	(0.000928)	(0.000953)
Therapeutic field (0/1)	Yes	Yes
Drug form (0/1)	Yes	Yes
Submission type (0/1)	Yes	Yes
Generic region of origin (0/1)	Yes	Yes
Year end of exclusivity (0/1)	Yes	Yes
Constant	0.0280***	0.0304***
	(0.00679)	(0.00688)
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 number of periods listed in the ETF iShares U.S. Pharmaceutical, an indicator for both headquarters located in the same region and their interaction. $***p < 0.01, **p < 0.05, *p < 0.1$.

The results in table 7 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.

Our results are robust to a series of different specifications, as can be seen from the tables in Appendix C. Table C1 presents logit and probit regressions for our main specification. Results show that our three common ownership measures negatively impact entry. Table C2 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 C3, 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 C3 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.

Finally, while we checked for the private companies that also operate in the UK that these do not have common ownership, we can not 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 C4, results are fully in line with our main specification.

7 Strategic effects

We now extend the basic framework to allow for strategic interaction between generics' entry decisions. We examine the various types of strategic interaction between generics and the equilibrium entry decisions.

7.1 Entry decisions: strategic complements or substitutes?

We investigate how the incentives to enter of generic G change as the generic G' is more likely to enter. Deriving Π_G in equation (1) with respect to p,

$$\partial\Pi_G(p,\delta)/\partial p = (\pi_G^T - \pi_G^D) + \delta(\Delta\pi_B^{DT} - \Delta\pi_B^{MD}), \tag{8}$$

we can identify two effects. The first term is negative, as $\pi_G^D > \pi_G^T$, and therefore G would have less incentives to enter if G' is more likely to enter. This is the traditional business stealing effect of reduced profits from competition. The second term, though, is positive and thus pulls in the other direction. As the other generic is more likely to enter, the effect on the brand firm's profits is more likely to go from duopoly to triopoly rather than from monopoly to duopoly. This is less detrimental for the brand firm, as well as for joint profits, given that the reduction in profits decreases with the number of entrants, i.e., $\left|\Delta\pi_B^{MD}\right| > \left|\Delta\pi_B^{DT}\right|$.[20] As a result, in the presence of common ownership, the best-response functions, which are fully characterized in the proof in Appendix D, may exhibit strategic complementarities:

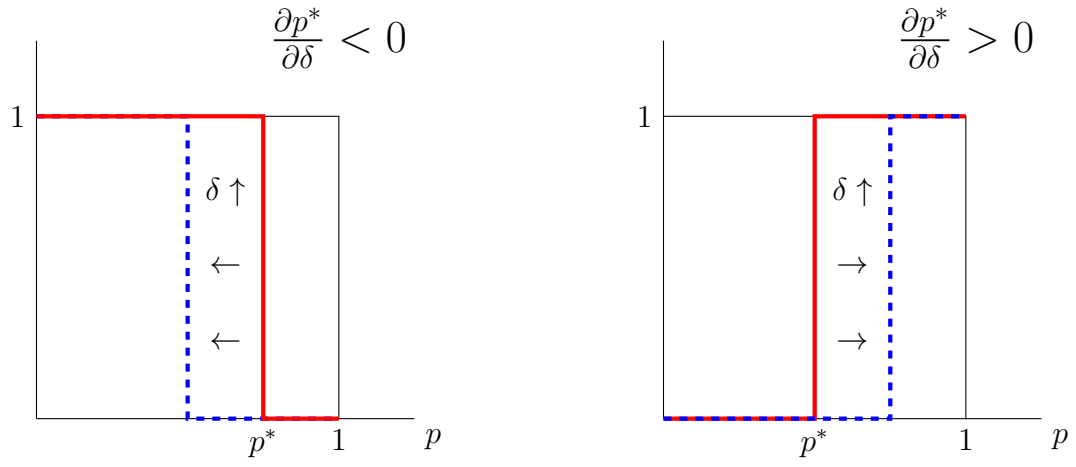
Lemma 2. *There exists* $\delta^* \equiv (\pi_G^D - \pi_G^T)/(\Delta\pi_B^{DT} - \Delta\pi_B^{MD})$ *such that:*
(a) If $\delta < \delta^*$*, a generic firm* G *is less likely to enter if the other generic firm* G' *is more likely to enter* ***(strategic substitutability)****.*
(b) If $\delta > \delta^*$*,* G *is less likely to enter if* G' *is less likely to do so* ***(strategic complementarity)****.*

Figure 4 represents two parametric examples, one with $\delta < \delta^*$ (strategic substitutability) and another with $\delta > \delta^*$ (strategic complementarity). We now show that, both under strategic substitutabilities and complementarities, an increase in the level of common ownership reduces the range of decisions of G' such that generic firm G decides to enter. In the case of strategic substitutability, generic firm G enters as long as the probability of the other entering is below a certain threshold, $p < p^*$. In case p^* is interior ($0 < p^* < 1$), as in Figure 4, p^* is such that $\Pi_G(p^*,\delta) = 0$ and an increase in the level of common ownership with the brand reduces entry as

$$\partial p^*(\delta)/\partial\delta = -[\partial\Pi_G(p,\delta)/\partial\delta]/[\partial\Pi_G(p,\delta)/\partial p] < 0. \tag{9}$$

For high enough levels of common ownership, not entering is a dominant strategy ($p^* = 0$), whereas for low enough levels it is dominant to enter ($p^* = 1$).

[20] The trade-off can be understood as a balance between the negative first-order derivative with respect to the number of firms on the profits of the two-generic firms (first term) against the positive second-order derivatives on the profits of the branded product company (second term).



(a) Strategic substitutes $\delta < \delta^*$

(b) Strategic complements $\delta > \delta^*$

Figure 4: Best responses

Similarly, in the case of strategic complementarity, generic firm G enters as long as the probability of the other entering is above a certain threshold, $p > p^*$. In case p^* is interior ($0 < p^* < 1$), as in Figure 4, p^* is such that $\Pi_G(p^*, \delta) = 0$ and an increase in the level of common ownership also decreases the area in which generic firm G enters, as

$$\partial p^*(\delta)/\partial \delta = -[\partial \Pi_G(p, \delta)/\partial \delta]/[\partial \Pi_G(p, \delta)/\partial p] > 0. \tag{10}$$

As before, for high enough levels of common ownership, not entering is a dominant strategy, whereas for low enough levels it is dominant to enter.

7.2 Equilibrium entry decisions

We now determine the equilibrium entry decisions, paying particular attention to the comparative static effects of the level of common ownership. We need to take into account not only the best response function of generic firm G to the decision of firm G' but also the best response function of G' to the decision of G. Depending on the levels of common ownership of both firms with the brand, (i) the decisions of both firms may be strategic substitutable to each other ($\delta, \delta' < \delta^*$), (ii) strategic complementary to each other ($\delta, \delta' > \delta^*$), (iii) the decision of G may be strategic substitute with respect to the decision of G but the decision of G' strategic complementary with respect to G's decision ($\delta < \delta^* < \delta'$), and (iv) vice-versa ($\delta > \delta^* > \delta'$).

Consider first the situation in which both levels of common ownership are low, so as to have mutual strategic substitutabilities. To gain some intuition, let us take the case in which

the best response of G' is not a dominant strategy, as described in the left panel of Figure 4. If the level of common ownership of G is so low that entering is a dominant strategy for this firm, then the equilibrium consists in only G entering, whereas in the case in which common ownership is so high that not entering is dominant, only G' enters in equilibrium.[21] This is the case because the best-reply function of G' is to enter whenever firm G does not. As a result, as the level of common ownership of G increases, entry of G is reduced and that of G' is increased.

Consider now the case in which both levels of common ownership are high, so as to have mutual strategic complementarities. Take again the case in which the best response function of G' is not dominant, as described in the right panel of Figure 4. If the level of common ownership of firm G with the brand is relatively low, then the equilibrium consists on both firms entering, whereas in the case in which it is high none enters. This is because the best-reply function of G' is to enter whenever firm G does. As a result, as the level of common ownership of G increases, entry of both generics is reduced.

In the case of highly asymmetric levels of common ownership, strategic reactions of G and G' may be different. Suppose, for instance, that the level of common ownership of G' is low, such that its entry decision is characterized by strategic substitutability with respect to the decision of G. Suppose at the same time that the level of common ownership of G is high, such that its entry decision is characterized by strategic complementarity. Here, as the level of common ownership of G increases, entry of G is reduced and that of G' is increased, as in the case of mutual strategic substitutabilities described above.[22]

The next proposition shows that this intuition carries over all the possible cases in equilibrium. To set up the empirical implementation, we state everything in terms of entry of the focal generic G:

Proposition 3. *Entry of a focal generic firm G is*
(i) Decreasing in the levels of common ownership between G and the brand B,
(ii) Decreasing in the level of common ownership of the other generic firm G' and the brand if and only if the level of common ownership of G and B is high, such that the entry decision of G is strategic complementary to the decision of G',
(iii) Increasing in the level of common ownership of the other generic firm G' and the brand if and only if the level of common ownership of firm G and the brand is low, such that the entry decision of G is strategic substitutable to the decision of G'.

[21] In intermediate regions, as shown in the proof of the following proposition, there are multiple equilibria.

[22] The main difference between the two cases is that, here, there is no multiplicity of equilibria in the intermediate region but a single mixed strategy equilibrium (see the proof of the proposition for all the details).

In sum, we have shown in this section that with two generics, who simultaneously consider entry, that the entry decision of a focal generic G is characterized by *strategic complementarities*, if and only if its levels of common ownership with the brand are high. On the other hand, entry of G is characterized by *strategic substitutabilities*, if and only if its levels of common ownership with the brand are low. We then showed that, in equilibrium, the results of the basic model extend to the case of multiple generics: entry is reduced by an increase in the level of common ownership between the focal generic and the brand. However, the effect of the level of common ownership of the other generic with the brand depends on whether entry decisions are characterized by strategic complementarities or substitutabilities. In particular, entry of a focal generic is reduced by the level of common ownership of the other generic firm if and only if the levels of common ownership of the focal generic with the brand are high. On the other hand, it is increased when the levels of common ownership of the focal generic with the brand are low.

7.3 Empirical implementation and results

Table 8 presents the results for specifications where we include a measure of common ownership for another generic entrant G' with the brand. We take a pragmatic approach and calculate δ' as the level of common ownership between the brand in the market and the *most experienced* other generic competitor. We reason that potential generic entrants are likely to consider the most experienced other potential generic entrant as a viable entry candidate, and hence are likely to take the common ownership of this firm with the brand into consideration. We identify the most experienced potential competitor as the firm that has the highest previous experience at the drug form/route level for the given drug market as measured by the variable *Experience Route*. Indeed, since we consider a large set of potential entrants in our empirical analysis, it would not be feasible to include measures of δ' for all other potential entrants. Moreover aggregating measures of δ' for a large set of potential entrants is likely to provide a meaningless statistic; whereas for the econometrician it is difficult to restrict to the set of potential entrants based on observable characteristics, for generic entrants it may be more clear which other generics are candidates to enter a specific drug market.

Table 8: Strategic Effects

	(1)	(2)	(3)	(4)	(5)	(6)
δ_S	-0.0124***			-0.0109**		
	(0.00438)			(0.00475)		
δ'_S	0.00674			0.00913*		
	(0.00512)			(0.00533)		
$\delta_S \times \delta'_S$				-0.0226		
				(0.0269)		
δ_C		-0.0427***			-0.0384***	
		(0.0131)			(0.0142)	
δ'_C		0.0118			0.0182	
		(0.0148)			(0.0154)	
$\delta_C \times \delta'_C$					-0.182	
					(0.194)	
δ_L			-0.0169***			-0.0159***
			(0.00401)			(0.00435)
δ'_L			0.00910*			0.0106*
			(0.00534)			(0.00554)
$\delta_L \times \delta'_L$						-0.0164
						(0.0252)
Subsidiary (0/1)	-0.0412***	-0.0406***	-0.0412***	-0.0412***	-0.0406***	-0.0412***
	(0.0102)	(0.0102)	(0.0102)	(0.0102)	(0.0102)	(0.0102)
Sales Rank (1-10) (0/1)	0.0222***	0.0221***	0.0222***	0.0221***	0.0221***	0.0222***
	(0.00622)	(0.00622)	(0.00622)	(0.00622)	(0.00622)	(0.00621)
Sales Rank (11-50) (0/1)	0.0223***	0.0224***	0.0224***	0.0222***	0.0223***	0.0224***
	(0.00364)	(0.00364)	(0.00364)	(0.00364)	(0.00364)	(0.00364)
Sales Rank (51-100) (0/1)	0.0176***	0.0177***	0.0175***	0.0176***	0.0177***	0.0175***
	(0.00308)	(0.00308)	(0.00308)	(0.00308)	(0.00308)	(0.00308)
Authorized Generic (0/1)	0.00102	0.000980	0.00107	0.00103	0.000991	0.00108
	(0.00151)	(0.00151)	(0.00151)	(0.00151)	(0.00151)	(0.00151)
Substitutes on Patent (ATC2)	-0.00449**	-0.00451**	-0.00441**	-0.00448**	-0.00449**	-0.00440**
	(0.00183)	(0.00184)	(0.00183)	(0.00184)	(0.00184)	(0.00183)
Substitutes off Patent (ATC2)	-0.000809	-0.000796	-0.000839	-0.000814	-0.000806	-0.000846
	(0.00152)	(0.00152)	(0.00152)	(0.00152)	(0.00152)	(0.00152)
Experience Route	0.00835***	0.00834***	0.00836***	0.00835***	0.00834***	0.00836***
	(0.000564)	(0.000564)	(0.000565)	(0.000564)	(0.000564)	(0.000564)
Experience ATC2	0.0602***	0.0602***	0.0601***	0.0602***	0.0602***	0.0601***
	(0.00699)	(0.00699)	(0.00699)	(0.00699)	(0.00699)	(0.00699)
Experience New Drug	0.00437**	0.00433**	0.00478**	0.00438**	0.00434**	0.00479**
	(0.00222)	(0.00217)	(0.00219)	(0.00222)	(0.00217)	(0.00219)
Breadth (ATC2)	0.00325***	0.00334***	0.00330***	0.00325***	0.00333***	0.00329***
	(0.000920)	(0.000924)	(0.000920)	(0.000920)	(0.000924)	(0.000920)
Therapeutic field (0/1)	Yes	Yes	Yes	Yes	Yes	Yes
Drug form (0/1)	Yes	Yes	Yes	Yes	Yes	Yes
Submission type (0/1)	Yes	Yes	Yes	Yes	Yes	Yes
Generic region of origin (0/1)	Yes	Yes	Yes	Yes	Yes	Yes
Year end of exclusivity (0/1)	Yes	Yes	Yes	Yes	Yes	Yes
Constant	0.0300***	0.0295***	0.0296***	0.0300***	0.0295***	0.0296***
	(0.00676)	(0.00676)	(0.00675)	(0.00676)	(0.00676)	(0.00675)
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	0.079	0.079	0.079

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

Our results are in line with the theory outlined above. First, we find that the coefficient on δ is negative and significant for our three different ownership measures in all specifications. In other words, the main result of our basic framework still holds: higher levels of common ownership between the focal generic firm and the brand firm reduce the likelihood of entry.

Second, as can be seen from coefficients on δ' in columns (1), (2) and (3), the overall impact of common ownership between the other potential generic entrant and the brand company, δ', is positive; i.e. higher common ownership between G' and the brand increases the likelihood that G enters on average. Therefore, according to our theory (Proposition 3), entry decisions between generic companies G and G' are characterized, on average, by strategic substitutabilities. The logic is as follows: higher common ownership between G' and the brand reduces the likelihood of entry by G'. This reduced likelihood of entry by G' in turn increases the likelihood of entry by the focal generic G.

Note, however, that these results are not very significant. This is perhaps not surprising, as we are measuring average effects that might hide heterogeneities in terms of strategic substitutability and complementarity. Therefore, in a next step we include interaction effects $\delta \times \delta'$ (see columns (4), (5) and (6)). The coefficient on the interaction term $\delta \times \delta'$ is negative, although not significant.

To understand how common ownership influences entry decisions of generics to be strategic substitutes or complements, we perform a thought experiment on δ_S and δ'_S and impose symmetry, i.e. $\delta_S = \delta'_S = x$. The overall effect of G''s common ownership with the brand on G's probability of entry is positive if $0.009x - 0.02x^2 > 0$, which can be re-written as $x < 0.45$. Hence, for symmetric common ownership levels of G and G' with the brand company, for lower levels of common ownership ($x < 0.45$), G''s common ownership with the brand has an overall positive effect on G's probability of entry (entrants are strategic substitutes). For higher levels common ownership ($x > 0.45$), G''s common ownership with the brand has an overall negative effect on G's probability of entry. Thus, entry decisions are strategic complements.

8 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%.

We further consider how common ownership between other rival generics and the brand may influence the focal generic firm's entry decision. Our theory shows that the classical result of entry decisions being strategic substitutes may be reversed into being strategic substitutes in the presence of high common ownership. We find some empirical evidence that this can indeed be the case for high enough levels of common ownership.

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 modeled.

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."[23] 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."[24]

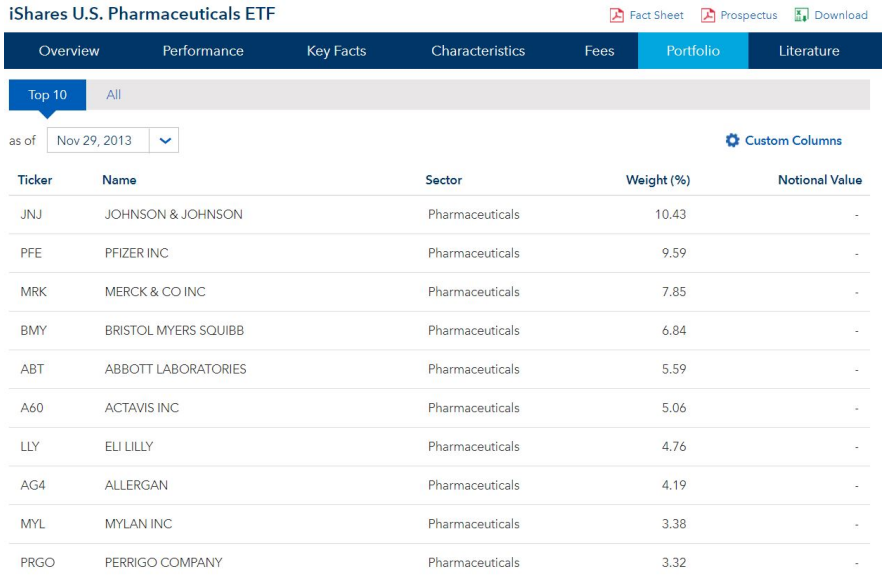
Specifically in pharmaceutical markets, institutional investors can be seen to take an active interest in the strategic decisions of companies. In 2016, a group of representatives of major US mutual funds (Fidelity Investments, T. Rowe Price Group Inc., Wellington Management Co., among others) met up 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.[25]

[23]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.

[24]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/

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

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	-

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 product markets were the original brand drug was withdrawn for safety reasons. We identify these markets as markets 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 markets results in 554 product markets. We drop two further product markets where generic applications (ANDAs) are approved before the NDA application for the same ingredient-form-strength. This results in 552 product markets.

We then aggregate these product markets 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 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."The duration of the exclusivity period differs in the type of drug: orphan drugs receive 7 years; generating antibiotics are eligible for 5 additional years; new chemical entities receive 5 years; new clinical investigations receive 3 years;

and the pediatric exclusivity adds 6 months 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. In total there are 160 drug product markets which are available in different forms. One ingredient may be offered in as many as 4 different forms (e.g. tablet; oral, for suspension, oral; capsule, oral; injectable, injection).

Each product is linked through exact text matching, based on compound-name, with the ATC/DDD Index 2015.[26] 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 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.[27] We recode the FDA form/route variable to construct five form/route classes namely oral, injection, topical, ophthalmic and inhalation.

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

[26]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.

[27]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).

ownership data, resulting in 451 product markets.

Subsidiary firms are assigned the ownership structure of the parent firm under the assumption that they are fully controlled by the parent. However in recognition of the fact that the subsidiary is a separate entity from the parent with its own previous experience, we determine all experience variables at the subsidiary level. That is, we do not assign the experience of the parent to the subsidiary. There are 43 unique pairs where the relationship between the brand and potential generic entrant is that of parent and subsidiary.

We are also able to identify cross ownership links in the data, that is, where one firm has an ownership stake of less than 50% in another firm. There are three pairs in the dataset where the brand has a stake-holding in the potential generic entrant for some time periods (Daiichi-Ranbaxy, Galderma-Alcon and Novartis-Alcon). There is one pair where the potential generic entrant has a stake-holding in the brand (Taro-Sun).

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 - Probit and Logit

	Probit			Logit		
	(1)	(2)	(3)	(4)	(5)	(6)
δ_S	-0.257**			-0.573**		
	(0.100)			(0.224)		
δ_C		-0.773***			-1.879***	
		(0.298)			(0.666)	
δ_L			-0.271***			-0.697***
			(0.104)			(0.230)
Subsidiary (0/1)	-0.948*	-0.935*	-0.937*	-2.297**	-2.258**	-2.271**
	(0.490)	(0.489)	(0.489)	(1.089)	(1.087)	(1.087)
Sales Rank (1-10) (0/1)	0.330***	0.330***	0.328***	0.846***	0.848***	0.845***
	(0.0862)	(0.0861)	(0.0862)	(0.192)	(0.191)	(0.191)
Sales Rank (11-50) (0/1)	0.331***	0.330***	0.332***	0.780***	0.778***	0.783***
	(0.0534)	(0.0534)	(0.0534)	(0.121)	(0.121)	(0.121)
Sales Rank (51-100) (0/1)	0.311***	0.312***	0.310***	0.712***	0.717***	0.712***
	(0.0485)	(0.0485)	(0.0485)	(0.110)	(0.110)	(0.110)
Authorized Generic (0/1)	0.0549	0.0551	0.0554	0.0937	0.0932	0.0937
	(0.0347)	(0.0347)	(0.0347)	(0.0793)	(0.0792)	(0.0792)
Substitutes on Patent (ATC2)	-0.0939**	-0.0943**	-0.0935**	-0.187**	-0.187**	-0.186**
	(0.0402)	(0.0402)	(0.0402)	(0.0896)	(0.0896)	(0.0894)
Substitutes off Patent (ATC2)	-0.0115	-0.0102	-0.0116	-0.0370	-0.0348	-0.0380
	(0.0438)	(0.0438)	(0.0438)	(0.103)	(0.103)	(0.103)
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***	0.736***	0.737***	0.736***
	(0.0461)	(0.0461)	(0.0461)	(0.101)	(0.101)	(0.101)
Experience New Drug	-0.0824**	-0.0840**	-0.0800**	-0.212***	-0.210***	-0.198**
	(0.0359)	(0.0356)	(0.0358)	(0.0796)	(0.0792)	(0.0795)
Breadth (ATC2)	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 (0/1)	Yes	Yes	Yes	Yes	Yes	Yes
Drug form (0/1)	Yes	Yes	Yes	Yes	Yes	Yes
Submission type (0/1)	Yes	Yes	Yes	Yes	Yes	Yes
Generic region of origin (0/1)	Yes	Yes	Yes	Yes	Yes	Yes
Year end of exclusivity (0/1)	Yes	Yes	Yes	Yes	Yes	Yes
Constant	-2.271***	-2.278***	-2.280***	-4.516***	-4.522***	-4.528***
	(0.226)	(0.226)	(0.226)	(0.563)	(0.563)	(0.563)
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. $***p < 0.01, **p < 0.05, *p < 0.1$.

Table C2: 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	-0.0103**			-0.00949**			-0.00923**		
	(0.00424)			(0.00439)			(0.00463)		
δ_C		-0.0343***			-0.0351***			-0.0459***	
		(0.0127)			(0.0128)			(0.0135)	
δ_L			-0.0144***			-0.0136***			-0.0193***
			(0.00391)			(0.00403)			(0.00428)
Subsidiary (0/1)	-0.0379***	-0.0375***	-0.0380***	-0.0450***	-0.0447***	-0.0451***	-0.0570***	-0.0572***	-0.0578***
	(0.01000)	(0.00998)	(0.00999)	(0.0104)	(0.0104)	(0.0104)	(0.0112)	(0.0112)	(0.0112)
Sales Rank (1-10) (0/1)	0.0191***	0.0192***	0.0191***	0.0242***	0.0242***	0.0242***	0.0274***	0.0275***	0.0275***
	(0.00596)	(0.00596)	(0.00596)	(0.00614)	(0.00614)	(0.00614)	(0.00571)	(0.00571)	(0.00571)
Sales Rank (11-50) (0/1)	0.0214***	0.0214***	0.0215***	0.0253***	0.0253***	0.0254***	0.0236***	0.0236***	0.0237***
	(0.00352)	(0.00352)	(0.00352)	(0.00365)	(0.00365)	(0.00365)	(0.00310)	(0.00310)	(0.00310)
Sales Rank (51-100) (0/1)	0.0164***	0.0165***	0.0164***	0.0167***	0.0168***	0.0167***	0.0189***	0.0190***	0.0189***
	(0.00296)	(0.00297)	(0.00296)	(0.00303)	(0.00303)	(0.00303)	(0.00275)	(0.00275)	(0.00275)
Authorized Generic (0/1)	-0.000111	-0.000104	-0.000105	0.000997	0.000999	0.00100	0.00343**	0.00342**	0.00342**
	(0.00145)	(0.00145)	(0.00145)	(0.00151)	(0.00151)	(0.00151)	(0.00137)	(0.00137)	(0.00137)
Substitutes on Patent (ATC2)	-0.00382**	-0.00384**	-0.00382**	-0.00470**	-0.00473**	-0.00470**	-0.00508***	-0.00513***	-0.00511***
	(0.00173)	(0.00173)	(0.00173)	(0.00186)	(0.00186)	(0.00186)	(0.00174)	(0.00174)	(0.00174)
Substitutes off Patent (ATC2)	-0.00100	-0.000982	-0.00101	-0.000474	-0.000451	-0.000482	-0.00247*	-0.00244*	-0.00247*
	(0.00145)	(0.00145)	(0.00145)	(0.00150)	(0.00150)	(0.00150)	(0.00135)	(0.00135)	(0.00135)
Experience Route	0.00795***	0.00795***	0.00797***	0.00854***	0.00854***	0.00856***	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**	0.00355	0.00359	0.00394*	0.00582**	0.00621**	0.00683***
	(0.00217)	(0.00212)	(0.00214)	(0.00225)	(0.00220)	(0.00221)	(0.00248)	(0.00244)	(0.00245)
Breadth (ATC2)	0.00281***	0.00287***	0.00285***	0.00328***	0.00335***	0.00330***	0.00563***	0.00578***	0.00575***
	(0.000894)	(0.000898)	(0.000894)	(0.000928)	(0.000931)	(0.000928)	(0.000981)	(0.000983)	(0.000980)
Therapeutic field (0/1)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Drug form (0/1)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Submission type (0/1)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Generic region of origin (0/1)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year end of exclusivity (0/1)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	0.0293***	0.0290***	0.0289***	0.0312***	0.00335***	0.0310***	0.0329***	0.0327***	0.0325***
	(0.00649)	(0.00648)	(0.00648)	(0.00659)	(0.000931)	(0.00658)	(0.00644)	(0.00644)	(0.00644)
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	0.077	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 C3: Robustness - Potential Entrants with Experience in Drug Form

	(1)	(2)	(3)
δ_S	-0.0242***		
	(0.00657)		
δ_C		-0.0723***	
		(0.0186)	
δ_L			-0.0261***
			(0.00558)
Subsidiary (0/1)	-0.0722***	-0.0707***	-0.0714***
	(0.0164)	(0.0164)	(0.0164)
Sales Rank (1-10) (0/1)	0.0295***	0.0294***	0.0293***
	(0.0101)	(0.0101)	(0.0100)
Sales Rank (11-50) (0/1)	0.0316***	0.0315***	0.0317***
	(0.00554)	(0.00553)	(0.00554)
Sales Rank (51-100) (0/1)	0.0261***	0.0262***	0.0260***
	(0.00509)	(0.00509)	(0.00508)
Authorized Generic (0/1)	0.00193	0.00198	0.00196
	(0.00266)	(0.00266)	(0.00266)
Substitutes on Patent (ATC2)	-0.00781**	-0.00783**	-0.00773**
	(0.00354)	(0.00354)	(0.00354)
Substitutes off Patent (ATC2)	-0.00340	-0.00336	-0.00341
	(0.00324)	(0.00324)	(0.00324)
Experience Route	0.00822***	0.00821***	0.00825***
	(0.000672)	(0.000672)	(0.000673)
Experience ATC2	0.0632***	0.0632***	0.0632***
	(0.00831)	(0.00832)	(0.00831)
Experience New Drug	0.00389	0.00354	0.00416
	(0.00293)	(0.00287)	(0.00290)
Breadth (ATC2)	0.00315**	0.00325**	0.00309*
	(0.00158)	(0.00159)	(0.00158)
Therapeutic field (0/1)	Yes	Yes	Yes
Drug form (0/1)	Yes	Yes	Yes
Submission type (0/1)	Yes	Yes	Yes
Generic region of origin (0/1)	Yes	Yes	Yes
Year end of exclusivity (0/1)	Yes	Yes	Yes
Constant	0.0840***	0.0826***	0.0827***
	(0.0151)	(0.0151)	(0.0151)
Observations	31,979	31,979	31,979
Drug Markets	451	451	451
R-squared	0.086	0.086	0.086

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

Table C4: Robustness - Private Firm Dummies

	(1)	(2)	(3)
δ_S	-0.0164***		
	(0.00592)		
δ_C		-0.0527***	
		(0.0161)	
δ_L			-0.0202***
			(0.00475)
Subsidiary (0/1)	-0.0426***	-0.0418***	-0.0425***
	(0.0103)	(0.0102)	(0.0102)
Sales Rank (1-10) (0/1)	0.0222***	0.0222***	0.0221***
	(0.00619)	(0.00619)	(0.00619)
Sales Rank (11-50) (0/1)	0.0224***	0.0223***	0.0224***
	(0.00364)	(0.00364)	(0.00364)
Sales Rank (51-100) (0/1)	0.0178***	0.0180***	0.0178***
	(0.00308)	(0.00308)	(0.00308)
Authorized Generic (0/1)	0.000721	0.000729	0.000743
	(0.00151)	(0.00151)	(0.00151)
Substitutes on Patent (ATC2)	-0.00469**	-0.00472**	-0.00465**
	(0.00185)	(0.00185)	(0.00185)
Substitutes off Patent (ATC2)	-0.000709	-0.000679	-0.000735
	(0.00152)	(0.00152)	(0.00152)
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*	0.00387*	0.00426*
	(0.00228)	(0.00227)	(0.00227)
Breadth (ATC2)	0.00307***	0.00316***	0.00307***
	(0.000929)	(0.000928)	(0.000928)
Generic Private (0/1)	-0.00297	-0.00286	-0.00324*
	(0.00192)	(0.00176)	(0.00168)
Brand Private (0/1)	0.000003	0.000248	-0.000104
	(0.00361)	(0.00353)	(0.00349)
Generic and Brand Private (0/1)	0.00515	0.00488	0.00521
	(0.00379)	(0.00371)	(0.00367)
Therapeutic field (0/1)	Yes	Yes	Yes
Drug form (0/1)	Yes	Yes	Yes
Submission type (0/1)	Yes	Yes	Yes
Generic region of origin (0/1)	Yes	Yes	Yes
Year end of exclusivity (0/1)	Yes	Yes	Yes
Constant	0.0306***	0.0300***	0.0301***
	(0.00677)	(0.00674)	(0.00674)
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. $***p < 0.01, **p < 0.05, *p < 0.1$.

Appendix D: Proofs

Proof of Lemma 2

We determine the optimal entry decision of generic firm G for each (exogeneous level) of p, the entry decision of G', i.e. the best response function. We also determine the effect of the level of common ownership to this best-response function.

We first distinguish between two scenarios. As shown by (8), $|\partial\Pi_G(p,\delta)/\partial p|_{\delta=0} = \pi_G^T - \pi_G^D < 0$ and $\partial^2\Pi_G(p,\delta)/\partial p\partial\delta = \Delta\pi_B^{DT} - \Delta\pi_B^{MD} > 0$. Then, there exists $\delta^* \equiv (\pi_G^D - \pi_G^T)/(\Delta\pi_B^{DT} - \Delta\pi_B^{MD})$ such that if $\delta < \delta^*$ then $\partial\Pi_G(p,\delta)/\partial p < 0$ (strategic substitutability) whereas if $\delta > \delta^*$ then $\partial\Pi_G(p,\delta)/\partial p > 0$ (strategic complementarity).

Consider the case in which $\delta < \delta^*$ (strategic substitutability). We are going to show that there exist δ_1, δ_2 and p^*, whereby $\delta_1 < \delta_2 < \delta^*$, such that the best-response function of firm G to the decision p of G' consists in (i) entering for any p if $\delta < \delta_1$, (ii) entering if and only if $p \leq p^*$ if $\delta_1 < \delta < \delta_2$, and (iii) not entering for any p if $\delta_1 < \delta < \delta^*$. Indeed, first notice that, as shown by (1), G should always enter if $\pi_G^T + \delta\Delta\pi_B^{DT} > 0$ or if $\delta < \delta_1 \equiv -\pi_G^T/\Delta\pi_B^{DT}$, as, even in the most adverse case, in which G' does enter with $p = 1$, G does have an incentive to enter. Similarly, as also shown by (1), G should never enter if $\pi_G^D + \delta\Delta\pi_B^{MD} < 0$ or if $\delta > \delta_2 \equiv -\pi_G^D/\Delta\pi_B^{MD}$, as, even in the most advantageous case, in which G' does enter with $p = 0$, G does not have an incentive to enter.[28] Finally, G enters if $p < p^*$ where p^* is such that $\Pi_G(p^*,\delta) = 0$ in (1) if $\delta_1 < \delta < \delta_2$. Notice that p^* can be written explicitely as

$$p^* \equiv \frac{\pi_G^D + \delta\Delta\pi_B^{MD}}{(\pi_G^D + \delta\Delta\pi_B^{MD}) - (\pi_G^T + \delta\Delta\pi_B^{DT})}.^{29} \tag{11}$$

Notice also that, as δ increases, it is less likely that generic firm G enters. Indeed, (i) it is less likely to be in the area in which it always enters, (ii) it is more likely to be in the area in which it never enters, and (iii) the area in which entry occurs in the intermediate area is smaller, $\partial p^*(\delta)/\partial\delta < 0$, as $sign\{\partial p^*(\delta)/\partial\delta\} = sign\{\Delta\pi_B^{MD}\pi_G^T + \pi_G^D\Delta\pi_B^{DT}\} = sign\{\delta_1 - \delta_2\}$ and $\delta_1 < \delta_2$.

Consider now the case in which $\delta > \delta^*$ (strategic complementarity). We are going to show that, there exists δ_1, δ_2 and p^*, the same as before, but now such that $\delta^* < \delta_2 < \delta_1$, such that

[28] Note that $\delta_1 < \delta_2 < \delta^*$. Indeed, let us first show that if (i) $\delta < \delta^* \equiv (\pi_G^D - \pi_G^T)/(\Delta\pi_B^T - \Delta\pi_B^D)$ then we have that if (ii) $\delta < \delta_1 \equiv -\pi_G^T/\Delta\pi_B^T$ then also (iii) $\delta < \delta_2 \equiv -\pi_G^D/\Delta\pi_B^D$. Indeed, from (i), we have that $\pi_G^T < \pi_G^D - (\Delta\pi_B^T - \Delta\pi_B^D)\delta$. From (ii) we have that $-\Delta\pi_B^T\delta < \pi_G^T$ and thus $-\Delta\pi_B^T\delta < \pi_G^D - (\Delta\pi_B^T - \Delta\pi_B^D)\delta$ and $\delta < -\pi_G^D/\Delta\pi_B^D = \delta_2$. Simple mathematical manipulation also shows that provided that $\delta_1 < \delta_2$ then $\delta_2 < \delta^*$.

[29] Notice that p^* is well defined. First, $p^* > 0$ if and only if $\delta < \delta_2$, as $\pi_G^D + \delta\Delta\pi_B^D > 0$ if and only if $\delta < -\pi_G^D/\Delta\pi_B^D = \delta_2$. Second, $p^* < 1$ if and only if $\delta > \delta_1$, as $\pi_G^D + \delta\Delta\pi_B^D < \pi_G^D + \delta\Delta\pi_B^D - [\pi_G^T + \delta\Delta\pi_B^T]$ if and only if $\delta > -\pi_G^T/\Delta\pi_B^T = \delta_1$).

the best-response function of firm G to the decision p of G' consists in (i) not entering for any p if $\delta^* < \delta < \delta_2$, (ii) entering if and only if $p \geq p^*$if $\delta_2 < \delta < \delta_1$, (iii) not entering for any p if $\delta > \delta_1$. Indeed, first notice that generic firm G always enters if $\pi_G^D + \delta\Delta\pi_B^{MD} > 0$ or if $\delta < \delta_2$, as, even in the most adverse case, in which G' does enter with $p = 0$, G does have an incentive to enter. Similarly, G never enters if $\pi_G^T + \delta\Delta\pi_B^{DT} < 0$ or if $\delta > \delta_1$, as, even in the most advantageous case, in which G' does enter with $p = 1$, G does not have an incentive to enter.[30] Finally, G enters if $p > p^*$ if $\delta_2 < \delta < \delta_1$. As δ increases, it is less likely that generic firm G enters: (i) it is less likely to be in the area in which it always enters, (ii) it is more likely to be in the area in which it never enters.

Proof of Proposition 3

We now determine the equilibrium entry decisions of generic firms G and G'. We also determine the effect of the level of common ownership to the equilibrium outcomes. We make use of the equivalent notation of the best-response function of G to the decision of G' for the best-response function of G' to the decision of G. We consider, in turn, the cases in which (i) the decisions of both firms may be strategic substitutable to each other ($\delta, \delta' < \delta^*$), (ii) the two decisions may be strategic complementary to each other ($\delta, \delta' > \delta^*$), (iii) the decision of G may be strategic substitute with respect to the decision of G but the decision of G' strategic complementary with respect to G's decision ($\delta < \delta^* < \delta'$), and (iv) vice-versa ($\delta > \delta^* > \delta'$).

Case (i): strategic substitutabilities Generic firm G' may have three different reaction functions, (a) always enter, (b) enter if $p' < p'^*$ and (c) never enter.

(a) Suppose G' always enters: then the equilibrium is (E,E) if G always enters, (NE,E) if G enters when $p < p^*$, and (NE, E) if G never enters, where "E" denotes entry and "NE" not entry and the first element is for G and the second for G'. Here, as the level of common ownership δ of G increases, it decreases entry of this firm and it does not affect the decision of the other generic.

(b) Suppose G' enters if $p' < p'^*$: then the equilibrium is (E,NE) if G always enters, there are three equlibria: (E,NE), (p'^*, p^*), (NE,E) if G enters when $p < p^*$, and (NE, E) if G never enters. Here, as δ increases, it decreases the entry of G but it increases the entry of the other generic.[31]

[30] Following the same strategy as in the previous footnote, we have that $\delta^* < \delta_1 < \delta_2$.

[31] Notice, though, that in the case of mixed strategies, it is decreasing the probability p^*, which means that it is entering with lower probability. At some point, for a relatively high δ the mixed strategy equilibrium (and the pure strategy equilibrium (E,NE)) disappear; only (NE,E) remains.

(c) Suppose G' never enters: then the equilibrium is (E,NE) if G always enters, (E,NE) if G enters when $p < p^*$, and (NE, NE) if G never enters. Here, as δ increases, it decreases entry of this firm and it does not affect the decision of the other generic.

Case (ii): strategic complementarities Generic firm G' may have three different reaction functions, (a) always enter, (b) enter if $p' > p'^*$and (c) never enter.

(a) Suppose G' always enters: then the equilibrium is (E,E) if G always enters, (E,E) if G enters when $p > p^*$, and (NE, E) if G never enters. Here, as the level of common ownership δ of G increases, it decreases entry of this firm and it does not affect the decision of the other generic.

(b) Suppose G' enters if $p' < p'^*$: then the equilibrium is (E, E) if G always enters, there are three equlibria: (NE,NE), (p'^*, p^*), (E,E) if G enters when $p > p^*$, and (NE, NE) if G never enters. Here, as δ increases, it decreases the entry of G and it also decreases the entry of the other generic.[32]

(c) Suppose G' never enters: then the equilibrium is (E,NE) if G always enters, (NE,NE) if G enters when $p > p^*$, and (NE, NE) if G never enters. Here, as δ increases, it decreases entry of this firm and it does not affect the decision of the other generic.

Case (iii): strategic substitute and strategic complementary Generic firm G' may have three different reaction functions, (a) always enter, (b) enter if $p' < p'^*$and (c) never enter.

(a) Suppose G' always enters: then the equilibrium is (E,E) if G always enters, (E,E) if G enters when $p > p^*$, and (NE, E) if G never enters. Here, as the level of common ownership δ of G increases, it decreases entry of this firm and it does not affect the decision of the other generic.

(b) Suppose G' enters if $p' < p'^*$: then the equilibrium is (E, NE) if G always enters, a unique mixed strategy equlibrium (p'^*, p^*) if G enters when $p > p^*$, and (NE, E) if G never enters. Here, as δ increases, it decreases the entry of G but it increases the entry of the other generic.[33]

(c) Suppose G' never enters: then the equilibrium is (E,NE) if G always enters, (NE,NE) if G enters when $p > p^*$, and (NE, NE) if G never enters. Here, as δ increases, it decreases entry of this firm and it does not affect the decision of the other generic.

[32]Notice, though, that in the case of mixed strategies, it is increasing the probability p^*, which means that it is entering with higher probability. At some point, for a relatively high δ the mixed strategy equilibrium (and the (E,E)) disappear (only (NE,NE) remains).

[33]In the case of mixed strategies, it is increasing the probability p^*, which means that it is also entering with higher probability. At some point, for a relatively high δ the mixed strategy equilibrium disappears (only (NE,E) remains).

Case (iv): strategic complementary and strategic substitute Generic firm G' may have three different reaction functions, (a) always enter, (b) enter if $p' > p'^*$and (c) never enter.

(a) Suppose G' always enters: then the equilibrium is (E,E) if G always enters, (NE,E) if G enters when $p < p^*$, and (NE, E) if G never enters. Here, as the level of common ownership δ of G increases, it decreases entry of this firm and it does not affect the decision of the other generic.

(b) Suppose G' enters if $p' > p'^*$: then the equilibrium is (E,E) if G always enters, a unique mixed strategy equlibrium (p'^*, p^*) if G enters when $p < p^*$, and (NE, NE) if G never enters. Here, as δ increases, it decreases the entry of G but it decreases the entry of the other generic.[34]

(c) Suppose G' never enters: then the equilibrium is (E,NE) if G always enters, (E,NE) if G enters when $p < p^*$, and (NE, NE) if G never enters. Here, as δ increases, it decreases entry of this firm and it does not affect the decision of the other generic.

[34]In the case of mixed strategies, it is decreasing the probability p^*, which means that it is also entering with lower probability. At some point, for a relatively high δ the mixed strategy equilibrium disappears (only (E,NE) remains).