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The effect of Paragraph IV decisions and generic entry before patent expiration on brand pharmaceutical firms☆

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ABSTRACT

This purpose of this paper is to investigate the impact of Paragraph IV patent infringement decisions on brand drug pharmaceutical firms. Paragraph IV decisions determine whether a generic firm can enter before the period of exclusivity ends. I construct a novel dataset of all Paragraph IV decisions and find that they disproportionately involve the highest revenue drugs, significant periods of patent protection, and a non-trivial portion of all brand drugs facing generic entry. I also estimate the impact of Paragraph IV decisions on brand firm profitability and find they have large value consequences.

1. Introduction

The regulation of the pharmaceutical industry creates some unique and substantial barriers to entry for generic competitors. FDA regulated drugs are the only products for which potential competitors must resolve conflicting patent claims before entering (Hollis, 2001). The Paragraph IV statute provides the regulatory mechanism for granting generic firms the right to enter before patent expiration, in some cases through winning patent infringement litigation. Therefore, when both brand and generic firms decide to pursue litigation, Paragraph IV decisions determine whether the owner of a brand name prescription drug will maintain or lose exclusive marketing.

Understanding how the Paragraph IV statute is being used by both brand and generic firms is crucial for determining how the current regulations are balancing the trade off inherent in granting patent protection; incentivizing the R&D necessary for new or improved drugs versus increased prescription drug prices.[1] Yet there has been very little research about the Paragraph IV statute. The FTC (2002) trace a sample of brand drugs from 1992 to 2001 through the Paragraph IV process to determine how many potential cases were never filed by the brand firm, were settled out of court, resulted in District Court decisions, or were resolved in other ways. Bulow (2003) questions the legality and antitrust issues raised by some brand firm's 'reverse payments' to the generic for settling Paragraph IV litigation out of court. Berndt et al. (2007) examine whether authorized generic entry decreases original Paragraph IV filings. Even so, this leaves many basic unanswered questions about how the Paragraph IV statute affects both brand and generic firms, along with the market for prescription drugs.

☆ This article is based on Chapter 2 of my doctoral dissertation at the California Institute of Technology.

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[1] Over, the last fifteen years, pharmaceutical expenditures, both total and per capita, have grown faster than the rate of inflation and total health expenditures (DiMasi et al., 2003; Regan, 2008). Aitken et al. (2008) find that annual growth in real prescription drug spending averaged 9.9% from 1997 to 2007. Furthermore, with the passage of the 'Medicare Prescription Drug, Improvement, and Modernization Act' of 2003, prescription drugs play an increasing role in the expenditures of the federal government. On February 9th, 2005, The Washington Post reported the White House released budgeting figures indicating that the cumulative cost of the Medicare Prescription Drug Act between 2006 and 2015 will reach $1.2 trillion. However, several major savings may reduce the federal government's bottom line cost to $720 billion (Allen and Connolly, 2005).

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In this paper, I focus on two main questions from the perspective of brand firms related to just one possible outcome of the Paragraph IV statute: Paragraph IV decisions. I first provide descriptive information regarding the content of Paragraph IV decisions. To accomplish this goal, I construct a novel dataset of all Paragraph IV decision through conducting a legal database search. Secondly, I estimate the value impact of Paragraph IV decisions on brand firm profitability for a subsample of decisions. I take advantage of a natural experiment created by the announcement of Paragraph IV decisions to overcome identification challenges and generate credible estimates. This paper treats the set of decisions as given and does not explore the strategic reasons why the brand and the generic firms chose to resolve their Paragraph IV disputes in court.

The dataset from my search yields 72 decisions pertaining to 76 brand name drugs. I find that Paragraph IV decisions are a relatively recent industry phenomena, largely starting in the late 1990s. They are a non-trivial portion of all brand drugs facing their first generic approval and that brand firms won 34 (47%) of the decisions.[2] Paragraph IV decisions involve a disproportionate number of the highest revenue brand drugs. The largest 40% of drugs involved in Paragraph IV decisions have one year retail sales alone greater than the average cost of brand drug development up to the point FDA marketing approval, estimated at $970.83 in millions of 2007 dollars (DiMasi et al., 2003).[3] Finally, I find that the average period of exclusivity at issue in Paragraph IV cases is six and half years, while the average length of patent protection is 11 or 12 years (e.g., Congressional Budget Office, 1998; Grabowski, 2002). Given evidence that the returns on R&D have been highly skewed and that only the top 30% of drugs, in terms of revenues, cover the cost of their development (Grabowski et al., 2002), Paragraph IV decisions may have considerable implications for R&D incentives.

Paragraph IV decisions have a number of unique features which I use to credibly estimate their value effect on brand drug firms. As bench trials, I argue that the outcome of these trials are essentially stochastic events. The unique regulatory environment makes pharmaceutical products the cleanest example of a change in the number of competitors due to patent expiration. Paragraph IV decisions also satisfy methodological requirements to use a short window event study to estimate how the financial market prices this change. This methodology can isolate the affect of one product in one market. Finally, I argue the announcement of a Paragraph IV decision generates a binomial outcome space; either the brand maintains monopoly rights until patent expiration or it faces generic entry. The binomial outcome space in conjunction with the state price (Arrow–Debreu) paradigm are used to interpret the result in the presence of market expectations about the case's outcome. Viewed within this paradigm, the estimates also form a lower bound for a market value of exclusivity.

For a subsample of 37 decisions, I find that Paragraph IV decisions have large value consequences for brand name pharmaceutical firms.[4] The average announcement cumulative abnormal return for the 17 cases in which the brand won was 3.84% (significant at the 1% level), while the average abnormal return for the 20 cases in which the generic won was −5.20% (significant at the 1% level).[5] The cumulative abnormal returns translate to $1904.73m for brand wins and −$1086.36m for generic wins.[6] However, the dollar values for the median decisions in each group are $443.70m and −$387.78m, respectively. In 10 decisions, the brand firm either lost or gained an amount greater than the estimate of R&D provided by DiMasi et al. (2003). This provides some evidence that brand firms may have considerable incentive to avoid the uncertainity and large potential profitability loses associated with Paragraph IV decisions.

My analysis proceeds in the next four sections. Section 2 provides a description of the Paragraph IV statute, some additional background about the industry's use of the statute, and the structure of Paragraph IV trials. Section 3 presents the event study methodology and the binomial state price paradigm. In Section 4, I discuss the construction of the 72 decision sample, and why I can only include 37 decisions in the event study. I also construct additional variables to explore the event study results. Section 5 presents some descriptive statistics of both the 72 and 37 decision sample, the event study conducted on the 37 decision sample, some additional cross-sectional regressions explaining the event study results, and an analysis of the related appellate court decisions. Section 6 concludes.

2. Industry background

2.1. The Paragraph IV statute: regulating generic entry before patent expiration

The Hatch–Waxman Act, formally known as The Drug Price Competition and Patent Term Restoration Act of 1984, established the current FDA regulations for approving generic copies of brand name drugs. One component of the Act created the abbreviated new drug application (ANDA), which lowered the regulatory barriers to entry for generic drugs.[7] An ANDA enables generic manufacturers to skip most of the expensive pre-clinical and clinical testing by allowing firms to establish *bioequivalency* to an approved drug.[8] The Act also permits generic firms to conduct bioequivalency testing while the referenced patents are still in force, without risking an infringement suit.[9]

In order to receive FDA approval, all ANDAs must certify that the proposed generic drug will not infringe upon any referenced patent listed in the Orange Book. The Orange Book is the FDA's official public list of all patents and exclusivities, along with their expiration dates, which protect a brand name drug.[10] An ANDA may claim one of four certifications for each patent listed in the Orange Book.

[2] A first generic approval can be understood as a proxy for generic entry.

[3] DiMasi et al. (2003) actually construct this estimate to be $802 million in 2000 dollars, which I adjust according to the Bureao of Labor Statistic Annual Historical US Inflation Rates so that all dollar amounts in this paper are consistently presented in 2007 dollars.

[4] The event study could only be conducted on 37 decisions due to the strict requirements of event studies.

[5] This paper does not consider the impact on generic firms because many decisions have more than one generic defendant and the shares of many generic companies are only listed on foreign exchanges.

[6] All monetary units in this article are in 2007 dollars.

[7] In comparison, brand drugs use the more lengthy and costly new drug application (NDA) to gain FDA approval.

[8] The FDA has defined bioequivalence as, "the absence of a significant difference in the rate and extent to which the active ingredient or active moiety in pharmaceutical equivalents or pharmaceutical alternatives becomes available at the site of drug action when administered at the same molar dose under similar conditions in an appropriately designed study." (http://www.fda.gov/cder/guidance/5356fnl.pdf).

[9] The Hatch–Waxman Act has greatly increased the volume of approved generic drugs. In 1984, only 14% of the prescriptions were written for generic copies compared to 54% in 2005. See Ted Sherwood's overview of the ANDA review process at www.fda.gov/cder/audiences/iact/forum/200609_sherwood.pdf.

[10] This publication, formally known as 'Approved Drug Products and Therapeutic Equivalents', can be found at www.fda.gov/cder/ob, and also lists all the approved brand name drugs and their respective generics, approval dates, and their approved dosages, routes of administration, and indications of usage.

1. 'Paragraph I Certification'—certifies that the required patent information has not been filed in connection to the referenced brand name drug.
2. 'Paragraph II Certification'—certifies that all patents listed in relation with the referenced brand name drug have expired.
3. 'Paragraph III Certification'—certifies that all patents have not expired and provides the dates the referenced patents will expire.
4. 'Paragraph IV Certification'—The listed patent is invalid or will not be infringed by the generic drug.

An ANDA with a 'Paragraph I or II Certification' may be approved by the FDA immediately, since the patents have expired or were never listed in the Orange Book. An ANDA with 'Paragraph III Certification' signals the generic manufacturer's interest in entering after the relevant patents have expired. This ANDA may only be granted 'tentative approval', as long as the bioequivalency requirements have been met, and approval is granted upon patent expiration.[11]

A generic manufacturer submits a 'Paragraph IV Patent Certification' when it is seeking approval to enter a market before the relevant patents have expired. The manufacturer is claiming either that its formulation of the brand drug does not infringe upon the relevant patents held by the brand name company, or that the original patents should never have been granted. By filing an ANDA with Paragraph IV certification, the generic manufacturer triggers two additional provisions in the Hatch–Waxman Act to resolve the conflicting patent infringement claim.

The first provision, referred to as the thirty-month stay, is largely considered a pro-brand provision. Upon filing a Paragraph IV ANDA, the generic manufacturer must notify the patent holder (brand name drug company) of its application and the factual and legal basis of its claim. The brand name firm then has forty-five days in which to file an infringement suit or face generic entry. As Higgins and Rodriguez (2006) write,

> "... by filing the suit, the FDA cannot grant approval until the earliest of: (1) the date the NDA patent being challenged expires, (2) there is a lower court ruling invalidating the patent or a decision of non-infringement, or (3) 30 months after the patent holder was originally notified of the Paragraph IV ANDA certification.' [p14]

Therefore, unlike any other product, generics are temporarily prevented from entering by every patent, listed in the Orange Book, regardless of the patent's merits. The FTC (2002) estimate that it takes approximately 25 months to resolve an infringement suit, which provides the brand name company an extra two years of exclusivity just for filing the suit.

At the same time, the FDA's role in listing patents in the Orange Book is solely procedural which means that it automatically lists all patents submitted by brand name firms. The Agency states that its function is to determine the safety and efficacy of potential drugs and that it does not have the resources or expertise to resolve the complex questions of patent coverage. The Agency relies on declarations of good faith, signed by brand name firms, that submitted patents have merit.

In contrast to the pro-brand bent of the first provision, the second provision, referred to as the 180 day exclusivity, attempts to incentivize generic manufacturers to initiate Paragraph IV litigation. The FDA writes 'the statute provides an incentive of 180 days of market exclusivity to the 'first' generic applicant who challenges a listed patent by filing a 'substantially complete' 'Paragraph IV Certification' and runs the risk of having to defend a patent infringement suit.' The regulatory landscape implementing the 180 day exclusivity has had a highly contentious and unstable history, which has continued to the present.[12] In the presence of pending litigation and current administrative review, the FDA had not published a final rule on the exclusivity as of July 2007.

In summary, Paragraph IV patent certifications provide the opportunity for generics to enter before patents listed in the Orange book expire. However, to enter before the patent expires, the generic manufacturer must invent around the patents, establish *bioequivalency* and obtain tentative approval from the FDA, and wait until one of the first provisions of the Hatch–Waxman Act is satisfied. This study focuses on one of those first provisions, the outcome of Paragraph IV litigation that determines generic entry.

2.2. The Paragraph IV statute and industry trends

What evidence is there about the pharmaceutical industry's use of the Paragraph IV statute? The FTC (2002) studies the resolution of Paragraph IV ANDAs filed from January 1, 1992 to January 1, 2001. These ANDA's related to 104 brand 'drugs', where a drug is defined by a unique NDA.[13] This study provides evidence that the proportion of ANDA's filed with a Paragraph IV certification has been increasing over the last two decades. The FTC (2002) reports that from 1984 to December 31, 2000, 8019 ANDA's were filed with the FDA and only 6% contained a 'Paragraph IV Certification'. However, between 1984 and 1989 only 2% of ANDA included this certification, between 1990 and 1997, the share increased to 12% and between 1998 and 2000, the share had risen to 20%. The FDA provides that the number of brand drugs, as defined by distinct NDA, facing their first paragraph IV certification was 47 from March through December in 2004, 56 in 2005 and 2006, and 89 in 2007.[14] Berndt et al. (2007) use a dataset provided by PhRMA which does not count different dosages as different drugs. They find that the number of brand drugs, according to their definition, facing their first Paragraph IV certification was 31 in 2003 and 2004, and 28 in 2005.

The post-1997 rise in Paragraph IV ANDA filings coincides with a change to the FDA's interpretation of the 180 day exclusivity. According to the FTC (2002), prior to 1992, the FDA only granted this exclusivity to three generic applicants and between 1992 and 1998, no generics were awarded this exclusivity. However, in 1998, the FDA lost a court ruling forcing it to change its interpretation of this exclusivity in a pro-generic direction. From 1998 to 2001, the FDA granted the 180 day exclusivity to 31 generic applicants.

Some brand drugs with a Paragraph IV filing never face a District Court decision. In their sample of 104 brand drugs, the FTC (2002) finds that there were District Court decisions for 30 brand drugs (NDA's)[15] and that 22 drugs still had pending cases at the end of the sample. Of the remaining 52 drugs, the brand company did NOT initiate infringement litigation for 29 drugs. Considering that a brand

[11] See FTC (2002), Bulow (2003) and Voet (2005) for excellent references on pharmaceutical patent certifications.

[12] According to the FTC (2002), the FDA only granted this exclusivity to three generic manufacturers prior to 1993. However, between, 1993 and 1997, the FDA did not grant this exclusivity to any generic applicants stating that applicants must win an infringement suit against a brand name company to be eligible. These regulations were challenged by the generic firm Mova, in *Mova Pharmaceutical crop. v. Shalala* 140 F.3d 1060, 1065 (D.C. Cir. 1998), and in April 1998, the Court of Appeals affirmed that the FDA's interpretation of the 180 day exclusivity was inconsistent with the Hatch–Waxman statutes. From 1998 to 2001, the FDA granted the 180 day exclusivity to thirty-one generic applicants.

[13] I will define a 'drug' differently in this study to correspond with the concept used in Paragraph IV cases. See Section 4 for the definition used in this study.

[14] See the FDA's website: www.fda.gov/cder/ogd/ppiv.htm.

[15] The brand company won in the case of eight NDA's and the generics won in the case of 22 NDA's.

firm can delay generic entry simply filing a case, it is startling that a case was not filed for roughly one third of the drugs. For these drugs, it is possible that the brand drug firm believed that the case did not have enough merit to even proceed to trial. Finally, 20 cases were settled out of court. There are numerous reasons for this to occur including that the participants were risk averse or that the trial outcome was relatively easy to predict facilitating an agreement.

2.3. The structure of Paragraph IV District Court litigation

The structure of Paragraph IV District Court cases generates considerable uncertainty in the outcome. Patent infringement trials are bench trials, which means they are decided by a single judge. Once the brand drug company files the suit, the judge determines whether the minimal legal requirements to proceed to trial have been met, sets the scope of the issues at trial, and hears a couple of days of oral arguments. Then the judge withdraws from the public and may announce her decision anytime within roughly the next year. After oral arguments, she does not communicate with the litigants or the public until she announces her decision.

The first order affect of the outcome of a Paragraph IV trial can be represented by a binomial state space. The two states are that either the brand wins and maintains exclusivity or the brand firm loses and there is generic entry. If the judge determines the brand firm's patent is infringed by the generic's copy, then the FDA cannot legally approve the generic version and the generic cannot enter until the patent at issue expires. With this decision, the brand firm wins the case and continues to have exclusive marketing rights until patent expiration. In the opposite case, a District Court decision of non-infringement allows the FDA to legally approve a generic version. The generic may then enter the market as soon as the company can physically bring its product to market. Assuming this simple outcome structure, the judge is deciding whether or not the brand firm may earn monopoly rents until the patent expires.

The binomial state space representation requires a number of assumptions. First, it requires that the patents at issue in the case expire at the same time. This implies that there is one period of exclusivity at issue in each case, which may differ between cases. I explore the implications of this assumption in Sections 4 and 5. The binomial state space representation also requires that the number of generic defendants or the issue of validity vs. infringement is not a first order affect. I argue this is true because uncertainty about the process of generic entry is only resolved over time. In other words, it is difficult to predict the number and timing of generic entrants based on the number of generic defendants for a number of reasons. For example, some generics decide to enter right away, while others wait until after the Appellate Decision to avoid the risk of potential treble damages. The number of generic defendants about to receive FDA approval is unknown because the FDA does not release that information. Finally, cross-licensing is prevalent among generics which means that the number of generics who receive FDA approval is nearly always less than those which finally enter. I do not explore the implications of this assumption any further.

3. Research design

3.1. Empirical methodology

This paper uses a short window event study to measure how the announcement of Paragraph IV District Court decisions affect the brand drug's stock returns. Event study methodology is rooted in the rational expectations/efficient market tradition in financial economics. There is little controversy about the underlying assumptions, statistical properties, and interpretation of short horizon event studies. The efficient market hypothesis argues that capital markets are efficient mechanisms which instantaneously impound all relevant information into the stock price of a firm. In such a market, share prices only change when the market receives value relevant new information. Within the context of this natural experiment, the methodology credibly establishes that the outcome of the litigation caused the change in returns.

To measure the value effect of Paragraph IV decisions on brand name pharmaceutical firms, I use the standard event study methodology codified by Campbell et al. (1997). First, I use OLS to estimate the market model for each security for the 271 days directly preceding the announcement of the decision. The estimation equation is

$$R_{it} = \alpha_i + \beta_i R_{mt} + \epsilon_{it},$$

where R_{it} is the stock return of firm i from day $t-1$ to day t and R_{mt} is the market return. I use the value weighted CRSP index excluding dividends as the market portfolio. Conceptually, the estimates $\hat{\alpha}_i$ and $\hat{\beta}_i$ represent the stock's 'normal' behavior in relation to the market before the decision. The abnormal return is the return during some event window, which includes the announcement of the Paragraph IV decision, minus what the return would have been only accounting for market movements. The abnormal return is

$$\hat{\epsilon}_i = R_i - \hat{\alpha}_i - \hat{\beta}_i R_m.$$

Essentially, the abnormal return can be understood as a forecast error.

I consider the abnormal returns over three different event windows as a sensitivity analysis. The first two event windows and their respective abnormal returns are the one day announcement return, AR, and the announcement day plus the day after return, CAR. These event windows begin on the announcement date because there was no information leakage before the event.[16] The last event window is the announcement day return plus the close to open return, denoted AR^+. Unfortunately, the exact time of day when the announcement is made is unknown and some announcements were definitely made after the market closed on the announcement day. In these cases, the abnormal returns do not show up in AR but they are present in the AR^+ and the CAR. While the two day event window is typically used when the time of the announcement is unknown, it may allow more noise to affect the estimates. Therefore, I provide the three event windows to account for the unknown announcement time and to provide a range of estimates.

Pricing the announcement of Paragraph IV decisions satisfies many of the standard, short window event study assumptions. I will show that abnormal returns are concentrated in the event window and there is no information leakage before the decision is announced. The timing of Paragraph IV decisions is determined by the individual judge which means that the announcements are not clustered in calendar time.[17] Finally, observations with confounding effects in the event window can be ruled out, there is no problem with inaccurate announcement dates, and the shares of the brand name companies in this sample are sold on the major American exchanges which rule out the need for thin market corrections.

[16] The one day period and the two day periods before the announcement were tested for leakage. The abnormal returns for each drug and for each window were all individually insignificant with the exception of Zyprexa. In the Zyprexa case, the judge announced that a decision would be announced the following day and so there was some return movement the day before the decision was announced.

[17] Event clustering invalidates the assumption of independence in the cross-section of abnormal returns (e.g., Khotari and Warner, 2007).

The unique regulatory environment of the pharmaceutical industry provides key econometric features for identifying and isolating the effects of generic entry. The Orange Book and the outcome of Paragraph IV litigation jointly provide a gate keeping mechanism that determines the characteristics of firm entry as independently as possible from the actual and potential industry participants. Pharmaceutical products provide the cleanest example of firm entry due to patent expiration because the FDA's Orange Book establishes a one-to-one correspondence between patents and products, not found with any other products. Furthermore, the bench trial structure of Paragraph IV cases add a stochastic element to whether generic entry will occur or not.

3.2. Interpreting abnormal returns within the state price paradigm

I interpret the change in the brand drug's stock returns due to the announcement of Paragraph IV decisions within the one period state price (Arrow–Debreu) paradigm to understand the role of market expectations in the estimates.[18] Because Paragraph IV trials are public knowledge, these decisions are anticipated events, which means that expectations about their outcomes are already impounded into the stock price when the decision is announced. The binomial state space assumption for the trial's outcome after the completion of oral arguments is that either the brand wins or the brand loses. The state dependent valuation or stock price for the brand firm given the brand wins includes monopoly rents until the time the patent expires, V_m, compared to the valuation given the brand faces generic entry, V_g. Expectations about the likelihood of each outcome are captured in the state prices, ρ_m and ρ_g.[19] Let V_0 be the pre-decision valuation and r_f be the risk-free rate. Therefore, just before the announcement:

$$V_0 = \frac{1}{1+r_f}\{\rho_m V_m + \rho_g V_g\}.$$

In other words, the brand firm's pre-decision stock price can be understood as a discounted convex combination of the rents from a monopoly industry structure until the time of patent expiration and the rents from generic entry.

The analysis of the binomial state price representation results from the realization that there is no premium for the uncertainty in the announcement date. This uncertainty is not priced because there is no correlation between the time that has passed since the end of oral arguments and the likelihood of a particular decision. For example, if a judge is taking a longer time than usual to decide a case, the market does not know whether she has a difficult case, she has a full calendar, or any other of a myriad of explanations. Therefore, the market learns nothing from the passage of time. Also, the probability of a decision occurring on any date is equally likely and independent of the probability of a decision occurring on the previous date.

The binomial state price representation can be used to interpret the sign of the change in returns, even in the presence of expectations. Using the above model of the brand firm's pre-decision stock price and assuming the state price probability of each trial outcome is strictly positive, the pre-decision share price lies strictly within the interval of the two post-decision state contingent valuations, V_m and V_g. Therefore, a significant positive abnormal return when the brand firm wins may be interpreted as the market believed that the decision increased the value of the firm, which makes sense as the brand firm maintains monopoly rents until patent expiration. The opposite explanation can be used for interpreting significant negative abnormal returns when the brand firm loses.

In other words, the abnormal returns measured in this study constitute an 'Announcement Effect' and not a 'Valuation Effect'. An Announcement Effect exists when events are both anticipated and uncertain because expectations can mitigate the magnitude of the event's value consequences. The abnormal returns generated by Paragraph IV decisions reflect an 'Announcement Effect' because they are a function of the pre-decision stock price, which according to the state price paradigm, includes expectations about the trial's outcome.[20] On the other hand, when events are value relevant and complete surprises, then abnormal returns naturally capture the 'Valuation Effect'. In this case, a 'Valuation Effect' would provide the added value a brand firm receives from competing in a monopoly compared to facing generic entry. A relative 'Valuation Effect', or $V_0^{-1}(V_m - V_g)$, can also be interpreted as a market value of exclusivity. This value of exclusivity can be related back to the abnormal returns using the identity $V_0^{-1}(V_m - V_g) = AR_t^m - AR_t^g$. However, I do not calculate the market value of exclusivity, $AR_t^m - AR_t^g$, partly because there is no way to determine the state prices for the individual cases and using average abnormal returns may produce skewed results.[21] Therefore, both the individual and averaged abnormal returns, AR_t^m and AR_t^g, should only be interpreted as a lower bound of a market value of exclusivity.

4. The data

4.1. Paragraph IV District Court decisions

The sample consists of all Paragraph IV District Court decisions pertaining to brand name prescription drugs. The possible time period of these decisions ranges from the passage of the Hatch–Waxman Act in 1984 through to 2007. The FDA publishes a list of all brand name drugs for which a 'substantially complete' Paragraph IV ANDA has been received by the Office of Generic Drugs.[22] To construct my sample, I began with the list of all brand drugs whose ANDA was filed before December 31, 2004. This cut-off date balances the trade-off of maximizing the sample while allowing enough time for the majority of drugs from this time period to reach their first District Court decision.[23] A 'drug' is defined as a molecule with a unique combination of active ingredient and brand name. Therefore, different forms, dosages, or indications within this combination do not constitute a distinct brand drug in this paper.

[18] The one period state price representation argues that an asset's price today can be represented as the summation over all possible states tomorrow of the state price multiplied by the state dependent valuation all discounted by the risk free rate.

[19] State prices are often given probability interpretations since the price of a security that pays one dollar only in the realization of a certain state increases with the probability of that state occurring.

[20] The abnormal return if the brand wins is $AR_t^m = V_0^{-1}(V_m - V_0)$, and if the brand loses is $AR_t^g = V_0^{-1}(V_g - V_0)$.

[21] I also considered the possibility of an alternative market value of exclusivity based on the change in the generic's stock returns. Assuming the total market for an active ingredient stayed constant before and after generic entry, one could argue that outcome of Paragraph IV litigation simply reassigns the property rights to that value. Therefore, an alternative market value of exclusivity could be the sum of the absolute value of the brand drug's abnormal return plus the absolute value of the generic's abnormal return. Unfortunately, there are many problems with this measure. First, there is no evidence that the total market for an active ingredient stays constant through patent expiration for an average drug or for the drugs in my sample. Second, on a more practical note, some cases have more than one generic defendant and the shares of many generic companies are listed on foreign exchanges.

[22] The Office of Generic Drugs is a department within the FDA. Note this list also includes the brand name drug's active ingredient, form, and dosage and it can be found on the FDA's web page 'Paragraph IV Patent Certifications' (http://www.fda.gov/CDER/ogd/ppiv.htm).

[23] I also examined drugs through December 31, 2005, but very few had reached their first decision.

There are 232 brand drugs for which an ANDA was first filed before December 31, 2004.

For each brand name drug on this list, I searched the LexisNexis® Academic Power Search of State and Federal Court Cases to find the complete set of brand drugs with a Paragraph IV District Court decision.[24] Partly due to the search terms, I only include those District Court decisions where the infringement and/or validity of a patent protecting the brand drug is the issue at trial. The search produced 76 distinct brand drugs with at least one District Court decision.[25] However, the 76 brand drugs corresponded to 72 series of cases because the following drugs were tried in the same case: Tenormin and Tenoretic, Wellbutrin SR and Zyban, Claritin and Claritin Reditabs, and Micro K and K Dur.

For the purpose of cross-sectional consistency, I chose one District decision per drug. While some drugs had relatively simple litigation which resulted in only one District Court decision, others had complicated proceedings which resulted in many District Court decisions occurring both simultaneously and over time. Therefore, I developed a decision rule to select the one decision which resolved the most uncertainty concerning generic entry. The decision rule selects the first decision with a binomial outcome space of exclusivity or generic entry. For a series of District Court cases with the same litigants and different patents, I chose the last case. This situation arises when the same generic defendants try to overturn patents in separate cases over time. The last case was chosen because each patent trial can be viewed as an independent event and only the last case has the binomial outcome space. If any uncertainty about the last patent case was resolved in earlier cases, then the estimates in this paper are understated.[26] For a series of cases with different litigants and the same patent, I chose the first case because it has a binomial outcome space and it establishes the precedent about how certain technical issues related to the patent will be interpreted.[27] Finally, for a series of cases with the same defendants and the same patents, where there is a District Court decision, followed by a Appellate Court decision which repeals and remands the District Court decision, followed by a second District Court decision, I chose the first of the District Court decisions.[28]

The construction of this data set differs from two previous studies of Paragraph IV filings and infringement litigation. The first study, conducted by the FTC (2002), studied all brand and OTC drugs that received notification of a Paragraph IV ANDA from 1/1/1992 to 1/1/2001. This selection criterion produced 104 drugs, where a drug is defined by a unique NDA.[29] The sample in this paper expands the time period studied by the FTC and focuses solely on the outcome of District Court decisions, not the outcome of ANDA filings. Berndt et al. (2007) examine whether authorized generic entry decreases Paragraph IV Certification filings. They examined three data sets; the FDA data set, a proprietary survey data set by PhRMA,[30] and a proprietary dataset by Paragraphfour.com which provides data on all Paragraph IV certifications that faced court challenges since 2003. The sample in this paper is the first complete single source data set of the 'main' Paragraph IV patent infringement District Court decisions.

To make the event study viable, I exclude 35 District Decisions for six reasons. The excluded decisions, along with the reason they were excluded are listed in Table 1. The first three reasons are related to the event study methodology. Since I used CRSP stock pricing data, I excluded privately owned companies and companies with foreign listings. I also excluded observations without an Announcement. The variable Announcement captures the date the decision became public knowledge which is operationalized as the first date any information about the decision appeared in the LexisNexis® Academic Power Search Database of US Newspapers and Wires.[31] Except for the District Case pertaining to Augmentin and Wellbutrin XL, the Announcement was always within a couple days after the District Case's official *Decision*. Thirdly, I exclude the District Court decisions with a firm level confounding event, as defined by Higgins and Rodriguez (2006), reported in the LexisNexis® Academic Power Search Database of US Newspapers and Wires on the Announcement or the day after.

The last three reasons I exclude decisions stem from accurately pricing the announcement of Paragraph IV decisions. I exclude brand drugs whose generic manufacturer entered before the District Court Decision. According to the Hatch–Waxman Act, a generic company can enter before a District Court decision if the patent expires or the 30-month stay runs out. However, if the generic manufacturer enters and a future District or Appellate Court decision finds for the brand, then a jury trial date is set to determine the damages.[32] Once generic manufacturers enter, trial outcomes determine potential damage awards and not the rents from exclusive marketing. The variable *Generic Entry* indicates the date which the IMS Health Market Research Database Product Directory for the second quarter of 2007 recorded the first generic firm selling the molecule. If the data is missing from the IMS source, then I used the FDA's Drugs@FDA website to determine the date the first generic received FDA approval to enter. I excluded Glucophage XR and Pepcid because the patent owner licensed the marketing rights to another firm and the licensing agreement is unknown. Lastly, I excluded Lovenox because it is a biologic and there was not an established regulatory pathway for generic entry.[33]

After dropping the above observations, the event study sample consists of 37 District Court cases pertaining to 39 distinct brand name drugs. Table 2 lists the brand name drugs with a District Court decision included in the study, along with the active ingredients, corporate owners, the date of generic entry if applicable, the official *Decision* date, the Announcement date, and the variable *Winner*. The variable *Winner* takes on the values *Brand* or *Generic*,

[24] I used the search terms "Brand and patent and (Paragraph IV or Hatch–Waxman or ANDA or infringe! or valid! or invalid!)".

[25] Please see the previous section for why brand drugs may not have a decision and the possible self-selection biases that may arise.

[26] Examples of brand drugs in this category include Augmentin, Altace, Paxil, and Taxol.

[27] An example of a brand drug in this category is Wellbutrin SR.

[28] I believe the decision rule adequately addresses the following drugs, Platinol, Hytrin, Paxil, Taxol, Buspar, Neurontin, and Tiazac, identified by the FTC (2002) as having multiple Paragraph IV decisions.

[29] There are important differences between my definition of a 'drug' and the one used by the FTC (2002). It is common for the different forms, dosages, or indications of the same active ingredient and brand name to be submitted under different NDA's. Therefore, one 'drug' according to the definition in this paper may correspond to multiple NDAs.

[30] The PhRMA data set includes information for about 73% of brand drugs from the FDA data set does not count different dosages as different drugs. I am unclear about forms or indications.

[31] I used the search terms "Brand or Active ingredient".

[32] The level of damages is subject to considerable variability partly because courts have the discretion of imposing triple damages if the infringement was deemed intentional.

[33] As Lovenox was originally approved through an NDA, its generic entry was still regulated by the Hatch–Waxman Act. However, the FDA has only approved one generic version of a biologic originally approved by a NDA and it stated they were not establishing a precedent. Therefore, this litigation faced considerable uncertainty due to the unestablished regulatory pathway for the generic entry of biologics and the stock return impacts of the trial outcome likely reflected more than rents from just the exclusivity marketing of Lovenox. I would like to thank an anonymous referee for this information.

Table 1
Paragraph IV District Court decisions excluded from the event study. The decisions in this table and Table 2 form the 72 decision dataset constructed for this paper.

	Brand	Active ingredient	Company	Generic entry	Decision	Winner	Exclusion reason
1.	Aciphex	Rabeprazole Sodium	Esai	N/A	05/11/2007	Brand	Foreign Stock Listing
2.	Actos	Pioglitazone Hydrochloride	Takeda	N/A	02/21/2006	Brand	Foreign Stock Listing
3.	Adalat CC	Nifedipine	Bayer	05/2000	03/16/1999	Generic	No Announcement Date
4.	Advil Cold and Sinus	Ibuprofen Potassium/Pseudoephedrine Hydrochloride	Wyeth	N/A [b]	08/11/2006	Generic	No Announcement Date
5.	Avelox	Moxifloxacin Hydrochloride	Bayer (Schering)	N/A	10/25/2007	Brand	No Announcement Date
6.	Axid	Nizatidine	Eli Lilly	07/2002	10/12/2001	Brand	No Announcement Date
7.	Buspar	Buspirone Hydrochloride	Bristol Myers	04/2001	03/13/2001	Generic	Confounding Event – Litigation
8.	DDAVP	Desmopressin Acetate	Sanofi Aventis	02/2005	02/07/2005	Generic	Confounding Event – New Senior Management
9.	Depakote	Divalproex Sodium	Abbott	N/A	03/29/2001	Brand	No Announcement Date
10.	Diflucan	Fluconazole	Pfizer	07/2004	02/14/2002	Brand	No Announcement Date
11.	Diprivan	Propofol	AstraZeneca	01/1999 [a]	11/02/2005	Brand	Generic Entry Before Decision
12.	Ditropan XL	Oxybutynin Chloride	Alza/J&J	11/2006 [a]	09/27/2005	Generic	Confounding Event – Litigation
13.	Flexeril	Cyclobenzaprine Hydrochloride	Merck	05/1989	08/31/1988	Generic	No Announcement Date
14.	Flomax	Tamsulosin Hydrochloride	Astellas/Boehringer Ingelheim	N/A	02/21/2007	Brand	Foreign Stock Listing
15.	Floxin	Ofloxacin	Daichii Sankyo	08/2007	08/01/2006	Brand	Foreign Stock Listing
16.	Glucophage XR	Metformin Hydrochloride	Bristol Squibb	04/2008	12/12/2007	Brand	Licensed from Dupont
17.	Lovenox	Enoxaparin Sodium	Sanofi Aventis	N/A	06/15/2005	Generic	Biologic – Regulatory Uncertainity
18.	Hytrin	Terazosin Hydrochloride	Abbott	08/1999	09/01/1998	Generic	No Announcement Date
19.	Micro K; K-Dur	Potassium Chloride	A.H. Robins	06/1990	04/18/1991	Generic	No Announcement Date
20.	Neurontin	Gabapentin	Pfizer	10/2004	08/22/2005	Generic	Generic Entry Before Decision
21.	Norvasc	Amlodipine Besylate	Pfizer	03/2007	02/27/2007	Brand	Confounding Event – Earnings Report
22.	Oxycontin	Oxycodone	Purdue Pharma LP	06/2005	01/05/2004	Generic	Privately Held
23.	Paraplatin	Carboplatin	Bristol-Myers	07/2004	07/25/2002	Brand	No Announcement Date
24.	Pepcid	Famotidine	Merck	04/2001	10/01/1998	Brand	Licensed from Yamamouchi
25.	Platinol	Cisplatin	Bristol Myers Squibb	11/1999	10/21/1999	Generic	Confounding Event – New Product
26.	Plavix	Clopidogrel Bisulfate	Bristol-Myers/Sanofi Aventis	08/2006	06/19/2007	Generic	No Announcement Date
27.	Plendil ER	Felodipine	AstraZeneca	11/2004	08/21/2003	Brand	Confounding Event – Product Failure
28.	Seldane	Terfenadine	Hoechst Marrion Roussel	01/1997	11/12/1996	Generic	Foreign Stock Listing
29.	Sinemet CR	Carbidopa/Levodopa	Merck	01/1993	08/24/1998	Generic	No Announcement Date
30.	Tambocor	Flecainide Acetate	3M Pharma	03/2002	04/17/2001	Generic	No Announcement Date
31.	Tenormin; Tenoretic	Atenolol; Atenolol/Chlorthalidone	Imperial Chemical Industries	10/1991	11/04/1991	Brand	No Announcement Date
32.	Topamax	Topiramate	Ortho-McNeil/J&J	03/20/2007	03/22/2007	Brand	Confounding Event – Product Failure
33.	Ultracet	Acetaminophen/Tramadol Hydrochloride	Ortho-McNeil/J&J	05/2005	10/19/2005	Generic	Generic Entry Before Decision
34.	Univasc	Moexipril Hydrochloride	Schwartz	05/2003	03/24/2003	Generic	Foreign Stock Listing
35.	Xalatan	Latanoprost	Pfizer	N/A	07/06/2004	Brand	Confounding Event – Litigation

[a] These generic entry dates come from FDA brand drug approval data, not the IMS Generic Spectra data.
[b] Indicates an over-the-counter (OTC) drug.

Table 2
Paragraph IV District Court decisions included in the event study. The decisions in this table and Table 1 form the 72 decision dataset constructed for this paper. The results for the event study are given in Table 11. Note the Announcement came before the Decision for Augmentin and Wellbutrin XL because the Court's decision was read into the record before the decision was filed.

	Brand	Active ingredient	Company	Generic entry	Decision	Announcement	Winner
1.	Accupril	Quinapril Hydrochloride	Pfizer	02/2007	06/28/2004	06/30/2004	Brand
2.	Acular	Ketorolac Tromethamine	Allergan/Roche	N/A	12/20/2003	12/31/2003	Brand
3.	Alphagan	Brimonidine Tartrate	Allergan	05/2003 [a]	05/08/2002	05/09/2002	Generic
4.	Altace	Ramipril	King	N/A	07/17/2006	07/18/2006	Brand
5.	Augmentin	Amoxicillin; Clavulanate Potassium	GlaxoSmithKleine	11/2002	07/19/2002	05/23/2002	Generic
6.	Celebrex	Celecoxib	Pfizer	N/A	03/20/2007	03/20/2007	Brand
7.	Claritin; Claritin Reditabs	Loratadine	Schering Plough	01/2003	08/08/2002	08/08/2002	Generic
8.	Duragesic	Fentanyl	Alza/J&J	07/2004	03/25/2004	03/25/2004	Brand
9.	Fosamax	Alendronate Sodium	Merck	N/A	08/28/2003	08/28/2003	Brand
10.	Levaquin	Levofloxacin	Ortho/J&J	N/A	12/12/2004	12/23/2004	Brand
11.	Lexapro	Escitalopram Oxalate	Forest	N/A	07/13/2006	07/14/2006	Brand
12.	Lipitor	Atorvastatin Calcium	Pfizer	N/A	12/16/2005	12/16/2005	Brand
13.	Mircette	Desogestrel; Ethinyl Estradiol	Akzo Nobel	04/2002	12/06/2001	12/07/2001	Generic
14.	Monopril	Fosinopril Sodium	Bristol Myers	11/2003	10/27/2003	10/27/2003	Generic
15.	Naprelan	Naproxen Sodium	Elan	12/2002	03/14/2002	03/15/2002	Generic
16.	Paxil	Paroxetine Hydrochloride	GlaxoSmithKline	09/2003	03/03/2003	03/04/2003	Generic
17.	Prilosec	Omeprazole	AstraZeneca	12/2002	10/11/2002	10/11/2002	Brand
18.	Protonix	Pantoprazole Sodium	Wyeth	09/2007	09/06/2007	09/07/2007	Generic
19.	Prozac	Fluoxetine Hydrochloride	Eli Lilly	08/2001	01/12/1999	01/13/1999	Brand
20.	Rebetol	Ribavirin	Ribapharm	04/2004	07/14/2003	07/16/2003	Generic
21.	Relafen	Nabumetone	GlaxoSmithKleine	08/2001	08/14/2001	08/14/2001	Generic
22.	Remeron	Mirtazapine	Akzo Nobel	02/2003	12/18/2002	12/19/2002	Generic
23.	Retrovir	Zidovudine	Burroughs Wellcome	09/2005	07/22/1993	07/22/1993	Brand
24.	Risperdal	Risperidone	Johnson & Johnson	N/A	10/13/2006	10/16/2006	Brand
25.	Sarafem	Fluoxetine Hydrochloride	Warner Chilcott	11/2008 [a]	07/29/2004	07/30/2004	Brand
26.	Sporanox	Itraconazole	Janssen/J&J	02/2005	07/28/2004	07/29/2004	Generic
27.	Taxol	Paclitaxel	Bristol Myers	10/2000	03/01/2000	03/01/2000	Generic
28.	Tiazac	Diltiazem Hydrochloride	Biovail	04/2003 [a]	03/06/2000	03/08/2000	Generic
29.	Toprol XL	Metoprolol Succinate	AstraZeneca	09/2007	01/17/2006	01/18/2006	Generic
30.	Tricor	Fenofibrate	Abbott	05/2002	03/19/2002	03/21/2002	Generic
31.	Ultane	Sevoflurane	Abbott	03/2006	09/26/2005	09/23/2005	Generic
32.	Vicoprofen	Hydrocodone Bitartrate and Ibuprofen	Abbott	04/2003 [a]	09/12/2002	09/12/2002	Generic
33.	Wellbutrin SR; Zyban	Bupropion Hydrochloride	GlaxoSmithKleine	01/2004	02/28/2002	03/01/2002	Generic
34.	Wellbutrin XL	Bupropion Hydrochloride	Biovail	12/2006 [a]	11/22/2006	08/02/2006	Generic
35.	Zantac	Ranitidine	Glaxo Inc	07/1997	09/17/1993	09/17/1993	Brand
36.	Zofran	Ondansetron Hydrochloride	GlaxoSmithKleine	12/2006	08/20/2004	08/24/2004	Brand
37.	Zyprexa	Olanzapine	Eli Lilly	N/A	04/14/2005	04/14/2005	Brand

[a] These generic entry dates come from FDA brand drug approval data, not the IMS data.

and indicates the realized state space or the outcome of the District case.[34]

4.2. Four explanatory variables of abnormal returns

In reality, the magnitude of the impact of Paragraph IV decisions on brand firms is determined by numerous factors. However, I focus on four variables partly due to the small dataset (see Table 3 for the definitions). First, I include the indicator variable *Generic* to test whether cases won by generics have statistically different sized abnormal returns than cases won by the brand. The state price paradigm provides an important reason why this could have been the case. As an Announcement return, the abnormal returns are a function of the state price multiplied by the value given the brand won minus the value given the generic won. One potential explanation for a statistical difference to exist could come from different average state prices if the market believed that systematically either the brand or the generic was more likely to win.

Since this study measures the impact of a product level event on the entire firm's value, I created the variable *Sales%* to represent the drug's relative value to the firm. *Sales%* is the individual drug's fraction of its total company sales during the fiscal year before the decision. The *Sales%* for individual brand drugs is listed in Table 5. I mostly used sales data from the Compustat Industrial Annual File to find the total company sales for the respective year. The drug level sales data mostly comes from the magazine *Drug Topics* (Drug Topics Magazine, 1999–2006) which published a list of the top 200 brand name drugs by US retail sales each year from 1999 to 2006

[34] Note that these state spaces were defined to capture the legal possibility of generic entry. Typically, the Brand wins when a relevant patent is found to be both valid and infringed, however, Prilosec provides an interesting counterexample. There were four generic defendants in the case and three were found to infringe, while the fourth firm, Kudco, was found not to infringe. According to my criteria, the case should have been labeled as Generic wins. However, two of the other generics, Andrex and Genpharm, had the 180 day exclusivity which meant that no other generic could enter until they shared 180 of exclusively marketing their generic. Because, Kudco could not enter before Andrex and Genpharm, generic entry was legally prevented until the patents expires and so the case was classified as Brand wins.

Table 3
Definition and description of regression-model independent variables. These variables are used to provide descriptive statistics and explore the magnitude of the value consequences district decisions have on brand firms. The summary statistics are provided in Tables 7–10, and the cross-sectional regression results for the 37 decision sample are provided in Table 13.

Variables	Description
Generic	Indicator equals 1 if the generic wins the case
Sales%	Brand drug's fraction of its total company sales during the fiscal year before the decision
Exclusivity at Issue	Years of exclusivity (monopoly rights) at issue in the decision
State Space	Indicator equals 1 if the decision violates the binomial state space assumption (or if the number of unique patent expiration dates plus one is greater than two)

Table 4
Sales%, *Exclusivity at Issue*, and Number of State Spaces—sample excluded from the event study. *Sales%*, *Exclusivity at Issue*, and *State Space* are defined in Table 3. See Section 4.2 for their construction. This table provides background information about their construction.

	Brand	Decision	Patents	Patent expiration	Number of State Spaces	*Exclusivity at Issue*	*Sales%*
1.	Aciphex	05/11/2007	5,045,552	05/2013	2	6.00	21.5 [d]
2.	Actos	02/21/2006	4,687,777	01/2011	2	4.92	17.8 [d]
3.	Adalat CC	03/16/1999	5,264,446	11/2010	2	11.67	1.1 [c]
4.	Advil Cold and Sinus	08/11/2006	5,071,643	06/2009 [a]	2	2.83	0.2
			5,630,615	06/2009 [a]			
5.	Avelox	10/25/2007	4,990,517	06/2009	3	6.42	1.5
			5,607,942	03/2014			
6.	Axid	10/12/2001	4,375,547	04/2002	2	0.50	2.1
7.	Buspar	03/13/2001	5,150,365	07/2010 [b]	2	9.33	1.5
8.	DDAVP	02/07/2005	5,047,398	09/2008	2	3.58	0.9
9.	Depakote	03/29/2001	4,988,731	01/2008	2	6.83	5.5
			5,212,326	01/2008			
10.	Diflucan	02/14/2002	4,404,216	01/2004	2	1.92	1.3
11.	Diprivan	11/02/2005	5,714,520	09/2015 [a]	2	9.83	1.8 [c]
			5,731,355	09/2015 [a]			
			5,731,356	09/2015 [a]			
12.	Ditropan XL	09/27/2005	6,124,355	05/2015	2	9.67	0.7
13.	Flexeril	08/31/1988	3,882,246	04/1994 [b]	2	5.67	– [e]
14.	Flomax	02/21/2007	4,703,063	10/2009	2	2.67	– [e]
15.	Floxin	08/01/2006	5,401,741	03/2012	2	5.58	– [e]
16.	Glucophage XR	12/12/2007	6,340,475	09/2016	2	8.75	– [e]
			6,635,280	09/2016			
17.	Hytrin	09/01/1998	5,504,207	04/2013	2	14.58	4.5 [c]
18.	Lovenox	06/15/2005	5,389,618	02/2012	2	6.67	1.6
19.	Micro K; K-Dur	04/18/1991	4,259,315	06/2000 [b]	2	9.17	– [e]
20.	Neurontin	08/22/2005	6,054,482	04/2017 [a]	2	11.67	3.8
21.	Norvasc	02/27/2007	4,879,303	09/2007 [a]	2	0.58	4.5
22.	Oxycontin	01/05/2004	5,508,042	04/2013	3	3.75	83.6
			5,549,912	10/2007			
			5,656,295	10/2007			
23.	Paraplatin	07/25/2002	4,657,927	04/2004	2	1.75	– [e]
24.	Pepcid	10/01/1998	4,283,408	10/2000	2	2.0	5.1
25.	Platinol	10/21/1999	5,562,925	10/2016 [b]	2	17.0	0.5 [c]
26.	Plavix	06/19/2007	4,847,265	11/2011	2	4.42	–
27.	Plendil ER	08/21/2003	4,803,081	10/2007	2	4.17	1.0
28.	Seldane	11/12/1996	4,254,129	04/1999 [b]	2	2.42	– [e]
29.	Sinemet CR	08/24/1998	4,832,957	10/2006	2	8.17	– [e]
			4,900,755	10/2006			– [e]
30.	Tambocor	04/17/2001	4,642,384	02/2004	2	2.83	0.6
			4,650,873	02/2004			
31.	Tenormin; Tenoretic	11/04/1991	3,934,032	04/1994 [b]	2	2.42	1.2
32.	Topamax	03/22/2007	4,513,006	09/2008	2	1.50	2.9
33.	Ultracet	10/19/2005	5,336,691	08/2011	2	5.83	0.7
34.	Univasc	03/24/2003	4,743,450	02/2007	2	3.92	– [e]
35.	Xalatan	07/06/2004	4,599,353	07/2006	3	6.67	0.8
			5,296,504	03/2011			
			5,422,368	03/2011			

[a] A six month Pediatric Exclusivity was in force at the time of the announcement and included the patent expiration date.
[b] Patent expiration date was determined as 20 years from the patent filing date.
[c] Drug level sales data is sourced from newspaper reports.
[d] Foreign total company sales data is sourced from newspaper reports.
[e] The *Sales%* could not be constructed due to four reasons; foreign stock listings and no news paper reports, an unknown license or joint venture agreement, and no newspaper sources could be found.

Table 5
Sales%, *Exclusivity at Issue*, and Number of State Spaces—sample included in the event study. These three variables are used in the cross-sectional regression analysis of the abnormal returns from the event study conducted on the 37 District decision sample. *Sales%*, *Exclusivity at Issue*, and *State Space* are defined in Table 3. The regression results are provided in Table 13. This table provides background information about their construction.

	Brand	Announcement	Patents	Patent expiration	Number of State Spaces	*Exclusivity at Issue*	*Sales%*
1.	Accupril	06/30/2004	4,743,450	08/2007 [a]	2	3.08	1.2
2.	Acular	12/31/2003	5,110,493	11/2009 [a]	2	5.83	9.2 [d]
3.	Alphagan	05/09/2002	6,194,415	12/2015 [a]	2	13.5	10.3
			6,248,741	12/2015 [a]			
4.	Altace	07/18/2006	5,061,722	10/2008	2	2.17	39.5
5.	Augmentin	05/23/2002	4,525,352	06/2002	4	0.50	6.3
			4,529,720	07/2002			
			4,560,552	12/2002			
6.	Celebrex	03/20/2007	5,466,823	05/2014 [a]	3	8.67	2.8
			5,563,165	05/2014 [a]			
			5,760,068	12/2015 [a]			
7.	Claritin; Claritin Reditabs	08/08/2002	4,659,716	10/2004 [a]	2	2.08	22.9
8.	Duragesic	03/25/2004	4,588,580	1/2005 [a]	2	0.75	2.5
9.	Fosamax	08/28/2003	5,994,329	1/2019 [a]	2	15.33	2.5
10.	Levaquin	12/23/2004	5,053,407	12/2010	2	5.92	2.8
11.	Lexapro	07/14/2006	RE. 34,712	12/2009 [a]	2	3.33	63.5
12.	Lipitor	12/16/2005	4,681,893	03/2010 [a]	3	5.42	11.4
			5,273,995	06/2011 [a]			
13.	Mircette	12/07/2001	RE. 35,724	10/2008	2	6.75	0.8 [d]
14.	Monopril	10/27/2003	5,006,344	01/2010 [a]	2	6.17	1.3
15.	Naprelan	03/15/2002	5,637,320	10/2014	2	12.5	2.0 [c]
16.	Paxil	03/04/2003	4,721,723	06/2007 [a]	2	4.17	6.7
17.	Prilosec	10/11/2002	4,786,505	10/2007 [a]	2	4.92	23.7
			4,853,230	10/2007 [a]			
18.	Protonix	09/07/2007	4,758,579	07/2010	2	2.75	9.9
19.	Prozac	01/13/1999	4,314,081	02/2001	3	4.83	22.7
			4,626,549	12/2003			
20.	Rebetol	07/16/2003	5,767,097	07/2016 [a]	3	14.25	69.1 [e]
			6,063,772	07/2016 [a]			
			6,150,337	11/2017			
21.	Relafen	08/14/2001	4,420,639	12/2002	2	1.25	1.3
22.	Remeron	12/19/2002	5,977,099	06/2017	2	14.42	2.7
23.	Retrovir	07/22/1993	4,724,232	09/2005	2	12.08	5.6 [c]
			4,828,838	09/2005			
			4,833,130	09/2005			
			4,837,208	09/2005			
			4,818,538	09/2005			
24.	Risperdal	10/16/2006	4,804,663	12/2007	2	1.08	2.9
25.	Sarafem	07/30/2004	4,971,998	05/2008	2	3.67	19.7 [d]
26.	Sporanox	07/29/2004	5,633,015	05/2014	2	9.75	0.4
27.	Taxol	03/01/2000	5,641,803	10/2015 [b]	3	16.42	4.2 [c]
			5,670,537	9/2016 [b]			
28.	Tiazac	03/08/2000	5,529,791	06/2013	2	13.17	87.8 [e]
29.	Toprol XL	01/18/2006	5,001,161	09/2007	2	1.58	5.4
			5,081,154	09/2007			
30.	Tricor	03/21/2002	4,895,726	01/2009	2	6.75	1.7
31.	Ultane	09/23/2005	5,990,176	07/2017	2	11.75	0.6 [d]
32.	Vicoprofen	09/12/2002	4,587,252	12/2004	2	2.17	0.9
33.	Wellbutrin SR; Zyban	03/01/2002	5,427,798	08/2013	2	11.33	4.0
34.	Wellbutrin XL	08/02/2006	6,096,341	10/2018	2	12.08	37.9 [e]
35.	Zantac	09/17/1993	4,521,431	02/2005	2	11.33	14.2
36.	Zofran	08/24/2004	5,578,628	02/2005	3	1.75	1.2
			4,753,789	06/2006			
37.	Zyprexa	04/14/2005	5,229,382	04/2011 [a]	2	5.92	13.6

[a] A six month Pediatric Exclusivity was in force at the time of the announcement and included the patent expiration date.
[b] Patent expiration date was determined as 20 years from the patent filing date.
[c] Drug level sales data is sourced from newspaper reports.
[d] Drug level sales data is approximated by the sales of the 200th drug in *Drug Topics* (1999–2006).
[e] Tiazac, Wellbutrin XL, and Rebetol had alternative constructions. See Section 4.2 for their construction.

Table 6
Paragraph IV Appellate Court decisions for the 37 District Court decision sample. An event study is conducted on these Appellate decisions to argue the uncertainty generated by Paragraph IV litigation is mostly resolved at the District Court level. The results are discussed in Section 5.4. The Affirmed variable indicates Yes when the District decision is upheld and No when it is either remanded to the District Court for full or partial reconsideration, or it is reversed outright. The 37 District Court decision sample is provided in Table 2.

	Brand	District winner	Generic entry	Appellate decision	Appellate announcement	Affirmed
1.	Accupril	Brand	02/2007	08/11/2005	08/11/2005	No
2.	Acular	Brand	N/A	05/18/2005	05/20/2005	No
3.	Alphagan	Generic	05/2003 [a]	03/28/2003	03/28/2003	Yes
4.	Altace	Brand	N/A	09/11/2007	09/11/2007	No
5.	Augmentin	Generic	11/2002	11/21/2003	11/21/2003	No
6.	Claritin; Claritin Reditabs	Generic	01/2003	08/01/2003	08/01/2003	Yes
7.	Fosamax	Brand	N/A	01/28/2005	01/28/2005	No
8.	Levaquin	Brand	N/A	12/19/2005	12/20/2005	Yes
9.	Lexapro	Brand	N/A	09/05/2007	09/05/2007	Yes
10.	Lipitor	Brand	N/A	08/02/2006	08/02/2006	No
11.	Mircette	Generic	04/2002	04/01/2003	04/01/2003	No
12.	Paxil	Generic	09/2003	04/23/2004	04/26/2004	No
13.	Prilosec	Brand	12/2002	12/11/2003	12/11/2003	Yes
14.	Prozac	Brand	08/2001	08/09/2003	08/09/2003	No
15.	Relafen	Generic	08/2001	08/15/2002	08/15/2002	Yes
16.	Retrovir	Brand	09/2005	11/22/1994	11/23/1994	No
17.	Sporanox	Generic	02/2005	06/13/2005	06/13/2005	Yes
18.	Taxol	Generic	10/2000	04/20/2001	04/20/2001	No
19.	Tiazac	Generic	04/2003 [a]	02/13/2001	02/14/2001	Yes
20.	Toprol XL	Generic	09/2007	07/23/2007	07/23/2007	No
21.	Tricor	Generic	05/2002	03/20/2003	03/21/2003	Yes
22.	Vicoprofen	Generic	04/2003 [a]	05/19/2004	05/19/2004	No
23.	Wellbutrin SR; Zyban	Generic	01/2004	09/22/2003	09/23/2003	No
24.	Zantac	Brand	07/1997	04/21/1995	04/21/1995	No
25.	Zyprexa	Brand	N/A	12/26/2006	12/26/2006	Yes

[a] These generic entry dates come from FDA brand drug approval data, not the IMS data.

and sporadically before 1999.[35,36] There are many limitations to using this variable as a measure of the drug's relative value to the firm. The ideal measure would capture the market's expectations at that time about what the drug's future relative value will be. Instead, I use an ex-post measure, which summarizes the value of the drug to the firm in the past. Furthermore, this measure does not include any intangible value from the drug, such as additional firm reputation effects, that may be captured in a market value but not an accounting value.

The variable *Exclusivity at Issue* was developed to explore the impact of the number of years of patent protection at issue in the cases. This variable was created by first recording the patents at issue in each case from the LexisNexis® Academic Power Search of State and Federal Court Cases. Next, I found when the FDA determined the exclusivity of each patent ended by searching two different publications of the FDA's Orange Book. The first publication, published by Microdex (2004), includes historic versions of the Orange Book and the second publication, the website Drugs@FDA includes the current Orange Book. I also doubled checked the FDA's website to see if the brand had been awarded a six month pediatric exclusivity at the time of the Announcement.[37] *Exclusivity at Issue* is calculated as the number of years between the Announcement and the date the patent expired where the first month was not included but the last month was. If there were more than one patent expiration date in the case, then the last patent expiration date was taken. Table 5 lists the patents at issue for each drug, the patent expiration dates, and the resulting *Exclusivity at Issue* for each drug.

Finally, the variable *State Space* was developed to explore the impact of deviations from the binomial state space assumption. This variable was constructed from the number of unique patent expiration dates in each case listed in Table 5. In order for the binomial state space assumption to apply to a case, there can only be one patent expiration date in that case. This can occur when there is only one patent at issue or when there are multiple patents with the same expiration date. With one patent expiration date, the two states are the brand firm either maintains exclusivity until the patent expiration date or it faces generic entry. Thus, one patent expiration date translates into two states. However, there are cases in my sample with more than one patent expiration date at issue. For example, with two patent expiration dates, the three states are that the brand firm either maintains exclusivity until the patent expiration date one, until patent expiration date two or it faces generic entry. Therefore, the *State Space* equals the number of unique patent expiration dates plus one. Based on the state price paradigm, I might expect cases with a *State Space* that violates the binomial state space assumption to have smaller abnormal returns. This variable was created to test whether violations in the binomial state space assumption affect the magnitude of the abnormal returns.

[35] The *Drug Topics* data is sourced from the Verispan/Scott-Levin Source Prescription Audit, which means it only captures sales through retail pharmacies. Please note that there are five drugs, Diprivan (Anesthesia), Paraplatin (Chemotherapy), Platinol (Chemotherapy), Taxol (Chemotherapy), and Ultane (Anesthesia), which are not dispensed through retail pharmacies. The sales data for these five drugs either came from newspaper reports or there was no sales data included in the study.

[36] If *Drug Topics* (1999–2006) sales data was not available, I used sales data from newspaper reports. Newspaper sources were unavailable for the four drugs, Acular, Mircette, Sarafem, and Ultane, so I approximated their sales with the sales of the 200th drug from *Drug Topics* (1999–2006) for the correct year. Three drugs had an alternative *Sales%* construction due to inconsistent Compustat data. For the two drugs owned by Biovail, Tiazac and Wellbutrin XL, I used *Drug Topics* (1999–2006) sales data divided by a newspaper report of company revenues. For the drug, Rebetol, owned by Ribapharm, I used a newspaper report which listed the sales of Ribavarian at 865 mil in US and 387 in Europe because Schering Plough licenses Ribavarian to market it as a dual therapy with Peg-Intron. So the *Sales%* in this case is 865/1252. The *Sales%* for ten decisions excluded from the event study could not be constructed due to three reasons; foreign stock listings and no news paper reports, an unknown license or joint venture agreement, and no newspaper sources could be found.

[37] For a list of the roughly 130 brand drugs that have been awarded the Pediatric Exclusivity since 1997, see http://www.fda.gov/cder/pediatric/labelchange.htm#New-listings.

Table 7
Number of Paragraph IV District Court decisions by year along with two measures of all brand drugs facing their first generic approval. The 72 decisions, listed in Tables 1 and 2, constitute the universe of all Paragraph IV District decisions found in this study. The 37 decisions, listed in Table 2, are used in the event study whose results are provided in Table 11. *Brand Wins* provides the number of decisions the brand wins by year for each respective sample. *Total First Generic Approvals (FGA)* provides a measure of all brand drugs that faced their first generic approval each year. This data comes from the FDA's Drugs@FDA database and resulted in 1706 active ingredients with an approved molecule since 1975. However, this variable should be understood as a lower bound because I exclude 1.3% of the active ingredients from consideration. See Section 5.1 for the data construction. The ratio *Normal/Potential ParaIV FGA* measures the relative rates at which the first generic approval for a brand drug occurred after the patents expired *(Normal)*, compared to the number of brand drugs that potentially faced a FGA before the patents expired due to a Paragraph IV decision *(Potential ParaIV)*.

Year	37 Decision sample		72 Decision sample		First generic approvals (FGA)	
	Decisions (#)	Brand wins	Decisions (#)	Brand wins	Total (#)	Normal/Potential ParaIV
1988	0	0	1	0	24	23
1989	0	0	0	0	19	–
1990	0	0	0	0	9	–
1991	0	0	2	1	6	1.0
1992	0	0	0	0	20	–
1993	2	2	2	2	19	9.5
1994	0	0	0	0	21	–
1995	0	0	0	0	22	–
1996	0	0	1	0	23	22.0
1997	0	0	0	0	25	–
1998	0	0	3	1	31	9.7
1999	1	1	2	1	24	11.5
2000	2	0	2	0	32	15.0
2001	2	0	7	2	30	3.6
2002	9	1	11	3	44	2.6
2003	5	2	7	3	48	6.3
2004	6	5	8	6	39	4.6
2005	3	2	9	3	25	2.1
2006	5	3	8	5	44	5.1
2007	2	1	9	7	26	2.7
Total	37	17	72	34	531	

4.3. Paragraph IV Appellate Court decisions

This study focuses on Paragraph IV District Court decisions because I argue that the uncertainty generated by patent infringement litigation was mostly resolved at the District Court level and not in the Appellate Court. The outcome of pharmaceutical patent infringement litigation is highly uncertain because patents are suppose to protect novel innovations, minimal legal requirements must be met to proceed to trial, and there may be minimal legal precedent directly applicable to the patents at issue or the exact way the generic potentially infringes. Paragraph IV cases begin in a District Court which means the District judge makes the first decision and sets the legal precedent. The litigation often proceeds to the Appellate Court, where it is heard by a three judge panel. The panel can either affirm or not affirm a decision. An affirmed decision is upheld with no modification. When a decision is not affirmed, then it is either remanded back to the District Court for partial or full reconsideration, or it is reversed outright. However, many Appellate decisions that are not affirmed still may not have any potential effect on the legal status of generic entry determined by the District Court. For example, some cases may be remanded for the District Court to consider changing a legal phrasing in their decision. Finally, the Supreme Court does not hear pharmaceutical patent infringement cases where the issue at trial is related to the technical merits of patent infringement or validity. The assumption that the uncertainty is mostly resolved at the District level is easily testable by studying the outcome of Appellate decisions along with the responses of the brand firm's stock returns. The results are provided in the next section and provide evidence in support of this assumption.[38]Table 6 lists the brand name drugs with an Appellate Court decision included in the study, along with the Appellate *Decision* date, the Appellate Announcement date, and whether the case was affirmed or not.

5. Results

5.1. Summary statistics for the two district court decision samples

This section provides some summary statistics for the entire 72 district court decision sample and the 37 decision sub-sample, upon which the event study is preformed. The entire sample provides some useful background information about the prevalence of drugs receiving Paragraph IV decisions. Table 7 indicates that Paragraph IV decisions are a relatively recent industry phenomena with nearly all of the decisions occurring after 1997. This timing is consistent with FTC (2002) and Berndt et al. (2007), who find that the number and proportion of ANDAs filed with a Paragraph IV certification dramatically increased after 1997. The date coincides with a pro-generic change in the FDA's interpretation of the 180 day exclusivity.[39] The FTC (2002) also finds that from 1992 through 2000, 30 NDA's were resolved in a court decision, while I find 11 decisions in the same time frame. There are four explanations for why this discrepancy exists. First, as described the previous section, there several NDA's may correspond to my definition of a single drug, the FTC (2002) study includes OTC drugs while I do not, some decisions correspond to two drugs according to my definition, and I only include cases where the issue at trial was patent infringement and/or validity.

The number of brand drugs which faced a Paragraph IV decision and potential generic entry before patent expiration are a non-trivial portion of all brand drugs facing their first generic approval.[40] To estimate the total number of brand drugs facing

[38] However, if any uncertainty is not resolved at the District Court level and resolved at the appellate level instead, then my district level results are understated.

[39] Please see Section 2.1 for a description of the 180 day exclusivity.

[40] A first generic approval can be understood as a proxy for generic entry.

their first generic approval, I used the Drugs@FDA database.[41] The variable, *Total First Generic Approvals (FGA)* in Table 7, provides the number of 'brand drugs', according to the definition in this paper (See Section 4), with their first generic approved in a given year. Due to the data construction, this variable only provides a lower bound.[42] There is a roughly increasing trend in the number of brand drugs with a first generic approved over time. However, the variable, *Total FGA*, includes brands whose first generic approved occurred both after the patents expired, and before the patents expired due to a Paragraph IV decision. I construct the ratio *Normal/Potential ParaIV FGA* to measure the number of brand drugs that had their first generic approved after the patents expired for every brand drug that faced a Paragraph IV decision and potentially pre-patent expiration generic approval.[43] This variable shows a considerable and sustained decrease starting in 2001 and dropping to a low of 2.1 in 2005. This result is consistent with the interpretation that Paragraph IV decisions are threatening generic entry before patent expiration for an increasing number of brand drugs compared to the number facing generic entry post patent expiration.

The brand firm won roughly half of the cases or 34 decisions in the entire sample and 17 cases in the 37 decision sample. While ex-ante, the market may have believed that the likelihood of the brand winning each individual case was different than 50%, ex-post, it appeared that a brand firm had just under a 50% chance of winning an average patent infringement case in both this sample and in the 72 case sample.[44] This is interesting because the thirty month stay provides an incentive for brand firms to file low quality or dubious patents. In other words, brand firms may file patents that are likely to lose in court to at the least, delay generic entry for the average 25 months it takes the courts to resolve the suit (FTC, 2002). However, if this were the case, one might expect to see brand firms losing a larger proportion of cases. In contrast, the FTC (2002) finds that out of the 30 NDA's resolved in a court decision, the brand won for eight NDAs. However, this difference in the percentage of cases won by each party may be due to my broader definition of a drug.

Paragraph IV decisions involve both a disproportionate number of high revenue drugs along with many small revenue drugs. Table 8 Panel A, which provides the drug's retail ranking the year before the decision, shows that 33.9% (42.9% in the 37 decision sample) were ranked in the top 25. On the other hand, 19.4% (14.4% in the 37 decision sample) had a ranking less than 200. Certainly, Paragraph IV decisions are the result of a series of decisions by both parties. I postulate that a generic's expected payoff of filing a Paragraph IV ANDA is higher when the patent is cheaper to invent around, the patent coverage is more likely to fail in court, and when the value of wining entry is high, such as for brand drugs with large revenues. I also postulate that the brand firm's expected payoff of facing a court decision increases in the probability that it will win and the payoff from preventing generic entry by going to trial. However, a brand firm may also be willing to go to court to establish a reputation for litigation in hopes of deterring future Paragraph IV filings. For the given reasons, it is not surprising that Paragraph IV decisions involve brand drugs with both relatively large and small retail sales. The 37 decision sample slightly over represents the top 25 ranked drugs and slightly under-represents the drugs with a ranking less than 200.

Table 8 Panel B provides the level of brand drug retail sales for both samples. The largest 25% earned more than $1468.38m ($1520.31m in the 37 decision sample), while smallest 25% earned less than $265.35m ($205.35m, respectively). In the 37 decision sample, the top five drugs starting with the largest is Lipitor, Prilosec, Prozac, Claritin, and Paxil, while the bottom five drugs starting with smallest are Naprelan, Mircette, Ultace, Acular, and Sarafem. Paragraph IV decisions could have additional implications for brand firms considering past evidence that pharmaceutical R&D is characterised by a highly skewed distribution of returns. Grabowski et al. (2002) study the returns of 118 NCEs introduced into the US market between 1990 and 1994 and find that only the top 30% covered average R&D costs.[45] Furthermore, the top decile accounts for roughly 52%.[46] DiMasi et al. (2003) also find the average cost of R&D up to the point of FDA marketing approval to be $802m in 2000 dollars or equivalently $970.83m in 2007 dollars.[47] Thus, roughly the top 40% of drugs in my sample (48% in the 37 decision sample) have one year of retail sales alone greater than this average cost of brand drug development.

The *Sales%*, which captures the drug's relative value to the firm, is provided in Table 8 Panel C. The distribution of the *Sales%* is skewed with a mean of 11.0% and a median of 2.8% (13.9% and 5.4%, respectively, for the 37 decision sample). Thus, while roughly 40% (48%) of the respective sample consists of drugs with just under 1 billion dollars in US sales, many of these drugs were still a relatively small fraction of the firm's total sales. The skew is partly the result of drugs like Oxycontin, Tiazac, and Rebetol, which are nearly their companies only source of sales revenue. Table 8 Panel C also indicates that the *Sales%* for cases won by brands versus generics within each sample had roughly similar means and medians.

The *Exclusivity at Issue* provided in Table 9 indicates that both the mean and median length of patent protection at issue was larger in cases won by the generic. In the 72 decision sample, the means were 5.0 versus 7.8 years for cases won by the brand versus generics respectively, while the means were 5.8 versus 8.2 years respectively for the 37 decision sample. These statistics imply one might anticipate larger abnormal returns for cases won by generic firms. There is also evidence that these sample averages are a non-trivial portion of the total length of patent protection. The Congressional Budget Office (1998) finds the average patent term remaining after FDA approval was 11.5 years, while Grabowski (2002) finds a range of 11.01–12.11 years for NCEs approved between 1991 and 1995.

Finally, Table 10 indicates that 86.1% of cases (81.1% in the 37 decision sample) satisfy the binomial state space assumption. In the 37 decision sample, the six drugs with three states were Celebrex, Lipitor, Prozac, Rebetol, Taxol, and Zofran. Augmentin has four states or three different patent expiration dates, however, its three

[41] The Drugs@FDA database includes a molecule's active ingredient, brand name, form, dosage, and approval date and can be found at http://www.fda.gov/cder/drugsatfda/datafiles/.

[42] I started with the 1706 active ingredients with an approved molecule since 1975. 258 of those active ingredients have no brand drug. This paper considered 1426 of the remaining active ingredients and ignored the 22 active ingredients (1.3%) which have more than 10 brands per active ingredient.

[43] The numerator, *Normal FGA*, indicates the number of FGA that occurred after the patent expired. It is constructed as *Total FGA* minus the number of generic wins (72 decisions) and is adjusted for the four decisions that include two drugs per decision. The denominator, *Potential ParaIV*, indicates the number of brand drugs which faced a Paragraph IV decision. It is constructed as *Decision* (72 decisions) adjusted for the four decisions that include two drugs per decision. *Normal/Potential ParaIV FGA* provides the number of brand drugs that have their first generic approved after the patents expire for every brand drug that faced a Paragraph IV decision. However, this variable should be understood as a lower bound due to my construction of the Drugs@FDA database.

[44] There also does not appear to be strong time trend in the number of cases won by the brand firm.

[45] An NCE or new chemical entity is a brand drug using an active ingredient for the first time. The drugs in my sample do include some NCEs.

[46] This is also remarkable considering, as discussed in the next section, I find an average of seven years of patent protection at issue for my 37 case sample.

[47] Based on the Bureau of Labor Statistics Annual Historical US Inflation Rates.

Table 8
(A) Lists the drug's retail ranking the year before the District decision. The data comes solely from the *Drug Topics* Magazine and so the table only includes drugs whose decision was between 1999 and 2007 for data consistency. If there was more than one drug per case, only the drug with the largest ranking was included. The 72 decisions are listed in Tables 1 and 2 and the 37 decisions are listed in Table 2. (B) Provides the drug's US retail sales the year before the District decision. The Bureau of Labor Statistics Annual Historical US Inflation Rates were used to adjust the sales data. See Section 4.2 and Table 4 for an explanation of why only 62 decisions from the 72 decision sample are included. (C) The *Sales%* is defined in Table 3 and used in the cross-sectional regression analysis provided in Table 13. See Section 4.2 and Table 4 for an explanation of why only 62 decisions.

	37 Decision sample		72 Decision sample	
Ranking	Frequency	Percentage (%)	Frequency	Percentage (%)
Panel A: Brand drug rankings by retail dollars				
1–25	15	42.9	21	33.9
26–50	4	11.4	7	11.3
51–75	4	11.4	6	9.7
76–100	2	5.7	7	11.3
101–125	1	2.9	3	4.8
126–150	2	5.7	2	3.2
151–175	2	5.7	4	6.5
176–200	0	0	0	0
<200	5	14.4	13	19.4
	35 Total decisions/brands		62 Total decisions/brands	
Distribution	37 Decision sample		72 Decision sample	
	Decisions (#)	US retail sales ($)	Decisions (#)	US retail sales ($)
Panel B: Distribution of brand drug retail sales in millions of 2007 dollars				
Min	1	34.16	1	34.16
~10%	4	134.95	6	117.46
~25%	9	205.35	16	265.35
~50%	19	969.56	31	425.47
~75%	28	1520.31	47	1468.38
~90%	34	2585.92	56	2132.89
Max	37	6361.65	62	6361.65

	37 Decision sample			72 Decision sample		
	Brand	Generic	All	Brand	Generic	All
Panel C: Summary statistics for Sales% by the decision winner						
Mean	14.0	13.8	13.9	10.2	11.7	11.0
St. dev.	16.5	24.1	20.7	13.8	23.7	19.4
Min	1.2	0.4	0.4	0.8	0.2	0.2
Max	63.5	87.8	87.8	63.5	87.8	87.8
25%	2.8	1.3	2.0	1.8	0.8	1.2
50%	9.2	4.1	5.4	3.7	1.8	2.8
75%	19.7	10.1	14.2	14.2	6.5	10.3
Obs.	17	20	37	30	32	62
Skew	1.8	2.2	2.2	2.4	2.4	2.7
Kurtosis	5.8	6.6	7.2	8.9	7.5	9.8

Table 9
Summary statistics for *Exclusivity at Issue* in number of years by the decision winner. *Exclusivity at Issue* is defined in Table 3 and used in the cross-sectional regression analysis provided in Table 13.

	37 Decision sample			72 Decision sample		
	Brand	Generic	All	Brand	Generic	All
Mean	5.7	8.2	7.0	5.0	7.8	6.5
St. dev.	4.1	5.3	4.9	3.5	4.8	4.5
Min	0.8	0.5	0.5	0.5	0.5	0.5
Max	15.3	16.4	16.4	15.3	17.0	17.0
25%	3.1	2.5	2.8	2.0	3.6	2.7
50%	4.9	8.3	5.9	4.9	6.8	5.8
75%	5.9	12.8	11.8	6.4	11.8	9.7
Obs.	17	20	37	34	38	72
Skew	1.0	-0.1	0.4	1.0	0.2	0.6
Kurtosis	3.1	1.5	1.8	3.7	1.9	2.3

Table 10
Summary statistics for the number of cases that satisfy the binomial state space assumption. The variable is defined in Table 3 and used in the cross-sectional regression analysis provided in Table 13.

	37 Decision sample		72 Decision sample	
	Decisions (#)	Percentage (%)	Decisions (#)	Percentage (%)
All cases	30	81.1	62	86.1
Brand wins	13	76.5	28	82.4

different patent expiration dates are one month, two months, and seven months after the Announcement. The seven cases that violate the binomial state space assumption have a mean *Sales%* of 25.9%, while the 30 cases that satisfy the assumption have a mean *Sales%* of 7.8%. Thus, in the 37 decision sample, the brand drugs with more unique patent expiration dates along with more patents were also more valuable to their firm.

5.2. The impact of Paragraph IV District decisions on the Brand's firm value

This section presents the results of the event study conducted on the 37 decision sample. Table 11 Panel A presents the abnormal returns across the three different event windows, according to the decision winner. Not surprisingly, there is a strong sign result according to which party won the case. The abnormal returns are positive (negative) when the brand wins (loses), with the intuitive explanation that maintaining (losing) exclusivity on brand drugs increases (destroys) firm value. Once again, this explanation is dependent on interpreting the abnormal returns within the binomial version of the state price paradigm. Furthermore, the abnormal returns across the three different event windows have the appropriate sign, given their respective trial outcomes.

The magnitude of the abnormal returns are economically meaningful and statistically significant. The standard two day return, or CAR, for the 17 cases won by the brand firm was 3.84% with a *t*-stat of 5.5, while the CAR for the 20 cases won by the generic firm was −5.20% with a *t*-stat of −5.9. The cumulative abnormal returns translate to \$1904.73m and −\$1086.36m, for brand versus generic wins respectively. However, Table 12 provides the individual dollar values associated with the CARs and indicates a considerable skew. The median CAR \$443.70m for cases won by the brand, and −\$387.78m for cases won by the generic, while the median retail sales for the 37 decision sample was \$969.56m (see Table 8 Panel B). In 10 cases, the brand firm either gained or lost an amount greater than \$970.83m, the average cost of R&D up to the point of marketing approval estimated by DiMasi et al. (2003). The three largest dollar values of CARs for cases won by the brand are \$13,870.62m (Lipitor), \$9377.01m (Prozac), and \$4600.87m (Risperdal), while the generic counterparts are −\$11,268.67m (Taxol), −\$3014.87m (Claritin), and −\$2261.39m (Ultane).

5.2.1. Sensitivity analysis on the abnormal returns

Due to the small sample size, I examine the robustness of the results in three different ways. First, I check for the existence and potential effect of outliers. Fig. 1 indicates that there are outliers for cases won by both the brand and the generic, and that the range of CARs is much larger for cases won by the generic. The two largest CARs are −24.7% (Wellbutrin XL) and −17.18% (Rebetol) for cases won by a generic and 15.29% (Lexapro) and 13.74% (Prilosec) for cases won by the brand. The CARs for cases won the brand have a positive skew of 32.8 while there is a negative skew of −34.1 for cases won by the generic. However, Table 11 Panel B provides four sensitivity tests of the estimates excluding outliers and finds that they remain both economically and statistically significant.

Next, I check the potential effects of CARs with the 'wrong' sign, i.e. negative if the brand won and positive if the generic won. CARs with the wrong sign provide strong evidence that these specific abnormal returns do not reflect the value relevance of the Paragraph IV decision. Fig. 1 indicates that some CAR's did have the wrong sign. There were three cases, pertaining to Accupril, Fosamax, and Altace, with negative CARs even though the brand won and three cases, pertaining to Monopril, Tricor, and Remeron, with positive CARs even though the generic won. One possible explanation for the sign of these six CARs is that the uncertainty about the outcome of the Paragraph IV decision was already resolved in the market before the announcement was made. However, another explanation addresses the potential effect of brand drugs with a small relative value to their respective firm. Table 11 Panel B Test #3 excludes the three cases with the 'wrong' sign for both cases won by the brand and the generic and finds that the magnitude of the estimates jumps by roughly 1% in both cases.

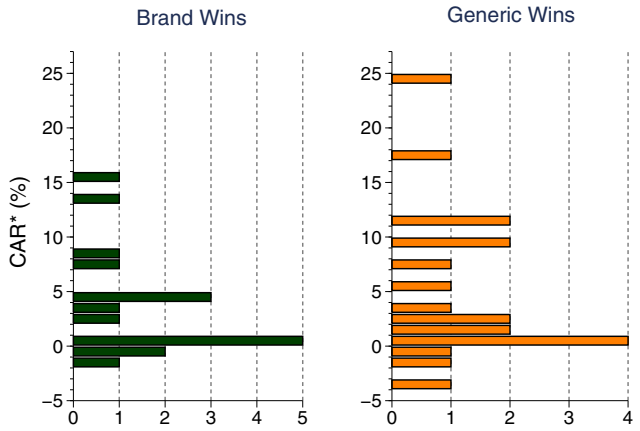

Fig. 1. The Dispersion of Cumulative Abnormal Returns (CARs) by decision winner. This table applies to the 37 decision sample listed in Table 2. The CAR is the two day announcement return. CAR* is equivalent to CAR, except to facilitate comparison, the sign has been switched if the generic wins.

Finally, I consider the implications of drugs with a relatively small *Sales%*. Typically, event studies are used to value an event that impacts the entire firm, such as mergers. However, in this paper, I study the impact of one product within a firm. On one hand, the short window methodology is ideal for isolating the effect of one drug in the US market when each pharmaceutical company consists of a portfolio of drugs sold in numerous countries. However, if the value of the individual drug is sufficiently small relative to some measure of the firm's value, it is possible that the effect of a Paragraph IV decision could be too small to show up in the abnormal return. To address this concern, the bottom two rows of Table 11 Panel C isolate those decisions where the brand name drug had between 0% and 1%, and between 1% and 2% of its company's sales.

The bottom two rows of Table 11 Panel C indicate that the sample includes four drugs with a *Sales%* was between 0% and 1% and that the generic won all four.[48] The sample also includes six drugs with a *Sales%* between 1% and 2% and that the generic won five of these cases.[49] The table indicates that the magnitudes of the abnormal returns for these decisions are small and not statistically significant. Furthermore, no individual abnormal return generated by a brand drug with a *Sales%* < 2% was significant at any conventional level. On the other hand, there were three decisions pertaining to a drug with a *Sales%* > 2% and the wrong sign.[50] To the extent that decisions involving a drug with a small *Sales%* or abnormal returns with the incorrect sign only contribute noise, the magnitude of my estimates are understated.

[48] These four cases pertained to the drugs Mircette, Sporanox, Ultane, and Vicoprofen.

[49] The two cases won by the brand pertained to Accupril and Zofran while the four cases won by the generic related to Monopril, Naprelan, Relafen, and Tricor.

[50] The drugs and their respective *Sales%* were Fosamax at 2.5%, Remeron at 2.7%, and Altace at 39.5%.

Table 11
(A) The results of the event study for the sample of 37 District decisions provided in Table 2. *AR* indicates the announcement day return, AR^+ indicates the announcement day return plus close-open return, and the CAR indicates the two day announcement return. All returns are expressed as percentages. (B) Test #1 excludes the largest magnitude CAR for both cases won by the brand and the generic. Text#2 is similar to Text#1 but excludes the largest two CARs. Test #3 excludes the three smallest magnitude CARs for cases won by the brand and the generic. Test #4 is a combination of Test #2 and Test #3. (C) *Sales%* is defined in Table 3.

Brand wins				Generic wins			
# Cases	*AR*(%)	AR^+(%)	CAR (%)	# Cases	*AR*(%)	AR^+(%)	CAR (%)
Panel A: Brand firm sample abnormal returns							
17	1.61	4.04	3.84	20	−4.31	−4.66	−5.20
	(3.0)	–	(5.5)		(−6.3)	–	(−5.9)

Tests	Brand wins				Generic wins			
	# Cases	*AR*(%)	AR^+(%)	CAR (%)	# Cases	*AR*(%)	AR^+(%)	CAR (%)
Panel B: Outlier tests for brand firm sample abnormal returns								
#1	16	0.71	3.36	3.13	19	−3.20	−3.69	−4.18
		(1.3)	–	(4.3)		(−4.6)	–	(−4.7)
#2	15	0.65	2.73	2.42	18	−2.29	−2.85	−3.46
		(1.2)	–	(3.4)		(−3.6)	–	(−4.3)
#3	14	2.04	4.96	4.82	17	−5.01	−5.37	−6.46
		(3.4)	–	(6.2)		(−6.4)	–	(−6.4)
#4	12	0.92	3.46	3.02	15	−2.67	−3.30	−4.53
		(1.5)	–	(4.0)		(−3.7)	–	(−4.9)

Sales%	Brand wins				Generic wins			
	# Cases	*AR*(%)	AR^+(%)	CAR (%)	# Cases	*AR*(%)	AR^+(%)	CAR (%)
Panel C: Brand firm sample abnormal returns stratified by Sales%								
> 2%	15	1.91	4.61	4.35	12	−7.05	−7.64	−8.26
		(3.2)	–	(5.6)		(−7.7)	–	(−6.9)
> 1%	17	1.60	4.04	3.84	16	−5.38	−5.75	−6.17
		(3.0)	–	(5.5)		(−6.6)	–	(−5.9)
[1%, 2%]	2	−0.63	−0.27	−0.01	4	−0.40	−0.05	0.12
		(−0.6)	–	(−0.0)		(−0.2)	–	(0.0)
[0%, 1%]	0	–	–	–	4	−0.03	−0.30	−1.35
		–	–	–		(−0.0)	–	(−0.9)

Table 12
The distribution of cumulative abnormal returns in millions of 2007 dollars. This table applies to the 37 decision sample listed in Table 2. The Bureau of Labor Statistics Annual Historical US Inflation Rates were used to adjust the dollar values.

Brand wins			Generic wins		
Number	Distribution (%)	Value ($)	Number	Distribution (%)	Value ($)
1	5.9	−2213.55	1	5.0	3305.99
4	5.11	38.39	4	20.0	−0.30
9	52.9	443.70	10	50.0	−387.78
13	76.5	2246.82	15	75.0	−891.33
16	94.1	9377.01	18	90.0	−2261.39
17	100	13,870.62	20	100.0	−11,268.67

5.3. Explaining the magnitude of the impact on brand firms

In this section, I explore how the four variables, *Generic*, *Sales%*, *Exclusivity at Issue*, *State Space* (see Section 4.2 for their definitions) affect the magnitude of the impact of Paragraph IV decisions on brand firms. I use the standard two-day abnormal return, CAR, to represent the impact on the brand firm's value. In order to simultaneously compare the CARs pertaining to cases won by the brand and the generic, I create the variable CAR* by switching the sign of the CAR for cases won by the generic. Table 13 presents the results of various OLS regressions of CAR* on the four variables.

I do not find evidence that the average CAR* won by a brand is statistically different than the average CAR* won by a generic. One potential explanation for a statistical difference to exist could come from different average state prices if the market believed that systematically either the brand or the generic was more likely to win. However, in the univariate analysis, the *Generic* variable is not statistically significant at any conventional level. This result is robust to excluding the drugs with the top two *Sales%*, the top five *Sales%*, the six cases with the 'wrong' sign, and the four drugs whose drug level sales data was approximated by the sales of the 200th drug in *Drug Topics* (1999–2006). This result also holds after controlling for *Sales%*, *Exclusivity at Issue*, and *Sales%* × *Exclusivity at Issue*. In an unreported regression, I also included a generic indicator for *Sales%* × *Exclusivity at Issue* and found an insignificant result.

Next, I examine how the *Sales%* and *Exclusivity at Issue* influence how Paragraph IV decisions affect brand firms. Fig. 2 illustrates that the five brand drugs with the largest *Sales%* could exert undue influence on regression estimates of this variable.[51] Also based on Fig. 2, I would not anticipate finding a strong linear relationship between the CAR* and *Exclusivity at Issue*. However, Fig. 2 does provide evidence supporting a linear relationship between CAR*

[51] The five brand drugs are Wellbutrin XL at 37.9%, Altace at 39.5%, Lexapro at 63.5%, Rebetol at 69.1%, and Tiazac at 87.7%.

Table 13
Cross-sectional regression estimates from regressing the brand firm's CAR* on selected independent variables for 37 Paragraph IV District Court decisions. CAR* is equivalent to a cumulative abnormal return with a two day event window except that the sign has been switched if the generic wins. See Table 3 for variable definitions and Table 2 for a list of the 37 decisions. The White (1980) heteroskedasticity-consistent *t*-statistics are reported in parenthesis.

Dependent variable	Independent variables	Model 1	Model 2	Model 3	Model 4	Model 5
Panel A: Univariate cross-sectional regressions						
*CAR**	*Generic*	1.3627 (0.70)				
	Sales%		0.1975 (3.99)***			
	Exclusivity at Issue			0.2547 (1.19)		
	Sales% × Exclusivity at Issue				0.0150 (3.07)***	
	State Space					4.1035 (1.71)*
	Constant	3.8409 (3.21)***	1.8303 (2.59)***	2.7919 (1.86)*	2.8835 (3.81)***	3.8012 (3.43)***
N		37	37	37	37	37
R^2		0.01	0.44	0.04	0.37	0.07
F-statistic		0.47	15.95	1.32	9.44	2.94
Panel B: Multivariate cross-sectional regressions						
*CAR**	*Generic*		1.3169 (0.99)			
	Sales%	0.2152 (2.50)**	0.2182 (2.54)**	0.1978 (2.23)**		0.1716 (2.04)**
	Exclusivity at Issue	0.1555 (1.04)	0.1236 (0.71)	0.1342 (0.74)	−0.0592 (−0.34)	
	Sales% × Exclusivity at Issue	−0.0026 (−0.32)	−0.0024 (−0.28)	−0.0005 (−0.06)	0.0155 (2.98)***	0.0025 (0.30)
	State Space	3.4815 (1.92)*				
	Constant	0.1364 (0.14)	0.2338 (0.18)	0.9417 (0.70)	3.2458 (2.42)**	1.9115 (2.85)***
N		37	37	37	37	37
R^2		0.50	0.46	0.46	0.37	0.45
F-statistic		13.07	4.29	5.46	4.54	7.62
Panel C: Univariate and multivariate cross-sectional regressions without outliers Rebetol and Tiazac						
*CAR**	*Generic*		1.7203 (1.57)			
	Sales%	0.0220 (0.28)	0.0379 (0.49)	0.0140 (0.17)	0.2723 (3.05)***	
	Exclusivity at Issue	−0.1649 (−1.28)	−0.1973 (−1.22)	−0.1788 (−1.06)		
	Sales% × Exclusivity at Issue	0.0552 (6.07)***	0.0535 (5.29)***	0.0551 (5.69)***		0.0539 (11.89)***
	State Space	3.7043 (2.11)**				
	Constant	1.0375 (1.07)	0.9379 (0.83)	1.8489 (1.40)	1.2296 (1.72)*	0.8758 (1.32)
N		35	35	35	35	35
R^2		0.73	0.70	0.68	0.42	0.65
F-statistic		77.64	66.95	75.69	9.28	141.37

*** Denotes significance at the 1% level.
** Denotes significance at the 5% level.
* Denotes significance at the 10% level.

Table 14
Total Number of Appellate decisions for the 37 and 72 District decision samples. The implications of these results are discussed in Section 5.4. The 72 decisions are listed in Tables 1 and 2 and the 37 decisions are listed in Table 2.

	37 District decisions		72 District decisions	
	Appellate decisions (#)	District brand wins (#)	Appellate decisions (#)	District brand wins (#)
Affirmed	12	6	26	11
Not Affirmed	19	9	27	14
Total	31	15	53	25

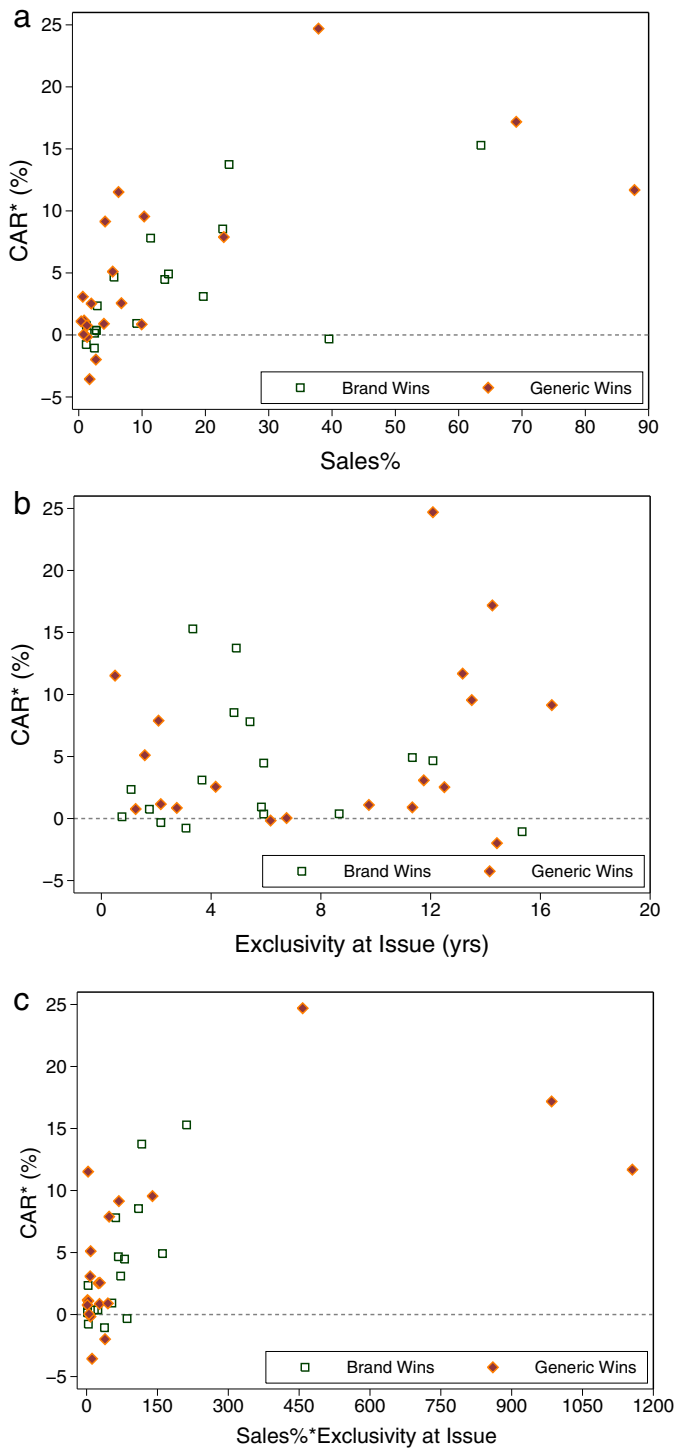

Fig. 2. Relationships between CAR* and *Sales%*, *Exclusivity at Issue*, and *Sales%* × *Exclusivity at Issue*. These scatterplots support the cross-sectional regression analysis provided in Table 13. CAR* is equivalent to CAR except that the sign has been switched if the generic wins. The variables are defined in Table 3 and they apply to the 37 decision sample provided in Table 2.

and the interaction term *Sales%* × *Exclusivity at Issue*. The two outliers, with a value greater than 100, are Rebetol and Tiazac. Rebetol, owned by Ribapharm, and Tiazac, owned by Biovial, have the two largest *Sales%* in this sample, the two smallest company sales, and they are the only two drugs to constitute virtually the entire sales of their company.[52] The univariate analysis provided in Table 13 Panel A confirms the intuition from the figure. *Sales%* and *Sales%* × *Exclusivity at Issue* are significant at the 1% level. I find that increasing the *Sales%* by 1% increases the CAR* by 0.1975%, while for a drug with an average *Sales%* of 13.9%, increasing the *Exclusivity at Issue* by one year increases CAR* by 0.2085%. *Exclusivity at Issue* is not significant at any conventional level. These results are robust to excluding the five drugs with the largest *Sales%*, excluding the six drugs that have CARs with the 'wrong' sign, and excluding the four drugs whose drug level sales data was approximated by the sales of the 200th drug in *Drug Topics* (1999–2006).[53] Table 13 Panel B does not provide strong evidence that combinations of these three variables provides more explanatory power.

Table 13 Panel C explores the impact of excluding Rebetol and Tiazac from the sample and provides results that differ from Panels A and B. The striking difference is that, for the univariate results, the magnitude of the *Sales%* increases to 0.2723 and the *Sales%* × *Exclusivity at Issue* has a magnitude of 0.0539 and a *t*-statistic of 11.9. For a drug with an average *Sales%* of 13.1%, increasing the *Exclusivity at Issue* by one year increases CAR* by 0.7492%. This result is robust to excluding the six decisions that have CARs with the 'wrong' sign and excluding the four drugs whose drug level sales data was approximated by the sales of the 200th drug in *Drug Topics* (1999–2006). Overall, I argue that Table 13 provides evidence that Paragraph IV decisions have a larger impact on brand firms, in absolute value, when the drug has a larger relative value to its firm and/or there are more years of exclusivity (patent protection) at issue in the case.[54]

Finally, I look at the impact the state space has on CAR*. Based on the state price paradigm, I might expect the seven cases with a *State Space* that violate the binomial state space assumption to have smaller magnitude CAR*s. However, throughout Table 13, the *State Space* is positive and statistically significant at the 10% level, even after controlling for *Sales%*, *Exclusivity at Issue*, and *Sales%* × *Exclusivity at Issue*. However, these results are not robust to excluding the six decisions with the 'wrong' sign or the four drugs whose drug level sales data was approximated by the sales of the 200th drug in *Drug Topics* (1999–2006). It is possible the *State Space* is positively correlated with some other variable measuring the drug's relative value, possibly along some other dimension not captured by the *Sales%*. In this case, the positive correlation could be indicating that firms protect more valuable drugs with more patents. However, there is no evidence that violations to the binomial state space assumption are associated with smaller magnitude CAR*s.

5.4. The impact of Appellate decisions on the brand firms value

The main purpose of this section is to argue that the uncertainty generated by Paragraph IV patent infringement litigation was mostly resolved in the District Court and not in the Appellate Court. However, first I discuss the number of related Appellate

[52] Ribapharm was spun off of ICN pharmaceuticals in early 2002 and had its IPO on April 12, 2002. Ribapharm was formed to manage the sale of drug products based on the active ingredient Ribavarian and had 2002 sales of $1252m. Biovail was founded 1982. By 1999, it had a promising pipline but Tiazac was its only drug on the market. Biovail's 1999 sales were $176.5m.

[53] A CAR is the 'wrong' sign if it is negative and the brand won or it is positive and the generic won.

[54] I considered weighting the abnormal returns by *Sales%* × *Exclusivity at Issue* to calculate a market value of exclusivity but again there is no way to determine the state prices for the individual cases and using average abnormal returns may produce skewed results.

Court decisions, along with whether or not they were affirmed, for both the 72 and the 37 District decision samples. Table 14 indicates that only 53 of the 72 decision sample (31 of the 37 decision sample) have an Appellate decision on record. While 26 of the 53 Appellate decisions resulted in an affirmation, only 12 of the 31 cases resulted in an affirmation. However, these statistics can be misleading because many Appellate cases that are not affirmed still leave the possibility of generic entry unchanged. Table 14 also examines the number of District cases the brand won for each category to determine whether these cases are more likely than cases won by a generic to result in an Appellate decision or an affirmed Appellate decision. Out of the total 53 Appellate cases, 25 were originally won by the brand in District Court and this number drops to 15 out of the 31 Appellate cases. Also, in both samples, the brand won roughly half of those District cases that both resulted in an Appellate decision and were affirmed.[55]

To test the assumption that uncertainty resulting from Paragraph IV litigation was not resolved in the Appellate Court, I ran an individual event study for each Appellate decision. Out of the 31 drugs that had an Appellate decision, 4 drugs did not satisfy the minimal requirements for an event study.[56] Out of the 26 remaining Appellate cases, 22 cases have small magnitude CARs, which are not statistically significant at any conventional levels.[57] In a study of litigated patents from all industries, Marco (2005) also found that share market responses to infringement decisions were larger at the District Court rather than the Appellate level. However, the remaining four drugs, Prozac, Altace, Fosamax, and Lexapro, with respective CARs and *t*-statistics of −29.76% (−5.6), −14.92% (−5.7), −10.18% (−3.1), and 9.13% (4.2) are dramatic exceptions. For these four drugs, the brand firm won the District case and the CAR is negative if the case was not affirmed and positive if it was affirmed. However, there are many other Appellate decisions that have these two characteristics and did not create large abnormal returns. Thus, from the 37 District case sample, 33 cases either had no Appellate decision or an Appellate decision with a small statistically insignificant abnormal return. This provides evidence consistent with the proposition that the market mostly resolved the uncertainty due to Paragraph IV litigation in the District Court.

6. Conclusion

This paper examined the outcome of Paragraph IV patent infringement litigation, which provides a mechanism for generic firms to enter the market before patent protection (exclusivity) ends. Specifically, I sought to understand how Paragraph IV decisions affect brand drug pharmaceutical firms. First, I constructed a novel dataset of 72 Paragraph IV decisions and found that Paragraph IV decisions included a non-trivial portion of all brand drugs that face generic entry, a disproportionate number of high revenue drugs, and cases where the period of exclusivity at issue was a large portion of the average length of patent protection. Next, I used a natural experiment created by the announcement of Paragraph IV decisions to credibly estimate the value impact of a 37 decision subsample on brand drug firms. I found that Paragraph IV decisions have considerable value consequences for brand pharmaceutical firms. The evidence from this paper suggests that the increase in Paragraph IV decisions, largely starting in the late 1990s, may have strong implications for R&D incentives and that brand firms may have a considerable incentive to avoid the uncertainty and large potential profitability loses associated with these decisions.

As this paper only examined one possible outcome of the Paragraph IV statute, from the perspective of one party, it raises many unanswered questions. I found that out of m232 brand drugs for which a Paragraph IV ANDA was first filed before December 31, 2004, only 76 brand drugs faced at least one Paragraph IV decision. Clearly the set of brand drugs facing a Paragraph IV decision is the result of a series of strategic decisions made by both brand and generic firms. This raises questions about what the possible brand and generic strategies are for determining an outcome within the Paragraph IV statute. For example, why didn't the brand company initiate litigation for 29 out of the 104 drugs studied by the FTC (2002), given the 30 month stay?

Other interesting questions arise about possible brand and generic strategies in response to the uncertain patent length due to Paragraph IV District Court decisions. Unlike every other industry, and regardless of the intention of the designers of the Hatch–Waxman Act, a practical reality for the pharmaceutical industry was that patent length was more certain before 1998 than it was in the period afterward. An uncertain patent length has the benefits of possible early generic entry but brand and generic reactions raise the potential for negative welfare consequences. There is a literature (e.g., Schmalensee, 1982; Bhattacharya and Vogt, 2003) which finds that brand firms follow a dynamic pricing strategy of pricing low at the product launch and raising the price over time. For these brand firms, does an uncertain patent length lead to higher introductory prices at launch and/or higher subsequent price increases? On the other hand, early entry for generic firms is costlier because the generic must invent around the patent and riskier because the generic may lose the legal case. Does early generic entry raise generic drug prices?

Finally, it would be interesting to explore what pharmaceutical industry outcomes would look like if conflicting patent claims were resolved according to the regulations applied to every other industry. This counter factual experiment would address the economic implications of regulating generic entry before patent expiration without the central Paragraph IV statutes of the pro-brand thirty month stay and the pro-generic 180 day exclusivity.

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[55] Table 6 provides a list of those drugs in the 37 decision sample that have Appellate decisions, whether or not the District decision was affirmed, and the Appellate decision date.

[56] Duragesic, Naprelan, Sarafem, and Ultane did not have announcement dates and Celebrex had an Appellate decision in 2008, beyond the range of this study.

[57] These magnitude of these CARs also appeared independent of the brand drug's *Sales%*.

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