Mergers with Future Rivals Can Boost Prices, Intensify Market Concentration, and Bar Entry

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June 2021

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Abstract

In 2010, the Federal Trade Commission (FTC) stated that mergers between incumbents and future rivals may be anticompetitive. Lacking evidence, however, this statement was never used in litigation. This study empirically examines the statement. In 2012, an incumbent pharmaceutical firm acquired a promising future rival that was expected to enter competition within two years. First, I find strong evidence that, immediately after the merger, the incumbent boosted its existing drug prices. Second, the merger indirectly boosted the incumbent's quantity of sales: higher drug prices increased the marginal returns on advertisement, and realizing that, the incumbent amplified its advertisement expenditures after the merger, and achieved a higher quantity of sales and market share. It explains how mergers with future rivals can increase market concentration by influencing advertisement. Third, mergers with future rivals can create strong entry barriers: by identifying and acquiring promising future rivals, incumbents can maintain their market dominance and postpone competition indefinitely. While mergers with future rivals are endemic to the pharmaceutical industry, I introduce a variation of it that explains the motive for major software industry mergers such as Facebook's acquisition of Instagram and WhatsApp and Google's takeover of Android and YouTube. Last, I propose an alternative merger analysis framework that suits mergers with future rivals.

Keywords: pharmaceutical, healthcare market, merger, future rival, fringe firm

1 INTRODUCTION

In 2010, the latest version of the FTC Horizontal Merger Guidelines stated that mergers[1] between incumbents and future rivals can be anticompetitive. To date, there is no evidence for the statement. So, neither the FTC nor the Department of Justice has used it in litigation. Using a pharmaceutical merger case and high-frequency claims data, I confirm the statement and show that mergers with future rivals can create an entry barrier that perpetuates the dominance of the incumbents.

I study Gilead's 2012 acquisition of Pharmasset. Gilead was a major incumbent in three therapeutic classes (more in section 2.2). Pharmasset was not in the market, but it had promising drugs pending Food and Drug Administration (FDA) approval. I examine the merger's effect on the Average Wholesale Price (AWP), retail price, out-of-pocket payment (OOP), the number of pills sold, and the number of prescriptions filled.

I use Truven Health MarketScan Research Databases (MarketScan data) provided by Truven Health Analytics®, part of the IBM Watson Health™ business[2] in a Difference-in-Difference (DD) specification. I find that the merger has increased Gilead's AWP by $4.15 per pill, leading to a $6.06 increase in the retail price and a $0.19 increase in the OOP. Post-merger, Gilead sold 20.68% more pills via 20.08% more prescriptions.

This paper provides the following contributions to the literature of merger studies. First and foremost, it points to a loophole in pharmaceutical antitrust enforcement. Antitrust authorities tolerate high levels of market concentration and markups in the short run, based on the premise that entry is free, and if there are

[1] I refer to mergers and acquisitions interchangeably.

[2] MarketScan is a registered trademark of Truven Health Analytics, part of the IBM Watson Health business.

excess profits, new firms will eventually enter and dilute the market concentration. The studied case demonstrates that mergers with future rivals can act as an entry barriers and deter competition, even when high profits incentivize entry. If incumbents use this mechanism consistently, they can sustain high levels of market concentration in the long run.

A variation of this finding applies to industries in which the future trajectory of fringe firms is predictable. In the software industry, for example, incumbents actively monitor and acquire promising fringe firms usually without facing litigation because they take place when the fringe firms are too small to attract regulatory attention. For four decades, software and technology firms have been consistently using this strategy to perpetuate their market dominance (Cabral, 2018).

Second, I show that the studied merger's effects spilled over in two dimensions: the merger boosted Gilead drug prices outside the market in which the merger took place, and it enabled higher prices for Gilead's close rivals. So, the FTC may underestimate merger effects by limiting the attention to the merging firms and the directly affected market.

Third, I portray the flow of the effect in the drug supply chain: the merger boosted the wholesale prices, pharmacies quickly reflected it in the retail prices, and insurers proportionately passed the extra cost on to patients. This quick and large pass-through of effects is important because it may cause underutilization which can persist for years (Rabbani, 2021).

I use actual pharmaceutical transaction data. It is more accurate and reliable than widely used alternatives such as charge prices or imputed prices (Capps, Carlton, & David, 2020; Duggan, 2000; Gaynor & Vogt, 2003). This study complements the literature by studying privately insured patients. These patients are under-represented in healthcare studies because public insurance data are more accessible in the form of Medicare, Medicaid, the British National Health Service, and similar administrative data sets.

This paper proceed as follows. Section 2.1 discusses pharmaceutical mergers, antitrust enforcement, and the scholarly work on the subject. Despite the importance of the subject, empirical studies of pharmaceutical mergers are surprisingly rare. Section 2.2 reviews the studied merger and its impact on drug markets. Section 2.3 explores the two data sources, namely, Truven MarketScan and the census data. Section 2.4 specifies the model. Section 3 introduces the baseline results as well as the results individually reported for each market, drug, and plan type. It also presents several robustness checks and diagnoses. Section 4 puts the findings in the perspective of the literature, offers an antitrust remedy to eliminate the entry barrier, examines the causality of the relationship, and generalizes the findings to the software industry. Section 5 concludes.

2 METHODS

2.1 Pharmaceutical Mergers and the Outcomes

The pharmaceutical is largely driven by financial incentives. When the incentives are in line with those of the public, the industry can create substantial value and save countless lives. The COVID-19 pandemic is a recent example in which drug manufacturers developed safe and effective vaccines in less than a year and facilitated the re-openings. This achievement was spurred by a pharmaceutical arms race to discover the first, and later the most effective, COVID-19 vaccine to gain a larger share of a market that has exceeded

$66 billion in sales. The two leading firms, Pfizer and Moderna, combined for 91% of the global revenues (Williams, 2021).

On the contrary, a conflict of interests between drug manufacturers and patients may lead to sub-optimal results. Vyera Pharmaceuticals' 2015 acquisition is an extreme example. Vyera acquired Daraprim – a life-saving infection drug for HIV/AIDS (HIV), cancer, and organ recipients – and raised the price from $17.5 per tablet to $750, overnight. Further, Vyera prevented generic entry by blocking access to samples that could show bioequivalence and prevented distributors from selling data to third parties. The FTC challenged the merger. In the court, the Vyera CEO metaphorically defended the decision stating that "*there [was] a company that was selling Aston Martins at the price of a bicycle, we bought [it] and charged Toyota prices*" (CBS, 2017; FTC, 2020b). Although the court voted 5-0 in favor of the FTC, the price settled at $375 (FTC, 2020b). It is one of the many recent mergers that have led to skyrocketing drug prices (Forbes, 2017). Markets are getting more concentrated, and drug prices keep rising by several times the inflation rate (Picchi, 2019; Williams, 2017).

Firms use mergers to weaken competition. In response, the Hart-Scott-Rodino Act of 1976 (HSR) imposed a due diligence process for mergers that exceed $84 million, and it can lead to litigation. Wollmann (2019) shows a bunching of mergers just below the $84 million HSR threshold, indicating that incumbents actively monitor rivals and initiate acquisitions just below the threshold. There were over 15,000 mergers in the United States (US) in 2017, out of which 2,052 underwent HSR review, 51 were investigated, and 21 received enforcement action. Most of the enforcements resolved without litigation (Shapiro, 2019).

When an incumbent pharmaceutical acquires a rival that has drugs in development, the drugs are likely to be discarded post-merger, particularly if they overlap the incumbent's portfolio. Cunningham, Ederer, and Ma (2021) called it "killer acquisitions" and showed that it is more likely to occur just below the HSR threshold.

Merger analysis usually has a quantitative component based on the Herfindahl-Hirschman Index (HHI): a merger is flagged as highly concerning if it adds more than 200 units to the HHI and the post-merger HHI exceeds 2,500. Non-flagged mergers usually safely proceed. Even flagged mergers have a chance to proceed without litigation because antitrust is underfunded and congested (Shapiro, 2019). To use its limited resources efficiently, the FTC picks cases that are more concerning and less costly to litigate.

The FTC has never litigated mergers with future rivals. But it has litigated three mergers between incumbent pharmaceuticals that were partially motivated by deterring future competition. The first instance is Bristol-Myers Squibb's (BMS) takeover of Celgene in 2019 for $74 billion (FTC, 2019). Celgene owned Otezla – the most popular oral treatment for psoriasis in the US – and BMS was developing a rival treatment. Once litigated, BMS agreed to divest Otezla by selling it to Amgen for $13.4 billion. Lupin-Gavis (FTC, 2016a) and Mylan-Meda (FTC, 2016b) mergers are similar examples. The former reduced the number of generic manufacturers from 4 to 2 in the market for generic doxycycline monohydrate capsules and prevented the entry of a generic mesalamine extended release. The latter prevented entry to the market for treating muscle spasm, stiffness, and refractory epilepsy.

The above mergers share several features: they eliminated future competition, the FTC did not leverage it as evidence of harm, the FTC won the cases in marginal 3-2 votes, and the cases were settled by partial divestitures, i.e., the mergers proceeded conditional on divesting certain assets to another large incumbent.

These indecisive victories hint at a lack of compelling evidence. When strong evidence is present, the FTC often decisively wins and rescinds mergers (FTC, 2020b; Rabbani, 2021).

2.2 The Studied Merger

Headquartered in Foster City, California, Gilead was a major provider in three markets[3], namely, antiviral, cardiac, and vasodilating drugs. Antiviral drugs include treatments for HIV, Hepatitis B (HBV), Hepatitis C (HCV), influenza, herpes, genital wart, smallpox, and COVID-19 (Wikipedia, 2021a). Cardiac drugs target conditions and anomalies such as coronary artery disease, angina pain, hypertension, chronic heart failure, and diabetic nephropathy. Vasodilating drugs widen blood vessels to facilitate blood flow. Appendix tables A-1 through A-4 detail Gilead drugs in each market alongside the rivals. For each drug, the tables report the monthly sales in dollars and units sold, the retail price per pill and month of use, the OOP per pill and month of use, and the unique number of patients. The tables compare the values before and after the merger. The post-merger period covers the last 349 days of 2012. So, the terms "pre" and "post" refer to the last 349 days of 2011 and 2012, respectively. Monthly values are normalized to 30 days.

Five drugs established Gilead as the dominant antiviral provider: Atripla, Truvada, and Emtriva for HIV, Hepsera for HBV, and Viread for both. Ranexa (cardiac) treats angina pain in coronary artery disease, and Letairis (vasodilating) treats pulmonary arterial hypertension. All Gilead drugs were patented in the study period. Also, all the reported Gilead and rival drugs were actively marketed throughout the study period.

Table 1 reports the market shares for Gilead and the rivals in terms of revenues, pills sold, and unique patients served (see tables A-5 through A-7 for details). Before the merger, Gilead sold 42.7% of antiviral drug in revenue terms, followed by Pfizer (9.1%) and BMS (8.8%). In the vasodilating market, Gilead and Actelion formed a near duopoly by controlling 34.6% and 56.89% of the market, respectively. Novartis (46.6%) and Daiichi (23.9%) dominated the cardiac market in which Gilead (2.2%) was a relatively small player. Using the merger, Gilead boosted its dominance, adding 4.49%, 1.02%, and 6.06% to its antiviral, cardiac, and vasodilating market shares, respectively.

The acquired firm, Pharmasset, was a clinical-stage pharmaceutical firm in New Jersey. Founded in 1998, Pharmasset was preparing to enter the antiviral market in 2013, with three promising drugs in phase II clinical trials, namely, Sovaldi, Racivir, and Levovir. Sovaldi was a major improvement in the oral treatment of chronic HCV (Speights, 2020; Wikipedia, 2021b, 2021c). At the time, no reliable HCV treatment was available, and each year, HCV afflicted 300 million people and took 10,000 lives (Krauskopf, 2011; Kuber, 2011). Targeting this untapped and lucrative market, Sovaldi was poised to generate tens of billions of dollars annually.

Before the merger, Pharmasset speculated a price of $36,000 for an episode of treatment. But Sovaldi entered the market in December 2013 for $84,000[4] (Staton, 2014). The FDA approval process was controversial and underwent senate scrutiny because the FDA revised the regulations to accommodate approving Sovaldi, and 18 of the 27 committee members who approved the revision were directly or indirectly hired by Gilead (Staton, 2014).

[3] I interchangeably use therapeutic class, drug market, and market.

[4] It sells for less outside the US. For example, it currently sells for $53,000 in the United Kingdom, $45,000 in Canada, $300 in Japan, and $5,900 in South Korea. In Japan and South Korea, insurers cover 99% and 70% of the cost, respectively. Many American patients travel to India to obtain Sovaldi at $500 (Wikipedia, 2021c).

Racivir for HIV and Levovir for HBV were in phase II clinical trials. They improved treatment efficacy and had no reported side effects (NCI, 2021). But Gilead ceased the clinical trials of both drugs for undisclosed reasons. It was likely a killer acquisition: Racivir and Levovir were discarded because they overlapped Gilead's lucrative HBV and HIV portfolio.

Gilead acquired Pharmasset on January 12, 2012, for $11.2 billion (Gilead, 2012). It is one of the largest mergers in the history of the industry (Krauskopf, 2011). It was considered risky because the transaction was 37% of Gilead's total assets. But it has paid off: Sovaldi has generated $60 billion since 2013, and it is expected to continue generating $4 billion annually (Speights, 2020).

Table 1: market share and concentration details.

Market share and HHI	By revenues		By pills sold		By unique patients	
	Pre	Post	Pre	Post	Pre	Post
Antiviral drugs						
HHI	**2,134**	**2,503**	**941**	**865**	**1,215**	**1,143**
Gilead	42.71%	47.20%	9.13%	9.55%	4.26%	4.28%
Brand rivals	37.81%	37.11%	23.32%	20.78%	7.64%	6.50%
Generic rivals	19.49%	15.68%	67.54%	69.67%	88.10%	89.22%
Cardiac drugs						
HHI	**2,909**	**3,419**	**2,932**	**3,369**	**2,895**	**3,529**
Gilead	2.22%	3.24%	1.72%	2.62%	1.10%	1.59%
Brand rivals	97.09%	95.93%	97.54%	96.30%	98.29%	97.56%
Generic rivals	0.69%	0.83%	0.74%	1.08%	0.62%	0.85%
Vasodilating drugs						
HHI	**4,449**	**4,348**	**2,373**	**1,923**	**3,535**	**3,574**
Gilead	34.65%	40.71%	0.89%	1.15%	0.44%	0.53%
Brand rivals	61.81%	55.89%	37.73%	38.82%	60.35%	60.69%
Generic rivals	3.54%	3.40%	61.38%	60.03%	39.21%	38.78%

Most of the media coverage of the merger exclusively focused on Sovaldi, while two strategic considerations were overlooked. First, Racivir and Levovir were strong future entrants that could undercut the prices of Gilead's existing HBV and HIV drugs. So, the merger eliminated the threat of entry and extended Gilead's HBV and HIV dominance. Second, Gilead had no HCV drugs at the time. But four of its rivals (Roche, BMS, Johnson & Johnson, and Merck) were developing HCV drugs (Krauskopf, 2011). So, the merger was a strategic move to fortify Gilead's presence in the antiviral market.

This merger is an excellent case to study. None of the Pharmasset drugs entered the market in the study period, and the merger had no impact on the markets except deterring entry. Thus, the only viable channel between the merger and drug markets is the elimination of the threat of entry. It gives credit to the study as it minimizes the impact of confounding factors. Second, the FTC guidelines state that mergers with future rivals are most concerning when the incumbent is dominant and the future rival is promising (FTC, 2010). This merger clearly satisfies these conditions.

2.3 Data

I use Truven MarketScan® data provided by Truven Health™ (Watson, 2012). It is a panel of insurance claims that spans 2011-2012 and represents the privately insured Americans. When an insurance enrollee fills a prescription, one row is added to the data set. For prescriptions that fill multiple drugs, each drug is recorded separately. The data set contains actual transaction details of patient and insurer payments as well as drug and patient characteristics such as drug name, manufacturer name, therapeutic class, quantity sold, whether the drug is generic or patented, the number of days of medication supplied, date of sale, the type of insurance used, drug purpose (chronic or acute), patient age, and whether the prescription is filled for the enrollee or a dependent. Most patients use drugs chronically and appear in the data set every month or

quarter. So, the data is temporally rich and enables a high-precision study of the timing of the effects on the prices and utilization.

To control socioeconomic characteristics, I use the US Census Bureau's American Community Survey 1-Year Estimates (census data) at the Metropolitan Statistical Area (MSA)-level (Bureau., 2014). Like Rabbani (2021), I use the 2010-2013 annual data to interpolate the monthly values for 2011 and 2012. Table 2 reports the summary statistics for the dependent variables (top), individual-level explanatory variables (middle), and MSA-level explanatory variables (bottom). The dependent variables include the natural logarithms of AWP per pill, retail price per pill, OOP per pill, daily pills sold, and daily prescriptions filled. The AWP measures retail pharmacy payments to drug manufacturers (upstream price). The retail price[5] is what insurers and patients pay to fill a prescription. The OOP is the patient cost-sharing and a primary channel of effect between the merger and drug utilization.

Note that the AWP is greater than the actual wholesale price and it is updated infrequently. Drug manufacturers inflate the AWP to have a convenient starting point to negotiate the wholesale prices. The AWP varies over time, geographies, insurance plan types, and drug packaging and specifications. Assuming that the AWP and actual wholesale prices are highly correlated, the AWP captures the upstream merger effects. As Figure 2 will show, the AWP has irregularities and should be interpreted with skepticism.

Table 2: the summary statistics.

Variable	Obs	Mean	SD	Min	Median	Max
Dependent variables (MarketScan data)						
AWP per pill ($)	549,735	26.04	31.65	0	12.69	241.29
Price per pill ($)	549,735	20.73	27.11	0	5.21	398.19
OOP per pill ($)	549,735	0.93	2.16	0	0.42	120
Daily units sold (1,000s)	10,922	2.8	3.07	0.03	1.83	15.75
Daily prescriptions filled	10,922	50.49	63.96	1	22	304
Explanatory variables (MarketScan data)						
Patient age	549,735	49.71	11.03	0	52	64
Plan type:						
Comprehensive	549,735	0.04	0.19	0	0	1
EPO	549,735	0.01	0.09	0	0	1
HMO	549,735	0.17	0.38	0	0	1
POS	549,735	0.12	0.32	0	0	1
PPO	549,735	0.58	0.49	0	1	1
POS with capitation	549,735	0	0.05	0	0	1
CDHP	549,735	0.06	0.23	0	0	1
HDHP	549,735	0.02	0.15	0	0	1
Relation to enrollee:						
self	549,735	0.70	0.46	0	1	1
spouse	549,735	0.26	0.44	0	0	1
child/other	549,735	0.03	0.17	0	0	1
Drug use:						
chronic	549,735	0.54	0.5	0	1	1
chronic and acute	549,735	0.46	0.5	0	0	1
Explanatory variables (Census data)						
Population (million)	549,735	2.82	2.94	0.06	1.85	11.65
Female (%)	549,735	51.07	0.71	43.28	51.18	53
Below poverty line (%)	549,735	10.59	3.02	3.69	10.61	51.5
Employed (%)	549,735	59.55	4.09	30.31	59.95	72.58
Unemployed (%)	549,735	6.07	1.14	2.08	5.93	10.65
Families with children below age 6 (%)	549,735	0.08	0.01	0.04	0.08	0.13
Median travel time to work (minutes)	549,735	26.34	4.18	14.58	25.83	37.03
Median family income ($1,000)	549,735	57.58	11.24	14.3	56.78	95
Median retirement income ($1,000)	549,735	23.72	3.43	10.41	23.58	40.21
Families on SNAP program (%)	549,735	10.52	3.73	2.61	10.29	45.03
Median income per capita ($1,000)	549,735	29.42	5.33	7.68	28.8	48.92
Median worker income ($1,000):						

[5] I interchangeably use the terms retail price, price, and downstream price.

Variable	Obs	Mean	SD	Min	Median	Max
male	549,735	50.87	7.7	18.39	50.07	76.53
female	549,735	40.02	6.11	19.16	39.27	58.31

On average, patients paid 3.5% of the price and insurers paid the rest. In an average MSA-day, each drug brand sold 2,800 pills by filling 50.49 prescriptions. Most prescriptions filled 30 (48.7%), 90 (20.5%), or 60 (10.4%) pills. 58% of the sample were on a Preferred Provider Organizations (PPO) plan. Given the relative generosity of PPOs, the observed individuals are more insulated from the costs than the overall US population.

The model uses all the explanatory variables in Table 2 as well as the following variables that are not reported for brevity: 390 MSA binaries, measures for education (percent below high school, finished high school, with some college education, with college degree or higher, separately controlled by gender), race and ethnicity (percent white, black, Asian, Native American/Alaskan, Native Hawaiian/Pacific Islander, other race, 2 or more races, Hispanic/Latino), occupation (percent employed in management, service, sales, natural resources, production), industry (percent working in agriculture, construction, manufacturing, wholesale, retail, transportation, information, finance, waste management, education, art, and other), work class (public, private, government, self-employed, unpaid), marital status (percent married, widowed, divorced, separated, and never married), age group (percent between 0-4, 5-9, 10-14, 15-19, 20-24, 25-34, 35-44, 45-54, 55-64, 65-74, 75-84, and over 85 years old), and income (mean family income and percent with annual incomes between 0-10, 10-15, 15-25, 25-35, 35-50, 50-75, 75-100, 100-150, 150-200, and 200+ thousand US dollars).

2.4 Implementation

I employ a Difference-in-Difference specification. The literature has substantially used and understood it, it is a reliable and intuitive model (Goodman-Bacon, 2021), and it has been the dominant identification strategy for merger studies (Gaynor, Ho, & Town, 2015). To find the merger effects, DD compares the treated versus the control group before versus after the merger. The treated group comprises all Gilead drugs. It includes antiviral (Atripla, Truvada, Viread, Hepsera, Emtriva), cardiac (Ranexa), and vasodilating (Letairis) drugs. The control group includes generic antiviral, cardiac, and vasodilating drugs that were actively marketed throughout 2011-2012 (see Tables A-1 through A-4 for details). The treated and control group are carefully chosen for the reasons discussed below.

Merger studies usually limit the attention to the directly affected market (FTC, 2010) which is the antiviral market in this case. Unlike that, I retained all Gilead drugs because the effect has likely spilled over to cardiac and vasodilating markets. It is because the drug markets are interconnected in two ways. Gilead, Pfizer, and Sandoz were present in the three markets, and BMS, Merck, Novartis, Mylan, Westward, and Greenstone were present in two. So, the firms are facing a multi-market competition, and Gilead may leverage the merger to redefine competition across markets.

The provider-insurer negotiations create the second channel for the spillover. When Gilead negotiates the drug prices with insurance companies, the rates for all Gilead drugs are discussed simultaneously. If the merger has added to Gilead's bargaining leverage, it may affect Gilead drug prices in all markets. The impact of bargaining leverage on healthcare prices is well-documented (Baker, Bundorf, & Kessler, 2020; Chorniy, Miller, & Tang, 2020; Lin, McCarthy, & Richards, 2021). While I do not disentangle the channels for the spillover effect, sections 3.2 and 3.5 confirm that it exists.

Figure 1 demonstrates an event study of the effect on the three markets combined. It aggregates all Gilead drugs (A), branded drugs (B), and generic drugs (C). Each dot is a monthly average. The vertical dashed lines indicate the merger date. A linear dashed line is fitted in the pre-merger period to highlight the post-merger discontinuity. The figure suggests that Gilead drug prices markedly increased post-merger, and it was partially mirrored by the branded rivals. Section 3.5 will motivate and empirically demonstrate that the branded rivals were partially treated by the merger and do not belong to the control group. The model is specified as follows:

$$LHS_{it} = Z_i\alpha_1 + X_{it}\alpha_2 + \beta_1 post_t + \beta_2 post_t Gilead_{it} + \gamma_0 date_t + \gamma_1 Gilead_{it} date_t + \gamma_2 Gilead_{it} date_t^2 + \varepsilon_{it}$$

Z_i is the vector of individual, drug, and MSA fixed effects including patient gender, race, and ethnicity, a binary for each drug, MSA binaries, and binaries to distinguish the main enrollee from dependents. X_{it} is the vector of time-variant controls including a binary for drug purpose (chronic or acute), patient age and its quadratic, and the socioeconomic characteristics discussed in section 2.3. $post_t$ is a binary equal to 1 after the merger, $Gilead_{it}$ is a binary equal to one for Gilead drugs, $date_t$ is an integer for the date of service, and ε_{it} is the error term with a standard normal distribution. LHS_{it} represents the dependent variables (see Table 2) in the logarithmic form.

Gilead drug prices were gradually rising beyond the rivals throughout the study period. To disentangle this trend from the merger effects, I include the interaction of $Gilead_{it}$ with $date_t$ and $date_t^2$. β_1 measures the average post-merger change in the dependent variables, and β_2 is the DD coefficient of interest.

The validity of the DD results hinges on the parallel trends assumption to hold, i.e., the assumption that, conditional on the explanatory variables, the treated and control group are in parallel paths. Figure 2 reports the quantitative test results for the parallel trends assumption. The test is implemented by including, in the DD model, the interactions of $\text{Gilead}_{\text{it}}$ with monthly binaries. I test the null hypothesis that the parallel trends assumption holds in each pre-merger month. April 2011 is the omitted month. In Figure 2, the center dots report the mean values, and the shaded areas provide a 95% confidence interval. Except for the AWP which shows irregularities, the trends confirm the parallel trends assumption.

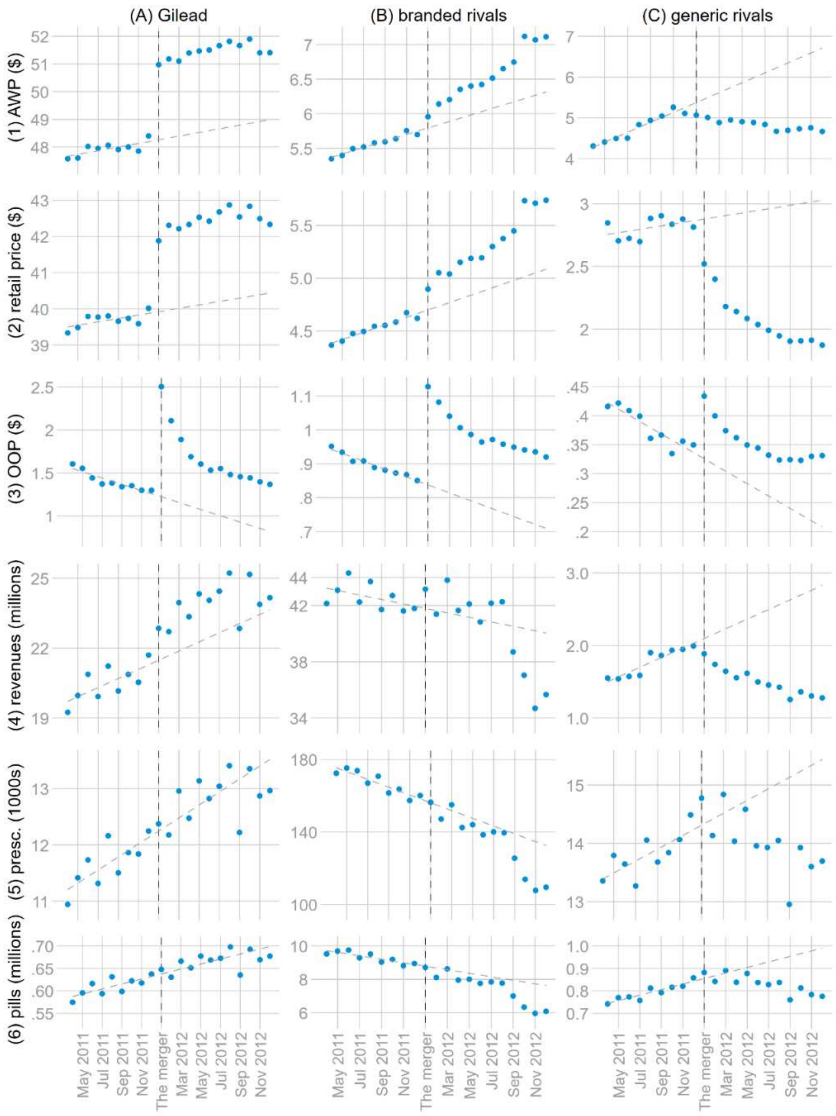

Figure 1: the event study. For Gilead, branded, and generic rivals, the figure demonstrates the trends of the AWP, price, OOP, revenues, number of prescriptions, and quantity of sales.

Figure 2 shows that the effects on pills and prescriptions appeared in June 2012. Later I introduce evidence that Gilead likely increased its marketing expenditures after the merger, and this five-month delay may reflect the time until the marketing attempts pay off. Treatment leads and lags (Appendix A-8) confirm this five-month delay. So, in the baseline specification for pills and prescriptions, I use June 2012 as the treatment time.

Before acquiring Pharmasset, Gilead acquired CGI Pharmaceuticals in June 2010 for $120 million, and Arresto Biosciences in December 2010 for $225 million. To limit the influence of these mergers, I use April-December 2011 as the pre-merger period. The post-merger period spans January-December 2012.

I dropped from the analysis a family of rival drugs named Acyclovir which treats certain types of genital herpes infection. It has no overlaps with Gilead drugs, it makes up 28.5% of all observations, and it is

extremely competitive with 17 manufacturers and 23 brands. The exclusion of Acyclovir helps limit the study to a more relevant market. Nevertheless, Table 9 includes Acyclovir as a robustness check.

The studied drug markets are of high policy relevance. Antiviral and cardiac drugs are among the top therapeutic classes globally in terms of pharmaceutical innovations and sales because heart disease and HIV are among the top five causes of disease burden and mortality (Barrenho, Miraldo, & Smith, 2019).

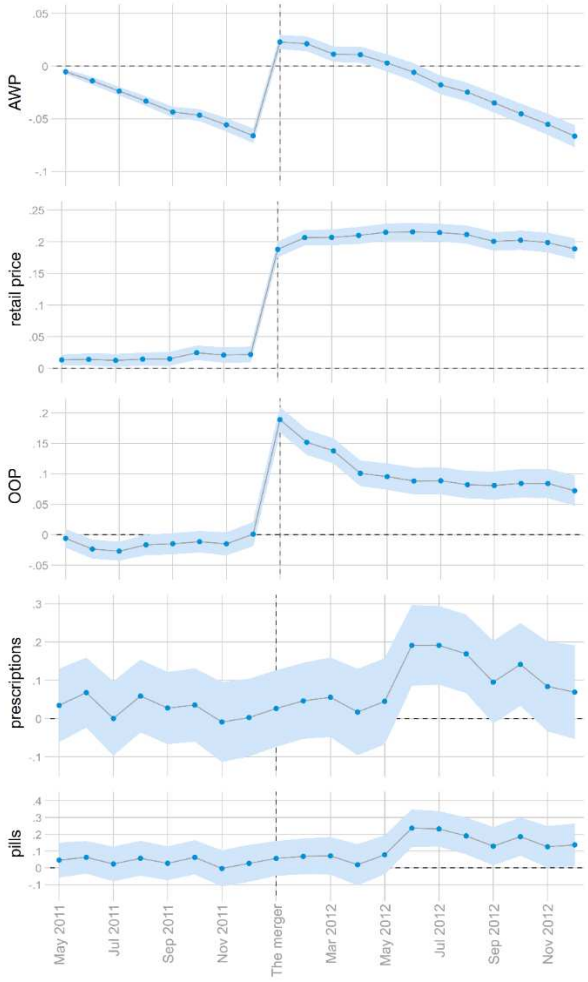

Figure 2: the parallel trend test results. Mean values (the center dots) are reported inside 95% confidence intervals for the interaction term of the binary for the treated group and the monthly binary coefficients.

3 Results

This section introduces the results and covers multiple analyses, robustness checks, and inspections. Subsection 3.1 presents the baseline results using the specification described in section 2.4. Subsection 3.2 repeats the analysis within therapeutic classes. It allows for disentangling the effect of the merger on the directly affected market (antiviral drugs) and indirectly affected markets.

A critical question that the baseline model does not answer is whether the findings are caused by heavy price increases for a few drugs, or the merger has evenly affected all Gilead drugs. If the effect is limited to a few Gilead drugs, it hints at the presence of latent drug-specific shocks. But if the effect appears evenly

for all Gilead drugs, it indicates that there has been a firm-level effect and it reinforces the causality of the findings (the causality). To answer this question, subsection 3.3 runs the analysis for each Gilead drug.

Subsection 3.4 repeats the analysis within insurance plan types to further assess the causality. To explain, mergers affect prices by increasing provider market power, and Health Maintenance Organizations (HMOs) resist provider market power more than other insurers (Harrington & Sayre, 2010). If the post-merger price increase for HMOs is smaller than other insurers, it corroborates that market power has been the channel of effect, further reinforcing the causality. Subsection 3.5 substitutes the branded rivals for Gilead drugs in the treatment to test the spillover effect on the branded rivals. Subsection 3.6 tests the robustness of the findings to various modifications.

Table 3: the baseline DD estimates. The standard errors are reported and clustered at the family level. The number of observations and adjusted R-squared are also reported. *** p < 0.01, ** p < 0.05, * p < 0.1.

	AWP	Price	OOP	Pills	Prescriptions
	(1)	(2)	(3)	(4)	(5)
β_2	0.104***	0.180***	0.168***	0.188***	0.183***
	(0.00382)	(0.00567)	(0.00938)	(0.0495)	(0.0462)
β_1	-0.0482***	-0.120***	0.0305***	-0.129***	-0.134***
	(0.00381)	(0.00499)	(0.00737)	(0.0321)	(0.0303)
γ_1	-0.00730***	0.00943***	0.0100***	0.0347*	0.0363*
	(0.00103)	(0.00191)	(0.00294)	(0.0151)	(0.0147)
γ_2	-0.0000192	-0.000167***	-0.000292***	-0.000734*	-0.000804**
	(0.0000181)	(0.0000339)	(0.0000527)	(0.000314)	(0.000305)
Chronic user	0.351***	0.617***	0.537***	0.125	0.166
	(0.0185)	(0.0290)	(0.0383)	(0.0945)	(0.0967)
age	-0.000383***	-0.00105***	-0.00688***	0.00673***	0.00587***
	(0.000108)	(0.000169)	(0.000349)	(0.00123)	(0.00112)
Black	-0.0598	-0.0214	0.00424	-0.0000490	-0.000251
	(0.0376)	(0.0542)	(0.0815)	(0.00113)	(0.00103)
Hispanic/Latino	0.0472**	0.00527	0.0353	-0.00129	-0.00149
	(0.0168)	(0.0252)	(0.0359)	(0.00105)	(0.000975)
Below the 100% poverty line	-0.0356*	-0.0277	0.0578	-0.0000425	-0.000620
	(0.0163)	(0.0234)	(0.0341)	(0.00613)	(0.00547)
Unemployed	-0.0241	-0.0619**	-0.0269	-0.00815	-0.00288
	(0.0155)	(0.0230)	(0.0307)	(0.00789)	(0.00742)
Dependent: spouse	0.00212	-0.00676	-0.0188**	0.0257	0.0147
	(0.00261)	(0.00396)	(0.00691)	(0.0181)	(0.0173)
Dependent: child/other	-0.000615	-0.0105	-0.0680***	0.249***	0.225***
	(0.00556)	(0.00989)	(0.0190)	(0.0609)	(0.0551)
N	551395	549735	511230	10922	10922
Adj-R^2	0.967	0.947	0.617	0.836	0.856

3.1 Baseline results

Table 3 reports the baseline estimates. β_2 measures the merger's effect on the AWP, price, OOP, units sold, and prescriptions filled, respectively reported in columns 1-5. Converting the coefficients to the implied percentage changes, the table indicates that after the merger the AWP increased by 10.96%, raising the price by 19.72%, and leading to an 18.29% higher OOP (columns 1-3). In dollar terms, the AWP, price, and OOP per pill increased by $4.15, $6.06, and $0.19, respectively. It amounts to $77.84 higher OOP and $2,404.85 higher insurer payments per patient to utilize Gilead drugs for a year. The results strongly confirm the FTC statement that mergers with future rivals can largely boost prices and harm consumers.

A limitation of the MarketScan data is that it does not account for rebates, i.e., payments made by drug manufacturers to insurers. It creates a partial disconnect between the observed prices and the actual net

prices (prices minus rebates) which may distort the findings[6] (Arcidiacono, Ellickson, Landry, & Ridley, 2013). The direction of the potential bias, if any, is unknown as it depends on the post-merger change in the ratio of rebates to prices.

The law of demand predicts that patients would buy fewer units of Gilead drugs after facing higher prices. But the opposite has been observed: Gilead has sold 20.68% more units via 20.08% more prescriptions (Columns 4-5). Marketing expenditures provide a possible explanation for this quantity increase: after boosting prices, Gilead's marginal profitability of advertisement has increased, and realizing this, Gilead has spent more on advertisement, reached out to more patients, and sold more units. NASDAQ reports Gilead's marketing expenditures under "selling, general, and administrative" expenses. This financial item grew substantially over the study period: $1.04 billion in 2010, $1.24 billion in 2011, and $1.46 billion in 2012 (SEC, 2021). It provides suggestive evidence for the role of advertisement on Gilead's post-merger sales. If the merger has justified the increase in advertisement expenditures, the increase in the quantity of sales is an indirect result of the merger.

3.2 The effect by therapeutic class

Table 4 reports the DD effects for each therapeutic class. For brevity, it only reports β_2. Columns 1-3 report the largest price increases in the antiviral market, corroborating the causality. To a smaller extent, however, the prices significantly increased in the cardiac and vasodilating markets, suggesting that the merger's effect has spilled over to the other markets where Gilead has been present. When the spillover effect is present, limiting the analysis to the directly affected market – the relevant market – would underestimate the effects. This type of spillover effect is likely to occur when the merging firms are present in multiple markets or when the prices in multiple markets are decided simultaneously. Under these conditions, mergers are likely more lucrative and harmful than previously assumed.

Table 4: β_2 estimated in each therapeutic class.

	AWP	Price	OOP	Pills	Prescriptions
	(1)	(2)	(3)	(4)	(5)
			Antiviral drugs		
β_2	0.0675***	0.249***	0.133***	0.238***	0.238***
	(0.00588)	(0.00905)	(0.0136)	(0.0658)	(0.0611)
N	353665	352562	329349	7240	7240
Adj-R^2	0.946	0.899	0.560	0.817	0.854
			Cardiac drugs		
β_2	0.0607***	0.119***	0.0964***	-0.00338	0.0165
	(0.00492)	(0.0117)	(0.0266)	(0.0783)	(0.0716)
N	50324	50175	46386	1282	1282
Adj-R^2	0.324	0.296	0.398	0.602	0.348
			Vasodilating drugs		
β_2	0.148***	0.117***	0.163*	0.222	0.198
	(0.00663)	(0.00912)	(0.0655)	(0.141)	(0.140)
N	147406	146998	135495	2400	2400
Adj-R^2	0.854	0.817	0.356	0.893	0.877

According to columns 4-5, the quantity increase is large and significant only in the antiviral market. It is consistent with the notion that advertisement is usually drug or market specific, and profit-maximizing firms advertise profitable brands more than others. Before the merger, Gilead's annual sales were $18.90, $0.55, and $1.06 billion in the antiviral, cardiac, and vasodilating market, respectively (Tables A-1 through

[6] Instead of monopolization, incumbents may use rebates and other exploitative conduct to maximize profits. For example, Calzolari and Denicolò (2021) show that it may be more beneficial for the dominant firm to keep marginalized rivals and exploit their strengths rather than forcing them to quit.

A-4). Likely, the merger has created the largest business opportunities in the antiviral market, and Gilead has invested more to advertise in this market, leading to the largest sales boost in it.

3.3 The effect on each Gilead drug

This subsection studies the merger effect on each Gilead drug to further investigate the causality. If there are large price increases for a few drugs and small increases for others, then the baseline results may be driven by latent drug-specific shocks such as an input price shock, an input shortage, or a demand surge. In contrast, if the price increase evenly applies to all Gilead drugs, then the baseline results are likely driven by a firm-level decision, and it corroborates the causality.

Table 5: β_2 individually estimated for Gilead drugs.

	AWP	Price	OOP	Pills	Prescriptions
Drug name	(1)	(2)	(3)	(4)	(5)
Emtriva	0.0650***	0.123***	0.257***	0.212	0.155
	(0.00567)	(0.0267)	(0.0769)	(0.156)	(0.124)
Atripla	0.106***	0.180***	0.163***	0.163	0.151
	(0.00381)	(0.00633)	(0.0123)	(0.0861)	(0.0851)
Letairis	0.102***	0.177***	0.133*	0.261	0.270*
	(0.00478)	(0.00728)	(0.0637)	(0.138)	(0.137)
Hepsera	0.0572***	0.121***	0.153**	0.269*	0.253*
	(0.00469)	(0.0292)	(0.0480)	(0.120)	(0.109)
Ranexa	0.106***	0.185***	0.147***	0.104	0.132*
	(0.00624)	(0.00955)	(0.0173)	(0.0717)	(0.0672)
Truvada	0.120***	0.192***	0.185***	0.169*	0.171*
	(0.00382)	(0.00738)	(0.0132)	(0.0839)	(0.0832)
Viread	0.0586***	0.140***	0.205***	0.160*	0.170*
	(0.00391)	(0.0109)	(0.0188)	(0.0800)	(0.0796)

To implement it, I run DD seven times, and in each run, I limit the treated group to one of the seven Gilead drugs. I retain the baseline control group. Table *5* reports the results. Columns 1-3 report economically large and statistically significant effects for every drug. The effect is so even across drugs that each drug individually sustains the baseline results. Such a uniform increase indicates a firm-level decision and reinforces the causality. The results in columns 4-5 are economically large and more than half of them are statistically significant. The small number of day-level observations explains the loss of statistical power in these columns.

3.4 The effect by insurance plan type

This subsection runs DD within insurance plan types to further test the causality. The sample consists of patients on PPO (58%), HMO 17%, Point of Service (POS) (12%), Consumer-Driven Health Plan (CDHP) and High-Deductible Health Plan (HDHP) (8% combined). Insurers vary in terms of market power and generosity, and it provides two sources to examine the causality. First, mergers affect prices by adding to the market power of the providers. If the merger has caused the price increase, the price increase must negatively correlate to insurer market power. Particularly, HMOs are known for their high bargaining power against providers and should better resist post-merger price increases (Harrington & Sayre, 2010).

Second, plan generosity and patient cost exposure can largely affect the utilization of healthcare (Anderson, 2021; Rabideau, Eisenberg, Reid, & Sood, 2021). Patients on generous plans are better insulated from the costs and may find it easier to continue using Gilead drugs after the merger. PPOs are the most generous insurers, and their enrollees likely have the most freedom to utilize medicine. In contrast, CDHPs and HDHPs highly expose the enrollees to the full extent of the cost increase, and their enrollees likely resist a post-merger quantity increase more than enrollees on other insurance types.

Table 6: the DD estimates by insurance plan type.

	AWP	Price	OOP	Pills	Prescriptions
	(1)	(2)	(3)	(4)	(5)
			PPO		
β_2	0.103***	0.209***	0.192***	0.161**	0.161***
	(0.00495)	(0.00785)	(0.0120)	(0.0490)	(0.0455)
N	321826	321215	305552	10408	10408
Adj-R^2	0.966	0.942	0.625	0.830	0.854
			HMO		
β_2	0.0906***	0.0748***	0.169***	0.148**	0.109*
	(0.00993)	(0.0131)	(0.0194)	(0.0559)	(0.0484)
N	94195	94020	89685	9149	9149
Adj-R^2	0.973	0.958	0.672	0.736	0.805
			POS		
β_2	0.128***	0.220***	0.0396	0.120	0.112*
	(0.0120)	(0.0155)	(0.0241)	(0.0612)	(0.0524)
N	63967	63564	60067	8303	8303
Adj-R^2	0.967	0.955	0.668	0.683	0.764
			CDHP and HDHP		
β_2	0.0621***	0.141***	0.111	0.0293	0.0526
	(0.0133)	(0.0215)	(0.0588)	(0.0626)	(0.0533)
N	43649	43157	29345	7411	7411
Adj-R^2	0.971	0.952	0.671	0.614	0.718

Table 6 reports the results by plan types. HMOs resisted the post-merger price increase the most, PPO patients increase their utilization the most, and CDHP/HDHP enrollees were the only group that did not increase their utilization after the merger. These findings are in line with the idea that the merger has caused the price increase, and utilization has responded to the price increase.

3.5 Merger benefits to the branded rivals

This subsection measures the merger effects on Gilead's branded rivals. Branded drugs in the same therapeutic class constrain the prices of one another, but generic prices do not constrain branded drug prices (Ornaghi, Siotis, & Castanheira, 2019). It is due to a direct rivalry among branded providers that is not imposed by generics. As Gaynor et al. (2015, p. 261) state:

> *"Hospital mergers will almost surely affect the price of close rivals. A hospital merger that leads to increased bargaining power will also spill over and increase the prices of competing hospitals that are not party to the merger."*

The above statement may be generalizable to pharmaceuticals. In line with Ornaghi et al. (2019) and Gaynor et al. (2015), this subsection confirms that the studied merger has boosted the prices for Gilead's branded rivals. To implement the test, I built a DD model that uses the baseline control group and substitutes the branded rivals for Gilead drugs in the treatment.

Table 7 reports the results by therapeutic class. Post-merger and in the antiviral market, the branded rival charged 23.5% higher prices and sold 16.8% more pills. These numbers are large and significant, but smaller than those of Gilead in Table 8 (28.3% and 26.9%, respectively).

Table 7: the DD effects on the branded rivals.

	AWP	Price	OOP	Pills	Prescriptions
	(1)	(2)	(3)	(4)	(5)
			Antiviral drugs		
β_2	0.0309***	0.211***	0.128***	0.155**	0.176***
	(0.00592)	(0.00919)	(0.0140)	(0.0555)	(0.0521)
N	453216	451531	404910	16921	16921
Adj-R^2	0.903	0.831	0.492	0.717	0.773
			Cardiac drugs		

	AWP	Price	OOP	Pills	Prescriptions
	(1)	(2)	(3)	(4)	(5)
β_2	0.104***	0.191***	0.171***	-0.0368	-0.0561
	(0.00283)	(0.00796)	(0.0193)	(0.0577)	(0.0549)
N	2707090	2699564	2583856	7041	7041
Adj-R^2	0.333	0.172	0.161	0.901	0.917
			Vasodilating drugs		
β_2	0.0548***	0.0432***	0.0207	0.0340	-0.0109
	(0.00643)	(0.00786)	(0.0136)	(0.0782)	(0.0729)
N	256405	255530	237943	4300	4300
Adj-R^2	0.894	0.831	0.380	0.877	0.858

In the vasodilating market, the branded rivals reciprocated Gilead's 12.4% price increase by a 4.4% increase. But there is no quantity increase for the branded rivals while Gilead sold 24.9% more pills. In the cardiac market, Gilead and the branded rivals increased the prices by 12.6% and 21.1%, respectively, and neither group has sold more pills. The results confirm that the branded rivals benefited from the merger, but to a lesser extent than Gilead. It established a new dimension for the spillover effect.

3.6 Robustness checks

This subsection tests the sensitivity of the results to the specification choice. It includes the addition of firm and therapeutic class time trends, alternative levels of clustering, dropping rivals that had mergers in the study period, the inclusion of Acyclovir, the use of similar calendar months in the pre-merger and post-merger periods, and the use of subsets of the rivals. Since all the following tests confirm the baseline findings, I avoid detailed discussions for brevity.

Table 8: the inclusion of manufacturer-specific and product-specific time trends, and clustering at the manufacturer and product level. The sample sizes are identical to the baseline results.

β_2	AWP	Price	OOP	Pills	Prescriptions
	(1)	(2)	(3)	(4)	(5)
Add manufacturer time trends	0.0974***	0.179***	0.170***	0.193***	0.191***
	(0.00381)	(0.00562)	(0.00943)	(0.0494)	(0.0461)
Add therapeutic class time trends	0.104***	0.180***	0.168***	0.187***	0.183***
	(0.00382)	(0.00566)	(0.00938)	(0.0494)	(0.0461)
Cluster at the drug level	0.104	0.180**	0.168***	0.188*	0.183*
	(0.0588)	(0.0565)	(0.0238)	(0.0862)	(0.0865)
Cluster at the manufacturer level	0.104	0.180***	0.168***	0.188*	0.183*
	(0.0511)	(0.0321)	(0.0176)	(0.0751)	(0.0776)

Table 9: β_2 estimated after the exclusion of rivals that had reported mergers in the study period (A), after the inclusion of Acyclovir (B), and using identical pre- and post-merger durations (C).

	AWP	Price	OOP	Pills	Prescriptions
	(1)	(2)	(3)	(4)	(5)
			Panel A: drop rivals that had mergers during April 2011-December 2012		
β_2	0.137***	0.181***	0.166***	0.172***	0.176***
	(0.00425)	(0.00604)	(0.0100)	(0.0518)	(0.0483)
N	490738	489263	455466	8851	8851
Adj-R^2	0.969	0.951	0.595	0.858	0.866
			Panel B: include Acyclovir		
β_2	0.0408***	0.0482***	0.0958***	0.178***	0.175***
	(0.00162)	(0.00369)	(0.00679)	(0.0480)	(0.0448)
N	2312746	2305210	2193220	11563	11563
Adj-R^2	0.813	0.760	0.346	0.885	0.905
			Panel C: limit the post-merger months to April-December 2012		
β_2	0.0952***	0.145***	0.146***	0.150**	0.150**
	(0.00565)	(0.00790)	(0.0120)	(0.0535)	(0.0500)
N	470144	468725	433315	9372	9372
Adj-R^2	0.967	0.947	0.617	0.835	0.855

Table 10: β_2 using subsets of rivals.

	AWP	Price	OOP	Pills	Prescriptions
	(1)	(2)	(3)	(4)	(5)
			Panel A: keep top 4 rivals		

β_2	0.185***	0.181***	0.149***	0.291***	0.278***
	(0.00559)	(0.00745)	(0.0117)	(0.0600)	(0.0569)
N	423947	422657	393928	7098	7098
Adj-R^2	0.960	0.943	0.569	0.852	0.857
			Panel B: exclude top 4 rivals		
β_2	-0.0285***	0.146***	0.174***	0.115*	0.117*
	(0.00379)	(0.00709)	(0.0119)	(0.0569)	(0.0529)
N	386200	385043	356684	8039	8039
Adj-R^2	0.990	0.964	0.673	0.859	0.876
			Panel C: keep top 8 rivals		
β_2	0.138***	0.185***	0.158***	0.280***	0.265***
	(0.00459)	(0.00646)	(0.0103)	(0.0570)	(0.0543)
N	488859	487417	453679	8516	8516
Adj-R^2	0.964	0.945	0.606	0.822	0.831
			Panel D: exclude top 8 rivals		
β_2	-0.0178***	0.110***	0.168***	0.0202	0.0324
	(0.00477)	(0.00931)	(0.0154)	(0.0581)	(0.0512)
N	321288	320283	296933	6621	6621
Adj-R^2	0.993	0.962	0.614	0.884	0.904

The pharmaceutical industry is fast paced and everchanging. It may confound the study by introducing latent firm- or market-level shocks. To control it, Panels A and B in Table 8 add firm and therapeutic class time trends. Panels C and D change the clustering to drug and manufacturer level, respectively. The sample sizes are identical to those in Table 3.

The baseline specification included all generic drug manufacturers, including those that had mergers in the study period. If the rivals' mergers have boosted their respective prices, it would attenuate the baseline results. Panel A in Table 9 reports the DD results after excluding rivals that had mergers during the study period, and Table A-9 lists these mergers.

The baseline model excluded Acyclovir. Panel B in Table 9 reports the results with the inclusion of Acyclovir, and finds smaller estimates for the AWP, price, and OOP. But the effects remain highly significant. The inclusion of Acyclovir did not largely affect the estimates for pills and prescriptions.

Many insurers reset the deductibles in January. As a result, the OOP is markedly higher in the first quarter of each year than in the other months (see Figure 1). It creates a seasonality. If the seasonality similarly affects the treated and control group, it may not bias the findings. To further examine the seasonality, Panel C in Table 9 uses identical calendar months in the pre- and post-merger periods. The results are convincingly close to the baseline results.

Table 10 compares Gilead drugs with subsets of the generic rivals to test the sensitivity to the choice of the control group. High sensitivity would hint at latent shocks to the rivals, and low sensitivity would reinforce the causality. The table also tests whether small and large rivals have responded to the merger differently, for example, by mirroring the price increase or implementing price cuts. Panel A limits the control group to the four largest rivals in terms of revenues. Panel B keeps all rivals but the top four. Panel C keeps the top eight rivals. Panel D keeps all rivals but the top eight.

In Table 10, price and OOP (columns 2-3) are insensitive to the choice of the included rivals, i.e., small and large rivals have similarly responded to the merger in price terms. But the quantitative responses are different (columns 4-5): the estimates in Panels A and C are substantially larger and more significant than those in Panels B and D. So, Gilead's newly-gained market share was predominantly taken from the large rivals. Possibly, the market is segmented such that Gilead and large rivals compete in one segment and small firms compete in the other. This statement remains a conjecture. Overall, the robustness checks are convincingly close to the baseline results and reinforce the validity of the findings.

4 Discussions

Below, I estimate the impact of the merger on Gilead revenues in the full US population. Using the baseline estimates and denoting P for the price and Q for sales quantity, the realized percentage change in Gilead's 2012 revenues is equal to $[\exp(\beta_1^P + \beta_2^P + \beta_1^Q + \beta_2^Q) - 1]$ which is 12.64%. Gilead has reported revenues of \$8.4 and \$9.7 billion in 2011 and 2012, respectively (Table A-10). Using the 12.64% estimate, the merger explains \$1.06 billion of the \$1.30 billion revenue increase in 2012.

For three reasons, this number is a conservative estimate for the true cost of the merger to patients. First, Gilead may have strategically delayed the full exercise of the market power to mitigate public backlash and avoid litigation (FTC, 2010). Instead, Gilead may have gradually transitioned to the new prices over multiple years. As an evidence, Table A-10 shows that Gilead's revenues grew by \$1.5 billion in 2013 for no known reason except the merger.

Second, higher post-merger prices may have deprived some patients of medication. Gilead drugs mainly targeted HIV and HBV patients. Without timely medication, these patients lose considerable quality-adjusted life years, and the taxpayers incur higher costs to finance later-stage treatments (CDC, 2019; Ong, Mak, Aung, Li, & Lim, 2008; Yang et al., 2001). The non-monetary cost of pain and suffering can be considerable. For example, patients who suffer from chronic pain are willing to pay \$56-145 per day to avoid it (Ólafsdóttir, Ásgeirsdóttir, & Norton, 2017). This monetized pain estimate is 25 times greater than the average OOP for Gilead drugs.

Third, Sovaldi was expected to cost \$36,000 per patient before the merger. But after the merger, it was priced at \$82,000. If the merger has contributed to this aggressive price increase, it adds another dimension to the adverse impacts of the merger on drug expenditures and accessibility.

Figure 1 suggested and Table 3 empirically confirmed ($\gamma 1$ and $\gamma 2$) that Gilead was expanding its market dominance before the merger: compared with the rivals, Gilead drug prices and OOP were, respectively, increasing by 0.95% and 1.01% every month. During the same period, Gilead's count of prescriptions and pills increased by 3.70% and 3.53%, respectively. Gilead's marketing attempts can explain this steady growth: its "selling, general, and administrative" expenditures increased by 19.23% and 17.74% in 2011 and 2012, respectively (SEC, 2021), and alongside AbbVie and Lilly, Gilead had the highest advertisement expenditures in the US (Bulik, 2020).

The findings confirm Town, Wholey, Feldman, and Burns (2006) and Rabbani (2021) that higher healthcare prices drive up the OOP largely and immediately. Rabbani (2021) verified it in inpatient childbirth services, and I found similar results in pharmaceuticals.

I documented that the merger effects spilled over to the other firms and markets. It suggests that dichotomously putting firms and markets in the treated and control may be an over-simplification. Instead, it may be more insightful to examine merger effects in a cascading manner: the effect is the largest for the merging firms in the directly affected market, and it shrinks as it spills over to the other firms and markets.

4.1 It is an antitrust loophole

Mergers with future rivals fly under the regulatory radar because of an antitrust loophole that is explored below. Define ΔHHI as the actual post-merger HHI change. Now consider the counterfactual in which the

merger is delayed long enough so that Pharmasset enters the market and grows to its expected full size[7]. Denote ΔHHI_c as the post-merger HHI change in this counterfactual setting.

Antitrust regulations state that a merger is "*unlikely to have adverse competitive effects and… requires no further analysis.*" if $\Delta HHI \leq 100$ (FTC, 2010, p. 19). This approach automatically approves all mergers with future rivals because in these mergers $\Delta HHI = 0$, by definition. The loophole is created because antitrust regulations are blind to the harms to future competition, and mergers with future rivals exclusively target future competition. In contrast, profit-maximizing firms are forward-looking (Zeithaml et al., 2006): they monitor the upcoming rivals, forecast the future market trends, anticipate threats, and plan accordingly.

ΔHHI_c contains critical information about the intentions behind mergers with future rivals and can expose and quantify the harms. Such information is categorically absent in ΔHHI. While firms take advantage of all available information, antitrust regulations limit the scope to ΔHHI. It creates an asymmetry between the information available to firms and the information used to show harm. In short, firms are free to harm competition if the harm appears in ΔHHI_c but not in ΔHHI. This information asymmetry has created a loophole that will continue to impair antitrust enforcement by leaving all mergers with future rivals unregulated.

4.2 A word on the causality

Previous sections documented large increases in Gilead drug prices and quantities immediately after the merger. This subsection compiles the findings to conclude whether the merger is the "cause" for the observed outcomes.

The effect was largest in the antiviral market and for Gilead drugs. The results persisted after excluding rivals that had mergers and persisted when various subsets of rivals were used. So, the cause is linked to Gilead's antiviral drugs. In addition, the post-merger increases in the AWP and retail prices appeared simultaneously. Assuming that a higher AWP can raise the retail price, but not vice versa, the effects were triggered at the wholesale level and the cause lies upstream.

HMOs, who resist provider market power the most, had the lowest post-merger price increase (Table 6). So, the cause has affected the markets by increasing provider market power. Table *5* reported similar effects for all Gilead drugs, hinting at the presence of a firm-level cause. Examining the timing of the effects (Table A-8), the cause was likely in January 2012. In addition, the results are highly robust to the choice of specification, included drugs and rivals, level of clustering, and the addition of firm and therapeutic class time trends.

In short, the cause is linked to Gilead's antiviral drugs, it happened in January 2012, it affected Gilead's market power, it was firm-level, and the findings are highly significant and robust. To my best knowledge, the merger is the only cause that fits the descriptions.

4.3 Beyond Pharmaceuticals: an application in the software industry

The main finding of the study, that mergers with future rivals create entry barriers, is relevant to the pharmaceutical industry where the FDA acts as the gatekeeper to delay entry and disclose critical information on drugs pending approval. This subsection introduces another version of the entry barrier that

[7] I leave it to future structural studies to estimate the counterfactual market shares.

is being exploited in the software industry: mergers between dominant incumbents and small fringe firms whose future growth trajectory is sufficiently predictable.

Several software mergers fit in this frame. To name a few, Facebook acquired Instagram (2012) and WhatsApp (2014) for $1 billion and $19 billion, and Google acquired Android (2005) and YouTube (2006) for $50 million and $1.65 billion, respectively. These mergers were small compared with the industry's $1.8 trillion value (ITA, 2021), and the impact on the HHI was negligible. So, they were not initially challenged. Instagram, WhatsApp, Android, and YouTube are currently valued at $100, $100, $3, and $300 billion, respectively (Jackson, 2014; MediaKix, 2017; Strauss, 2019; TWR, 2021). Thus, if the mergers were to take place today, they would warrant litigation.

In fact, in a recent attempt, the FTC litigated Facebook in January 2021, claiming that "*Facebook has maintained its [social networking] monopoly position by buying up companies that present competitive threats and … potential rivals*" (FTC, 2020a, page1). The FTC claimed that after "toppling" Myspace, Facebook achieved a monopoly power that has been defended by anti-competitive means, including the acquisition of Instagram and WhatsApp, reflecting the CEO's, Mark Zuckerberg, view that "*it is better to buy than compete*." (FTC, 2020a, page2). In an internal email on the importance of acquiring Instagram, the CEO explained that it is not about buying a product. Instead, it is about deterring competition stating that "what we're really buying is time." (FTC, 2020a, page5). The case is still open.

The software mergers mentioned above may be considered horizontal, vertical, or conglomerate mergers, depending on the level of market definition. Nevertheless, they have two elements in common with the Gilead-Pharmasset merger: they caused large ΔHHI_c values while keeping ΔHHI near zero. Put differently, they dramatically reshaped future competition, and they took place when the acquired firms were too small to leave a chance for litigation. By acquiring future (fringe) rivals before entry (before growing to their potential size), incumbent pharmaceutical (software) firms can extend and expand their market dominance indefinitely. And this is how pharmaceutical and software mergers are taking advantage of the same barrier to entry.

Software firms have been exploiting this entry barrier since the eighties (Cabral, 2018). Google, Amazon, Facebook, and Apple acquired 383 rivals during 2010-2019, the vast majority of which were recent entrants. Only three of them received significant media attention, namely, the acquisitions of Waze, WhatsApp, and Instagram (Cabral, 2021).

Antitrust policy targets consumer protection. For years, software companies offered free or cheap services to consumers. So, their harms to consumers were hard to prove, and even their aggressive acquisitions flew under the regulatory radar until they became too big for the regulator to control. The influence of the software industry on consumer welfare is far beyond its sheer economic size. Google, Apple, Facebook, Amazon, and Microsoft are inseparable parts of most people's daily lives, and directly affect consumer privacy, security, quality of life, political power, and freedom of speech (Cabral, 2021).

Incumbents usually pay premiums to buy future rivals and fringe firms. For example, Gilead paid 89% beyond the market value to buy Pharmasset (Krauskopf, 2011). They justify the premiums by claiming that they have better financial and distribution means to turn inventions into profits. While this claim remains open to examination, there is an alternative motivation for paying high premiums that merging firms may not admit to: incumbents who charge high markups may experience a severe revenue decline in the face of competition. So, the premiums may reflect the incumbents' willingness to pay to maintain the markups. In

this sense, the premiums create a symbiosis between the incumbents on the one hand and future rivals and fringe firms on the other that benefits both sides and can continue indefinitely. But it can impair competition, retard innovation, and hurt consumers.

5 Conclusions

The Federal Trade Commission (FTC) stated in 2010 that mergers between incumbents and future rivals can be anticompetitive. This study provided the first empirical evidence for this statement. Using Truven MarketScan data in a Difference-in-Difference specification, I studied a merger between a dominant pharmaceutical firm (Gilead) and a promising future rival (Pharmasset). The merger substantially increased Gilead drug prices, and ample evidence support that the relationship is causal. In addition to confirming the FTC statement, the findings indicate that mergers between incumbents and future rivals can create an entry barrier that impairs antitrust efforts: incumbents can deter entry indefinitely by proactively acquiring promising future rivals, and it can perpetuate market concentration.

The studied merger's effects spilled over in two dimensions, namely, to Gilead's close rivals, and to Gilead drugs outside the market in which the merger took place. It indicates that the standard approach to merger analysis – limiting the attention to the merging firms in the directly affected market – may underestimate the true impact of mergers.

Healthcare studies often use public insurance data such as the Medicare, Medicaid, British National Health Service, and similar administrative data sets (Cooper, Gibbons, Jones, & McGuire, 2011; Ho & Hamilton, 2000; Kemp, Kersten, & Severijnen, 2012; Kessler & McClellan, 2000). Public data over-represent senior and retired patients. Using private insurance data, this study demographically complements the literature. Being limited to privately insured individuals, however, the extent to which the findings generalize to publicly insured individuals is unclear. Public insurance rates are decided in prospective payment systems or similar administrative schemes that may better resist price increases.

Antitrust policy aims to achieve competition by imposing limitations such as forbidding collusion and predatory pricing as well as preventing mergers that largely raise the HHI. Under these limitations, markets are believed to automatically achieve competition in the long run. In other words, high market concentration is presumed to be short-lived because entry is free and excess profits attract rivals whose entry promotes competition (Viscusi, Harrington Jr, & Sappington, 2018).

This study casts doubt on the above reasoning because entry may not be free if mergers with future rivals remain unregulated: excess profits incentivize entry. But if a promising firm initiates entry, an incumbent offers a buyout. If the benefit to the incumbent of deterring entry is greater than the entrant's expected profits – which is likely for large incumbents – there exists a price that the incumbent is willing to offer, and the entrant is willing to take to exit. Thus, excess profits can last in the long run, and entry may be delayed indefinitely.

References

A-1: antiviral drugs: branded.

		Monthly sales ($1,000)		Monthly sales (1,000 pills)		Price ($/pill)		Price ($/month)		OOP ($/pill)		OOP ($/month)		Unique patients	
Manufacturer	Drug name	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Gilead	Atripla	11,040.91	12,839.59	210.45	228.70	53.79	57.49	1,548.80	1,679.40	1.66	1.75	43.66	46.84	8,618	9,325
Gilead	Truvada	5,869.25	6,876.63	169.31	184.04	35.50	38.20	1,025.90	1,116.45	1.39	1.50	36.36	39.77	7,524	8,147
Gilead	Viread	1,599.39	1,988.27	70.52	79.13	23.24	25.72	672.37	750.65	1.34	1.52	35.48	40.40	3,084	3,396
Gilead	Hepsera	337.53	312.81	11.73	9.85	29.43	32.40	818.61	946.21	1.22	1.23	31.97	32.22	507	411
Gilead	Emtriva	44.85	48.11	3.32	3.32	13.89	14.81	401.74	426.99	1.01	1.17	27.22	30.85	147	156
Abbott	Norvir	1,308.21	1,363.29	157.70	164.31	8.50	8.48	308.23	306.84	0.95	1.04	28.87	31.53	5,668	5,923
Abbott	Kaletra	812.73	730.98	144.60	125.49	5.77	5.97	671.82	696.78	0.34	0.36	36.03	38.81	1,726	1,527
Bms	Reyataz	2,259.73	2,340.18	93.68	90.13	27.11	29.11	907.37	965.22	1.14	1.28	34.79	38.38	3,252	3,177
Bms	Baraclude	1,076.07	1,295.96	41.47	45.07	26.56	29.40	760.38	863.49	1.43	1.55	37.43	40.75	1,779	1,879
Bms	Sustiva	581.33	588.58	33.12	31.88	18.09	19.05	531.02	560.44	1.12	1.31	30.73	35.00	1,333	1,277
Genentech	Valcyte	1,182.99	1,470.72	27.70	29.65	43.48	50.42	2,121.21	2,510.50	1.10	1.17	43.95	51.82	1,470	1,532
Genentech	Invirase	76.16	78.22	11.09	11.27	7.10	7.27	750.73	851.22	0.31	0.26	29.81	30.06	117	113
Gsk	Valtrex	475.85	342.57	60.02	42.71	8.30	8.46	278.50	287.84	1.72	1.77	43.22	45.63	5,789	3,858
Gsk	Epivir	67.55	59.88	5.93	4.89	11.67	12.51	342.89	374.79	1.19	1.17	30.66	32.21	276	230
Janssen	Prezista	1,641.30	2,044.10	105.01	123.27	16.00	16.93	921.24	990.99	0.65	0.69	33.48	36.88	2,459	2,818
Janssen	Intelence	589.93	663.64	78.42	69.45	8.70	10.97	732.02	782.33	0.41	0.52	31.57	33.91	1,096	1,128
Merck	Isentress	2,579.65	3,126.92	166.03	190.06	15.93	16.85	921.76	984.34	0.64	0.68	33.71	36.29	3,679	4,189
Novartis	Famvir	43.31	31.74	4.79	3.31	10.22	10.76	459.57	487.49	0.55	0.68	22.46	24.29	358	225
Pfizer	Epzicom	1,456.69	1,632.27	49.40	52.38	30.27	31.96	880.83	932.91	1.31	1.43	34.52	37.61	2,067	2,182
Pfizer	Combivir	831.51	89.11	60.96	6.30	13.97	14.25	818.64	848.83	0.66	1.32	35.90	72.87	1,447	200
Pfizer	Trizivir	502.04	462.43	22.91	19.47	22.47	24.39	1,313.10	1,421.39	0.70	0.73	37.81	39.51	490	421
Pfizer	Lexiva	433.92	397.55	36.33	31.03	12.29	13.14	853.70	926.82	0.61	0.62	34.39	35.74	654	546
Pfizer	Selzentry	288.41	369.24	19.29	22.71	15.38	16.69	963.67	1,078.81	0.54	0.64	27.55	32.84	377	438
Pfizer	Ziagen	207.34	102.39	24.53	11.41	8.68	9.16	506.82	535.47	0.57	0.74	31.12	39.20	550	436
Pfizer	Epivir	170.37	23.84	21.26	2.69	8.95	9.76	335.18	346.44	0.87	1.61	28.98	52.34	708	113
Pfizer	Viracept	134.19	128.44	22.99	20.43	5.97	6.43	699.29	752.09	0.31	0.33	31.85	35.60	259	221
Prestium	Zovirax	5.71	6.66	1.28	1.39	4.47	4.72	243.49	262.82	0.88	0.89	42.78	41.39	79	86

A-2: antiviral drugs: generic.

Manufacturer	Drug name	Monthly sales ($1,000) Pre	Monthly sales ($1,000) Post	Monthly sales (1,000 pills) Pre	Monthly sales (1,000 pills) Post	Price ($/pill) Pre	Price ($/pill) Post	Price ($/month) Pre	Price ($/month) Post	OOP ($/pill) Pre	OOP ($/pill) Post	OOP ($/month) Pre	OOP ($/month) Post	Unique patients Pre	Unique patients Post
Actavis	Acyclovir	95.25	62.58	25.68	21.22	3.98	3.16	147.55	118.83	0.89	0.76	24.61	20.58	5,031	4,211
Akorn	Acyclovir	0.86	0.73	3.32	2.95	0.30	0.33	69.46	82.37	0.14	0.14	27.48	32.81	339	277
Apotex	Acyclovir	0.40	52.97	1.02	132.42	0.42	0.46	27.52	22.78	0.22	0.20	12.01	8.11	148	13,182
Apotex	Famciclovir	0.02	29.96	0.01	8.25	3.44	3.81	206.39	202.55	0.42	0.57	25.00	19.48	1	1,231
Aurobindo	Acyclovir	530.78	834.91	144.73	271.50	3.92	3.28	146.97	124.22	0.70	0.63	18.88	16.63	22,635	48,709
Aurobindo	Didanosine	17.16	16.55	2.47	2.38	7.13	6.99	208.20	210.09	0.36	0.37	9.58	9.38	139	125
Aurobindo	Zidovudine	3.24	2.33	3.93	3.07	0.76	0.69	52.93	46.97	0.12	0.13	6.87	6.84	120	85
Camber	Stavudine	6.01	7.30	3.15	4.07	1.92	1.78	114.33	107.81	0.14	0.14	7.39	7.74	105	109
Camber	Zidovudine	1.46	2.89	2.19	4.51	0.69	0.66	39.97	38.28	0.13	0.14	7.44	7.17	93	120
Carlsbad	Acyclovir	109.89	114.89	289.98	314.72	0.42	0.41	24.84	23.30	0.21	0.22	10.77	10.73	34,019	35,575
Greenstone	Acyclovir	447.27	194.44	114.56	60.76	4.16	3.42	157.19	130.98	0.68	0.66	18.35	17.43	21,144	13,451
Heritage	Acyclovir	0.86	2.28	3.33	9.36	0.27	0.25	22.87	17.68	0.16	0.16	12.57	9.35	425	1,075
Kadmon	Ribasphere	524.71	402.35	62.18	57.42	11.98	10.18	817.35	678.48	0.35	0.42	25.34	28.33	1,736	1,514
Lannett	Amantadine_Hcl	16.73	10.95	37.80	20.45	0.46	0.56	27.42	33.44	0.15	0.17	7.51	8.09	1,517	1,035
Mylan	Acyclovir	2,234.58	1,918.41	692.21	895.46	3.59	2.43	125.41	89.09	0.68	0.54	15.55	13.71	84,886	103,745
Mylan	Stavudine	3.40	0.31	1.93	0.11	1.74	2.84	105.40	164.35	0.15	0.30	8.70	16.34	94	9
Northstar	Acyclovir	246.70	235.70	67.55	86.24	3.96	3.02	147.19	109.13	0.75	0.62	19.79	16.12	12,420	14,345
Par	Acyclovir	13.75	1.70	40.24	4.82	0.36	0.37	19.12	21.26	0.20	0.19	8.20	9.29	4,663	794
Ranbaxy	Acyclovir	1,665.18	1,374.53	515.33	551.44	3.66	2.85	134.83	104.76	0.71	0.66	20.46	18.49	80,394	83,978
Reddys	Acyclovir	403.61	467.39	110.47	162.43	3.90	3.20	130.77	104.15	0.82	0.71	17.09	14.72	14,036	18,094
Roxane	Zidovudine	2.00	0.01	3.03	0.01	0.68	0.56	39.72	33.90	0.14	0.08	7.94	5.00	123	2
Sandoz	Acyclovir	105.39	71.55	29.14	23.82	3.89	3.18	145.49	118.87	0.70	0.62	16.77	14.35	4,836	3,746
Sandoz	Famciclovir	86.91	8.24	15.24	2.31	6.27	3.70	278.76	173.72	0.63	0.68	15.57	17.65	1,536	453
Sandoz	Amantadine_Hcl	18.75	67.35	42.51	56.29	0.45	1.22	27.12	73.77	0.14	0.21	6.76	9.29	1,732	2,258
Sandoz	Ribavirin	14.43	9.30	5.80	4.82	2.51	1.96	385.99	304.80	0.13	0.13	18.50	20.20	155	178
Teva	Acyclovir	801.12	599.94	918.65	667.16	0.88	1.07	44.48	45.05	0.26	0.30	9.54	9.82	79,277	59,694
Teva	Famciclovir	603.63	314.44	101.40	93.35	6.59	3.75	314.19	175.64	0.93	0.74	27.57	21.04	15,717	12,811
Teva	Didanosine	32.64	21.85	4.85	3.25	6.90	6.93	199.31	198.58	0.41	0.39	10.57	10.47	268	168
Upsher	Amantadine_Hcl	19.60	44.57	27.13	37.72	0.67	1.22	43.54	70.90	0.16	0.21	7.24	9.25	1,059	1,589
Watson	Acyclovir	0.37	0.11	1.01	0.22	0.43	0.53	27.41	26.54	0.24	0.37	12.23	17.06	130	27
Westward	Acyclovir	476.72	103.09	128.17	30.51	3.95	3.56	143.31	137.36	0.64	0.72	16.28	19.73	19,920	8,166
Westward	Famciclovir	70.03	68.81	12.89	20.26	6.39	3.79	284.46	178.72	0.74	0.65	19.97	19.32	1,659	2,769
Wockhardt	Acyclovir	#REF!	171.88	#REF!	58.97	#REF!	3.10	#REF!	114.36	#REF!	0.55	#REF!	14.60	#REF!	11,907
Zydus	Ribavirin	66.14	116.98	29.87	73.34	2.24	1.59	354.14	253.09	0.15	0.12	23.90	18.71	588	1,226

A-3: cardiac drugs.

		Monthly sales ($1,000)		Monthly sales (1,000 pills)		Price ($/pill)		Price ($/month)		OOP ($/pill)		OOP ($/month)		Unique patients	
Manufacturer	Drug name	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
						Brand									
Gilead	Ranexa	548.50	682.52	138.91	159.41	4.03	4.38	235.50	256.77	0.58	0.65	29.70	33.92	3,948	4,492
Abbott	Teveten	40.48	24.31	13.19	7.22	3.17	3.45	92.11	101.37	0.72	0.54	19.80	14.93	561	303
Astrazeneca	Atacand	602.97	523.77	232.18	164.88	2.66	3.25	78.09	95.41	0.90	0.99	23.55	25.80	9,951	7,139
Bms	Avapro	1,381.43	127.39	497.22	42.58	2.87	3.08	83.28	90.03	1.08	1.21	28.82	32.63	22,698	3,063
Boehringer	Micardis	2,208.67	2,242.95	731.47	630.45	3.17	3.73	90.64	106.76	0.92	1.00	23.79	25.84	33,263	27,812
Daiichi	Benicar	5,904.15	6,124.63	2,082.08	1,863.41	2.96	3.43	84.98	98.58	0.87	0.96	22.82	25.09	95,745	84,082
Merck	Hyzaar	102.57	74.50	36.71	25.15	2.98	3.17	83.40	88.90	0.91	0.84	23.56	22.28	1,934	1,116
Merck	Cozaar	88.55	65.29	44.96	26.90	2.17	2.58	59.11	72.82	0.74	0.80	19.51	21.25	2,618	1,286
Noden	Tekturna	828.27	506.78	280.71	162.01	3.05	3.25	88.55	93.73	0.92	0.98	23.94	25.34	13,596	7,819
Novartis	Diovan	11,530.38	10,379.88	3,720.09	2,919.69	3.22	3.69	93.81	108.11	0.87	0.97	23.43	25.97	162,130	142,192
Pfizer	Caduet	1,308.80	114.50	251.19	18.89	5.41	6.20	155.73	181.61	1.28	1.78	32.68	47.45	11,387	1,074
						Generic									
Greenstone	Eplerenone	168.12	167.21	58.81	63.02	2.89	2.67	106.73	100.15	0.33	0.32	9.82	9.52	2,143	2,257
Sandoz	Eplerenone	2.65	7.29	0.96	2.92	2.90	2.68	102.10	95.79	0.29	0.24	8.10	6.79	76	139

Manufacturer	Drug name	Monthly sales ($1,000) Pre	Monthly sales ($1,000) Post	Monthly sales (1,000 pills) Pre	Monthly sales (1,000 pills) Post	Price ($/pill) Pre	Price ($/pill) Post	Price ($/month) Pre	Price ($/month) Post	OOP ($/pill) Pre	OOP ($/pill) Post	OOP ($/month) Pre	OOP ($/month) Post	Unique patients Pre	Unique patients Post
						Brand									
Gilead	Letairis	1,058.70	1,410.78	5.45	6.87	194.14	205.25	5,547.90	6,157.64	2.18	2.21	62.40	66.19	263	317
Actelion	Tracleer	1,738.13	1,794.73	17.74	17.42	97.98	103.03	5,878.67	6,181.92	0.87	1.15	52.19	68.90	394	387
Arbor	Bidil	28.77	30.82	15.08	15.75	1.95	2.00	146.68	151.13	0.54	0.56	33.23	34.49	439	442
Arbor	Nitrolingual	20.40	1.40	0.92	0.07	23.13	22.37	285.47	263.01	3.84	4.12	44.24	44.96	674	52
Espero	Nitrolingual	39.84	43.49	1.60	1.70	27.25	27.96	273.78	288.33	5.14	5.56	46.31	51.20	1,266	1,350
Pfizer	Nitrostat	61.37	66.49	196.59	197.32	0.37	0.39	20.60	21.55	0.29	0.31	15.67	16.20	33,245	33,975
						Generic									
Alvogen	Isosorbide_Mononitrate	5.13	4.52	24.63	22.76	0.22	0.21	6.29	6.00	0.11	0.11	3.15	3.09	1,124	1,024
Glenmark	Nitroglycerin	1.45	0.27	6.98	1.16	0.26	0.28	15.33	15.21	0.19	0.21	10.20	10.21	1,243	221
Kremer	Isosorbide_Mononitrate	27.96	22.08	73.35	60.80	0.39	0.38	12.44	11.67	0.21	0.21	6.12	5.92	5,180	4,151
Mylan	Nitroglycerin	4.24	3.25	5.28	4.05	0.80	0.80	23.82	23.94	0.26	0.27	7.70	7.90	761	546
Par	Isosorbide_Mononitrate	11.68	21.51	21.79	39.52	0.47	0.51	16.98	17.47	0.18	0.22	5.26	6.46	1,640	3,138
Par	Isosorbide_Dinitrate	1.44	2.05	10.29	8.46	0.18	0.27	7.75	11.86	0.11	0.14	4.46	5.18	383	324
Sandoz	Isosorbide_Dinitrate	1.01	2.35	11.96	9.93	0.09	0.26	6.47	17.66	0.07	0.10	4.87	5.92	465	453
Torrent	Isosorbide_Mononitrate	4.27	22.44	12.25	79.11	0.38	0.34	11.00	8.74	0.19	0.18	5.49	4.53	1,449	4,655
Valeant	Nitroglycerin	2.69	4.45	3.36	5.43	0.80	0.82	23.67	23.97	0.28	0.28	8.21	8.30	476	722
Westward	Isosorbide_Mononitrate	45.57	31.41	174.39	105.54	0.28	0.29	8.14	9.44	0.16	0.17	4.57	5.02	9,696	7,068
Westward	Isosorbide_Dinitrate	2.69	3.49	33.08	22.35	0.10	0.16	5.92	11.10	0.07	0.08	3.85	4.40	985	835

A-4: vasodilating drugs.

A-5: the market shares and concentration: antiviral drugs.

Manufacturer	By revenues		By pills		By unique patients	
	Pre	Post	Pre	Post	Pre	Post
			Brand			
Gilead	42.71%	47.20%	9.13%	9.55%	4.26%	4.28%
Pfizer	9.10%	6.86%	5.06%	3.15%	1.40%	0.91%
Bms	8.85%	9.04%	3.30%	3.16%	1.36%	1.27%
Merck	5.83%	6.69%	3.26%	3.59%	0.79%	0.84%
Janssen	5.04%	5.79%	3.60%	3.64%	0.76%	0.79%
Abbott	4.79%	4.48%	5.93%	5.48%	1.59%	1.49%
Genentech	2.85%	3.31%	0.76%	0.77%	0.34%	0.33%
Gsk	1.23%	0.86%	1.29%	0.90%	1.30%	0.82%
Novartis	0.10%	0.07%	0.09%	0.06%	0.08%	0.04%
Prestium	0.01%	0.01%	0.03%	0.03%	0.02%	0.02%
			Generic			
Mylan	5.06%	4.10%	13.62%	16.93%	18.22%	20.73%
Ranbaxy	3.76%	2.94%	10.11%	10.42%	17.23%	16.78%
Teva	3.25%	2.00%	20.11%	14.44%	20.42%	14.52%
Aurobindo	1.25%	1.83%	2.97%	5.24%	4.91%	9.77%
Westward	1.24%	0.37%	2.77%	0.96%	4.63%	2.18%
Kadmon	1.19%	0.86%	1.22%	1.09%	0.37%	0.30%
Greenstone	1.01%	0.42%	2.25%	1.15%	4.53%	2.69%
Reddys	0.91%	1.00%	2.17%	3.07%	3.01%	3.61%
Northstar	0.56%	0.50%	1.33%	1.63%	2.66%	2.87%
Sandoz	0.51%	0.33%	1.82%	1.65%	1.77%	1.33%
Carlsbad	0.25%	0.25%	5.69%	5.95%	7.29%	7.11%
Actavis	0.22%	0.13%	0.50%	0.40%	1.08%	0.84%
Zydus	0.15%	0.25%	0.59%	1.39%	0.13%	0.24%
Upsher	0.04%	0.10%	0.53%	0.71%	0.23%	0.32%
Lannett	0.04%	0.02%	0.74%	0.39%	0.33%	0.21%
Par	0.03%	0.00%	0.79%	0.09%	1.00%	0.16%
Camber	0.02%	0.02%	0.10%	0.16%	0.04%	0.05%
Roxane	0.00%	0.00%	0.06%	0.00%	0.03%	0.00%
Akorn	0.00%	0.00%	0.07%	0.06%	0.07%	0.06%
Heritage	0.00%	0.00%	0.07%	0.18%	0.09%	0.21%
Apotex	0.00%	0.18%	0.02%	2.66%	0.03%	2.88%
Watson	0.00%	0.00%	0.02%	0.00%	0.03%	0.01%
Wockhardt	0.00%	0.37%	0.00%	1.11%	0.00%	2.38%

A-6: the market shares and concentration: cardiac drugs.

Manufacturer	By revenues		By pills		By unique patients	
	Pre	Post	Pre	Post	Pre	Post
			Brand			
Gilead	2.22%	3.24%	1.72%	2.62%	1.10%	1.59%
Novartis	46.65%	49.33%	45.99%	47.97%	45.03%	50.28%
Daiichi	23.89%	29.11%	25.74%	30.62%	26.59%	29.73%
Boehringer	8.94%	10.66%	9.04%	10.36%	9.24%	9.84%
Bms	5.59%	0.61%	6.15%	0.70%	6.30%	1.08%
Pfizer	5.30%	0.54%	3.11%	0.31%	3.16%	0.38%
Noden	3.35%	2.41%	3.47%	2.66%	3.78%	2.77%
Astrazeneca	2.44%	2.49%	2.87%	2.71%	2.76%	2.52%
Merck	0.77%	0.66%	1.01%	0.86%	1.26%	0.85%
Abbott	0.16%	0.12%	0.16%	0.12%	0.16%	0.11%
			Generic			
Greenstone	0.68%	0.79%	0.73%	1.04%	0.60%	0.80%
Sandoz	0.01%	0.03%	0.01%	0.05%	0.02%	0.05%

A-7: the market shares and concentration: vasodilating drugs.

Manufacturer	By revenues		By pills		By unique patients	
	Pre	Post	Pre	Post	Pre	Post
			Brand			

Gilead	34.65%	40.71%	0.89%	1.15%	0.44%	0.53%
Actelion	56.89%	51.79%	2.89%	2.91%	0.66%	0.65%
Pfizer	2.01%	1.92%	31.98%	32.98%	55.70%	56.95%
Arbor	1.61%	0.93%	2.60%	2.64%	1.86%	0.83%
Espero	1.30%	1.25%	0.26%	0.28%	2.12%	2.26%
			Generic			
Westward	1.58%	1.01%	33.75%	21.38%	17.90%	13.25%
Kremer	0.92%	0.64%	11.93%	10.16%	8.68%	6.96%
Par	0.43%	0.68%	5.22%	8.02%	3.39%	5.80%
Alvogen	0.17%	0.13%	4.01%	3.80%	1.88%	1.72%
Torrent	0.14%	0.65%	1.99%	13.22%	2.43%	7.80%
Mylan	0.14%	0.09%	0.86%	0.68%	1.28%	0.92%
Valeant	0.09%	0.13%	0.55%	0.91%	0.80%	1.21%
Glenmark	0.05%	0.01%	1.13%	0.19%	2.08%	0.37%
Sandoz	0.03%	0.07%	1.94%	1.66%	0.78%	0.76%

A-8: alternative treatment month. The table reports the estimated effects up to four months before and 11 months after the actual merger month.

Assumed treatment month	Log(AWP) (1)	Log(price) (2)	Log(OOP) (3)	Log(pills) (4)	Log(prescriptions) (5)
Sep-11	0.0126***	0.0177**	-0.0491***	-0.135*	-0.161***
	(0.00344)	(0.00608)	(0.00871)	(0.0528)	(0.0485)
Oct-11	0.0427***	0.0700***	0.0229**	-0.121*	-0.144**
	(0.00342)	(0.00602)	(0.00845)	(0.0515)	(0.0475)
Nov-11	0.0660***	0.109***	0.0779***	-0.175***	-0.172***
	(0.00340)	(0.00572)	(0.00836)	(0.0497)	(0.0461)
Dec-11	0.0875***	0.149***	0.137***	-0.107*	-0.102*
	(0.00356)	(0.00555)	(0.00867)	(0.0469)	(0.0440)
Jan 12 (merger)	0.104***	0.180***	0.168***	-0.0741	-0.0515
	(0.00382)	(0.00567)	(0.00938)	(0.0461)	(0.0433)
Feb-12	0.0643***	0.114***	0.0870***	-0.0220	-0.00259
	(0.00394)	(0.00551)	(0.00855)	(0.0467)	(0.0439)
Mar-12	0.0280***	0.0376***	0.0356***	0.0338	0.0621
	(0.00391)	(0.00549)	(0.00817)	(0.0466)	(0.0438)
Apr-12	0.00617	-0.0175**	-0.00836	0.113*	0.132**
	(0.00360)	(0.00533)	(0.00803)	(0.0468)	(0.0443)
May-12	-0.0183***	-0.0521***	-0.0279***	0.173***	0.162***
	(0.00351)	(0.00529)	(0.00801)	(0.0481)	(0.0458)
Jun-12	-0.0467***	-0.0749***	-0.0422***	0.188***	0.183***
	(0.00359)	(0.00536)	(0.00811)	(0.0495)	(0.0462)
Jul-12	-0.0658***	-0.103***	-0.0470***	0.118*	0.135**
	(0.00362)	(0.00533)	(0.00817)	(0.0486)	(0.0457)
Aug-12	-0.0645***	-0.120***	-0.0513***	0.0413	0.0700
	(0.00362)	(0.00534)	(0.00816)	(0.0503)	(0.0478)
Sep-12	-0.0632***	-0.122***	-0.0407***	0.0454	0.0433
	(0.00366)	(0.00538)	(0.00820)	(0.0518)	(0.0485)
Oct-12	-0.0672***	-0.115***	-0.0373***	0.0444	0.0420
	(0.00391)	(0.00557)	(0.00813)	(0.0502)	(0.0474)
Nov-12	-0.0520***	-0.0972***	-0.0322***	0.0337	0.0264
	(0.00388)	(0.00557)	(0.00833)	(0.0539)	(0.0503)
Dec-12	-0.0291***	-0.0754***	-0.0343***	0.0792	0.0517
	(0.00416)	(0.00656)	(0.00988)	(0.0651)	(0.0630)

A-9: reported mergers during April 2011-December 2012.

Acquirer	Acquired	Date	Transaction ($ million)	Merger purpose
Teva	Cephalon	May 2, 2011	6,800	Market expansion: entry to branded narcolepsy drugs by Provigil[8]
Apotex	Aveva	March 30, 2012	Unspecified	Market expansion: transdermal patches[9] (a drug delivery system)

[8]https://www.thestreet.com/investing/stocks/teva-acquires-cephalon-for-68-billion-11101059

[9]https://www.cmocro.com/news_detail/Apotex+Acquires+Aveva+Drug+Delivery+Systems+From+Nitto+Denko/129751/index.h

Acquirer	Acquired	Date	Transaction ($ million)	Merger purpose
Alvogen	Kunhwa	October 18, 2012	Unspecified	Geographic expansion: Asia Pacific[10]
Cadila	Biochem	January 2011	Unspecified	Market share: multiple drug markets in India
Upsher	Proximagen	June 13, 2012	555	Market share: central nervous system diseases, inflammation[11]
Sandoz	Fougera	July 23, 2012	2,100	Market share: dermatology[12]
TPG	Par	July 16, 2012	1,840	Management change: an asset management firm took over Par[13]

A-10: select Gilead market trends during 2011-2014 [MacroTrends, 2021, Mikulic, 2021]. Values are reported in $ billion. The 2014 revenue boost coincided with the introduction of Sovaldi.

Year	Year-end market capitalization ($ billion)	revenues ($ billion)	R&D expenditures ($ billion)
2011	30	8.4	1.2
2012	56	9.7	1.8
2013	114	11.2	2.1
2014	165	24.9	2.8

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[10]https://en.alvogenkorea.com/newsroom/read/alvogenacquiresmajorityofsharesinkunwhapharmaceuticals

[11]https://www.businesswire.com/news/home/20120814005877/en/Upsher-Smith-Completes-Acquisition-Proximagen-Group-plc#:~:text=MAPLE%20GROVE%2C%20Minn.--%20%28BUSINESS%20WIRE%29--%20Upsher-Smith%20Laboratories%2C%20Inc.,of%20the%20central%20nervous%20system%20%28CNS%29%20and%20inflammation.

[12]https://drugstorenews.com/pharmacy/sandoz-acquires-fougera-15-billion#:~:text=Sandoz%20announced%20the%20acquisition%20of%20Melville%2C%20N.Y.-based%20Fougera,it%20the%20world%27s%20largest%20company%20in%20the%20space.

[13]https://www.prnewswire.com/news-releases/par-announces-completion-of-acquisition-by-tpg-171799271.html

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