Journal of Economic Analysis

Homepage: https://www.anserpress.org/journal/jea

Effects of Horizontal Mergers on Prices of Generic Drugs

Antonio J. Trujillo [a, *], Mariana Socal [a], Gerard Anderson [a]

[a] *Bloomberg School of Public Health, Johns Hopkins University, Baltimore, MD, USA*

ABSTRACT

This paper quantifies the impact of horizontal mergers on the prices of drugs. We study all mergers between two publicly traded pharmaceutical companies working in the US between 2010 and 2015 and their effect on their drugs prices. Using a differences-in-differences approach, we estimate that drugs marketed by the merging firms experience an AWP increase of about between 8% and 15% during the five years following the merger. These price increases are present even in markets with more than five competitors.

KEYWORDS

Horizontal Merger; Generic Drugs; Market Concentration; Pharmaceutical Industry; Event Analysis

* Corresponding author: Antonio J. Trujillo
E-mail address: atrujil1@jhu.edu

ISSN 2811-0943
doi: 10.58567/jea04020004

Received 21 January 2024; Accepted 3 December 2024; Available online 24 January 2025; Version of Record 15 June 2025

1. Introduction

A focus of US Federal Trade Commission (FTC) is to review mergers that could be anticompetitive and could end in price increases. The challenge that FTC faces is to use current information on market structure to predict the dynamic changes in prices that might occur after the approval of a merger. Decisions based on inaccurate scenarios may lead to the denial of mergers that provide benefits to consumers or to the approval of mergers that might harm consumer surplus. Recently, the (FTC) has adopted a policy of reviewing mergers where the FTC intervened to determine if the approval (or denial) of mergers affected prices. Retrospective evaluation of horizontal mergers is an important source of information for improving anti-trust policies and its effect on consumer welfare (Hunter, Leonard, and Olley, 2008; Farrell, Pautler, and Vita, 2009; Hosken, Silvia, and Taylor, 2011; Kwoka Jr, 2012). This paper studies the impact of horizontal mergers between two public companies that occurred in the market for prescription drugs in US during the period of 2010-2017.

Examining recent mergers in the pharmaceuticals industry is relevant on several grounds. First, even though overall prices of generic drugs declined during the period 2010 to 2017; several important generic drugs had experienced significant price increases (Dave et al., 2017). The Government Accountability Office examined the price histories of 1,400 generic drugs and it found 351 cases of extraordinary price increases within a single year (GAO, 2016b). Several observers of the industry have suggested that the waves of horizontal mergers that occurred between 2008 and 2014 could have been responsible for these changes (Dave et al., 2017; Gagnon and Volesky, 2017; Joyce et al., 2018). Despite speculation that horizontal mergers are a possible explanation for the increases in prices for certain generic drugs, we have not identified a study that examines the impact of horizontal mergers on generic prescription drug markets. We understand that a horizontal merger occurs when two firms competing in the same market join forces. From the perspective of the pharmaceutical industry as a whole, all of the analyzed mergers occur within the same industry. However, at the same time we have to acknowledge that at the drug level, most of the merging pharmaceuticals do not necessarily produce the same drugs. For the purpose of our research, and considering that all the studied firms compete on the same industry, the pharmaceutical industry, we will refer to all mergers as horizontal.

Second, it is frequently assumed that after the patent for a branded drug expires, the market for generic drugs is likely to become competitive. When there is robust competition, prices are expected to reflect marginal costs, and market entry or exit is expected to happen at a low cost (Reiffen and Ward, 2005). However, contrary to this view, market concentration for generic drugs has been increasing, as it was recently estimated that ten pharmaceutical companies are responsible for 57.8% of the total volume of generic sales (dollar value) in the US (IMS Health, 2015). Lack of competition in the markets can arise as a result of brand drugs companies paying generic pharmaceuticals to stay out of the market for a specific product (Kadura, 2007). Additionally, brand drug companies may obstruct the effort of generic drug companies to replicate brand products by creating limited distribution chains (Lee et al., 2016). Mergers between brand and generic companies may propel this type of anti-competitive behavior (Granier and Trinquard, 2010; Morton, 2002).

Using claim level data from the IBM MarketScan Commercial Database (2010-2017), we conducted a difference-in-differences approach to assess the impact of horizontal mergers between two publicly traded companies on the prices of drugs. Our identification strategy relies on using drugs marketed by non-merging labelers as our control group. To analyze the effects of mergers on the market for generic drugs, we examine the average wholesale prices (AWP) of affected drugs, the patient's co-payment, and payment amount to provider. We estimate that drugs produced by the merging firms experience an AWP increase of about between 8% and 15% during the five years following the merger.

The most difficult task in developing a credible difference-in-difference research design is finding a credible counterfactual. In a merger setting, this means identifying some product that experiences similar demand and costs

shocks as the product(s) affected by the merger, but that is itself unaffected by the merger. Most papers estimating the price effects of mergers study products that are sold in relatively narrow geographic markets, e.g., hospital services. This allows the researcher to exploit geographic variation in how the merger affected competition. For instance, in estimating the effects of hospital merger in one metro area, the researcher can use hospital prices in other metro areas as controls. However, because generic drugs are sold nationally, this identification approach is not feasible. Instead, we search for the same drugs produced by labelers not affected by mergers to be controls for drugs that were affected by mergers. Notice that this is a narrowest possible control group and risky one as generics tend to be homogeneous. An alternative is to use different drugs who have not been affected by mergers. This alternative is less attractive as we would be combining drugs with different demand and cost shocks.

As prices of drugs are often affected by confidential agreements between pharmaceuticals, insurance companies, and retailers, researchers in this field have argued that average whole prices (AWP) might not be a good indicator for drug's prices, especially for generic drugs, as they do not measure the discounts and rebates that may occur in the margin. As a result, and due to a lack of a better measure, we conducted our analysis using additional proxies for prices available in our main data set. These include co-payment and total payment to providers. We are aware that co-payments are partially determined by the regime of a drug coverage and it can evolve based on the need of the drug plan for cost control without influence of the manufacturers. In short, factors outside merger may influence co-payments. Despite these factors, we include co-payments in the analysis as it is well known that AWP may not reflect the final prices of the drugs as we do not observe rebates and other discounts in the market.

In our econometric strategy, we control for several observable covariates including at the drug level, generic or branded status, number of labelers marketing the drug, type of merger depending on the characteristics of the acquiring and acquired companies, the proportion of market is covered by generic drugs, and number of substitutes at the therapeutic level.

This permits incorporation in the models the possibility of consumers' substitution patterns which would impact prices after the merger. We explore the heterogeneity of the effect of horizontal mergers by number of labelers in a market: low (less than 5 labelers), medium (between 5-10 labelers) and high (more than 10 labelers) per market. In addition, we also evaluate the differential effect of horizontal mergers by market size and pre-merger level of market concentration.[1]

For instance, after horizontal mergers, prices of generic drugs may follow the trajectory proposed by Dylst and Simoens (2011) where the number of competitors in the market is an important predictor of prices. Generics in low concentrated markets might see low changes in prices after a merger, while generics in highly concentrated market may experience large price increases. We also study drugs affected by mergers where both the acquirer and target firms are generic firms, and drugs affected by a horizontal merger where a branded labeler acquires a generic firm, or vice versa. This may be relevant as a branded drug may acquire a generic drug company to reduce competition for the branded product. Finally, we study drugs affected by a horizontal merger where the two involved companies produce the same product, resulting in an effective reduction the number of competitors.

Our work fits into the retrospective literature on merger evaluation (Kovacic, 2000; Carlton, 2007; Hosken, 2011). For example, in the airline industry, (Kim and Singal, 1993; Luo, 2014), banking, (Focarelli and Panetta, 2003; Garmaise and Moskowitz, 2006), hospitals, (Krishnan, 2001; Dafny, 2009; Haas-Wilson and Vita, 2011), oil, (Hosken, Silvia, and Taylor, 2011; Silvia and Taylor, 2013), and supermarkets, (Pires and Trindade, 2018; Hosken, Olson, and Smith, 2018). In addition, some of these studies assess the effect of a merger by identifying and studying a single event, in most cases a merger that was close to be rejected by the FTC. We depart from this single merger approach,

[1] In addition to these variables, the data also includes a variable called "ingredient cost". Despite of its name this variable does not reflect the cost of raw materials, or the cost of any active ingredient. Rather this variable measures the charges associated with the pharmaceutical product. In other words, it is a measure of the ingredient cost plus any dispensing fee from providers and any applicable sales tax. As a result this variable is not included as a control variable in our analysis.

by looking at the universe of mergers between two publicly traded companies occurring in the generic space between 2010 and 2016.

We incorporate several internal empirical checks to test the robustness of our findings. This analysis is helpful for anti-trust enforcement agencies to identify potential screening variables to evaluate mergers prior to approval. Our dataset allows us to explore patterns of price changes in markets affected by mergers in which one of the involved companies sells mostly patented drugs, and in mergers in which the horizontal merger reduces number of labelers in the market. To illustrate the relevance of these issues it is helpful to cite that the 2016 NAM report indicates that horizontal mergers between companies that produce both brand and generic drugs treating the same condition can have anti-trust consequences that may result in undesirable price increases in the absence of competition.

We estimate the effect of mergers on prices up to five years after the event, as assessing the existence of short-term and long-term differentials in the effect of horizontal mergers is relevant for policy making. Observers of market dynamics have suggested that government interventions resulting from short-term spikes in prices might be unnecessary as price increases might revert automatically after few years. Studies that include long-term assessment of the effect of mergers are lacking in this field (Ashenfelter, Hosken, and Weinberg, 2014). Our findings are in line with the empirical evidence that suggest that horizontal mergers may cause excessive increases in prices (Shapiro, 2010; Ashenfelter, Hosken, and Weinberg, 2014; Pautler, 2015). Interestingly, our results of the effects of mergers on generic drugs prices are larger in size to the ones recently reported by (Bonaime and Wang, 2019). One tentative explanation for our larger effects is that we focused exclusively on the price of generics which report lower baseline prices.

Furthermore, we estimate an important increase in prices of drugs in markets with more than 5 labelers before the transaction. Thus, even though pre-merger number of labelers and market concentration are important factors to consider in investigating the approval of horizontal mergers, the analysis suggests that enforcement authorities may need to consider additional screening factors to decide which merger to investigate and approve to protect consumers from price increases.

Our paper is silent on describing the exact mechanism by which mergers could affect competition. Further research will be needed in this direction. However, there are two likely different mechanisms which may imply different identification strategy. First, one can view competition between generic drug manufacturers as being limited to specific drugs. In the U.S., firms receive permission from the FDA to produce a generic drug if they can convince the FDA that their generic is bioequivalent to the originator drug. If the drug is approved, the manufacturer receives an ANDA (Abbreviated New Drug Application) from the FDA that can be viewed as a property right to produce the drug. A merger of two firms with ANDAs for a given drug simply results in a reduction of the number of effective competitors that produce that drug. A potential control group for a drug affected by a merger would be the set of drugs that had the same number of ANDAs as the affected drug pre-merger. Our identification strategy would provide evidence on this mechanism.

Second, a merger of generic drug manufacturers could be viewed as affecting the entire generic drug industry. Generic drugs are produced in factories that produce many different drugs. As the ownership of productive capacity has become more concentrated, it is possible that all generic drug prices may have increased. The market power created by the merger does not come from increased concentration in the ownership of ANDAs, but rather is the result of increased concentration in ownership of manufacturing capacity. However, because drugs are produced in a world market (a large fraction of drugs are imported into the U.S.), it is not clear what a valid control group would be to test the effect of mergers on prices.

The paper is structured as follows, in Section 2 we discuss the data used in our analysis; our empirical strategy is presented in Section 3; Section 4 discusses our results and we present conclusions in section 5 as well as some

policy implications of our findings.

2. Data

The data used in our analysis comes from two sources, the Securities Data Company (SDC) Platinum by Thomson Reuters, and the IBM Market Scan Drugs Claims (MarketScan). From the first source we obtained information that allow us to identify all publicly traded companies involved in a merger and/or acquisition in the 2010-2017 period. The second source allow us to obtain information on the prices, sales volumes, and number of labelers marketing a specific drug, in a given year.

2.1. Horizontal Mergers

In order to identify all the drugs in our study sample, we first needed to identify all the labelers that were involved in a horizontal merger between two publicly traded pharmaceuticals. Using the SDC Platinum by Thomson Reuters' Mergers and Acquisitions data set, we started by looking at all completed transactions between two publicly traded, non-veterinarian, pharmaceutical companies with the SIC code 2834 (pharmaceutical preparations) from 2010 to 2015. From all events recorded in the data set, we ignored all transactions regarding debt restructuring or other internal transactions as well as those regarding minority stake acquisitions. A total of 70 horizontal mergers involved at least one labeler marketing a drug with at least one claim recorded in the IBM MarketScan Database between 2010 and 2017. A total of 95 different labelers were identified.

Figure 1 shows the total number and transaction value per year of all mergers included in this analysis. As seen from this figure, the highest number of mergers (18) took place in 2015. Looking at value of the mergers, the highest value also happened in 2015 - almost 150 billion dollars. The number of transactions as well as total value of mergers in the generic industry increased consistently between 2012 and 2015. The size of the mergers also increased with the number of horizontal mergers growing by 157% between 2012 and 2015; while the value of total transaction per year increased almost 400% during the same period.

In short, the studied period included years in which several horizontal mergers with high transaction value took place in the generic industry.

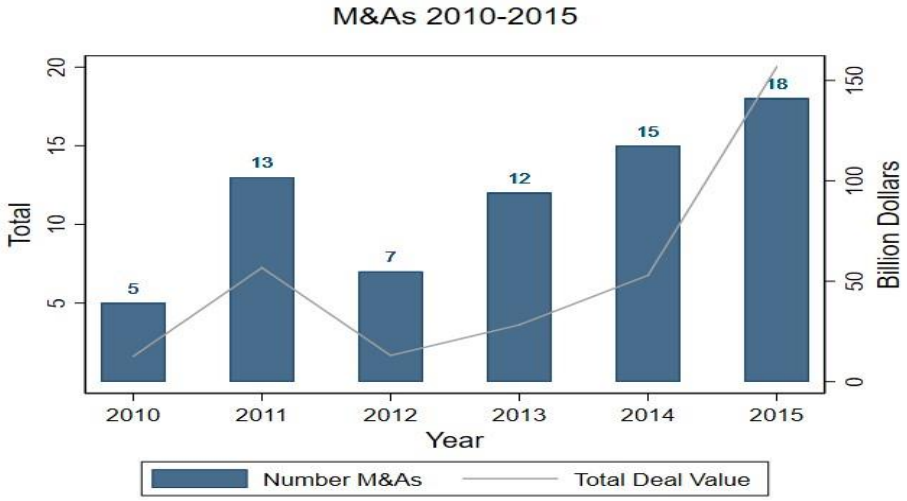

Figure 1. Horizontal Mergers 2010-2015.

Anti-trust experts and general observers in the popular press have previously identified concerns about whether horizontal mergers in the pharmaceutical industry reduce consumer surplus. Some of these concerns are

that the entry of generic products in markets where a brand company's patents are near to expire and they use the generic company to delay entry of generics in the market. Others have mentioned the possibility of post-merger collusion practices as the root for a price increase. In addition, some of these horizontal mergers involved two companies producing the same products in markets with already low competition levels.

Table 1 reveals the top 15 horizontal mergers that involve a labeler producing generic drugs. Some of these were controversial such as the one between Novartis AG a branded-drug company and Alcom Inc. a generic company with an acquisition price of $12.9 billion. We also studied all generic products impacted by the 2011 mergers between Sanofi-Aventis SA and Genzyme Corp that involves a deal value of $23.8 billion. Our final sample includes the 2015 merger between Actavis PLC (a generic company) and Allergan inc (branded company) for an estimated value of $68.4 billion. We included all generic drugs impacted by the horizontal merger between Pfizer inc and Hospira which happens in 2015. Both firms have in their portfolio brand as well as generic drugs. These are few examples to illustrate the variety of horizontal mergers studied in this work. Appendix A lists all the horizontal mergers included in this work.

Table 1. Top 15 Mergers and Acquisitions. 2010-2015.

Rank	Year Completed	Acquiring Company	Target Company	Deal Value $ Million
1	2015	Actavis PLC	Allergan Inc	68,445
2	2014	Actavis PLC	Forest Laboratories Inc	25,440
3	2011	Sanofi-Aventis SA	Genzyme Corp	23,899
4	2015	AbbVie Inc	Pharmacyclics Inc	20,774
5	2015	Pfizer Inc	Hospira Inc	15,820
6	2015	Valeant Pharmaceuticals Intl	Salix Pharmaceuticals Ltd	14,468
7	2011	Novartis AG	Alcon Inc	12,900
8	2013	Amgen Inc	Onyx Pharmaceuticals Inc	9,693
9	2015	Merck & Co Inc	Cubist Pharmaceuticals Inc	9,348
10	2013	Perrigo Co	Elan Corp PLC	8,538
11	2015	Celgene Corp	Receptos Inc *	
12	2012	Bristol-Myers Squibb Co	Amylin Pharmaceuticals Inc	6,748
13	2011	Teva Pharmaceutical Industries	Cephalon Inc	6,311
14	2010	Merck KGaA	Millipore Corp *	
15	2014	Mallinckrodt PLC	Questcor Pharmaceuticals Inc	5,592

*Deal value at time of announcement in dollars of year of announcement. * Companies without a claim in MarketScan.*

2.2. Drug Data

Once that we identified the labelers that were involved in a merger, we turn our attention to identify the drugs that were affected by a horizontal merger and their price trajectory. For this purpose we use The IBM Market Scan Drugs Claims from 2010 to 2017. MarketScan is a data set that captures individual's health care utilization and expenditure across inpatient, outpatient, prescription drug and other health care providers. These data is comprise of fully-paid and adjudicated service-level claims from approximately 41.1 million individuals and their families who are covered by employer-sponsored private health insurance in the US.

It is important to clarify that most drugs tend to be available in different preparations (e.g. capsules, tablets, injections) and strengths (e.g. 125mg, 250mg, and 500mg) in addition to being sold by multiple labelers. Thus, when we refer to a specific drug, we refer to a specific active ingredient/preparations/strength combination. For example, Doxycycline, tablet, 500mg is analyzed as a different drug from Doxycycline, tablet, 1,000mg. Furthermore, from our analysis perspective, we consider each drug as a single market unit. From this point on we will use the term market and drug interchangeably.

Each drug can be sold by multiple labelers (e.g. Pfizer and Hospira), as a result we are going to consider each one of these labelers as independent players in each market. Although one might be tempted to refer to the labelers as manufacturers, in the pharmaceutical industry one manufacturer can supply drugs to different labelers. However, our data set allows to only differentiate across labelers. Hence, as is common practice in the empirical work on the pharmaceutical sector, when considering the number of producers in a market, we are going to consider number of labelers instead.

In our data we encounter that in many markets, a single labeler might sell the same product in different packages sizes, for example in packages of 50 and 100 pills. As a result, when computing all monetary variables, such as payment, average whole sale price, and patient's co-payments, we first computed the annual average per-day supply price of each drug/labeler/package size combination. Then, for each drug/labeler combination we computed a single drug/labeler value as weighted average of the market share of each package size. These values were then deflated to dollars of 2010 using the consumer price index for all urban consumer medical care commodities of an average urban city. In addition, for each drug we computed the number of active labelers in a year, and the HHI for each market as a measure for market concentration based on each drug/labeler annual sales volume.

One of the advantages of using Market Scan is that it allows us to identify active labelers based on actual claims submitted as opposed to using other information sources which might define number of labelers such as the number of approved new drug applications (ANDA's), or abbreviated new drug applications (NDA's), which might not reflect a drug's true com-petition level.

The data also allow us to estimate the number of substitutes at the therapeutic level. We define the number of substitutes as the total number of labelers producing a drug that might be considered as a substitute at the active ingredient level. For example, for a specific drug/preparation/strength/labeler, a substitute is not only the same drug/preparation/strength but a different labeler, but also different preparation (tablet or capsule), or strength (250mg or 500mg).

In addition to observing the number of active labelers, the data allow us to observe whether each drug is branded or generic, which allow us to compute the proportion of each market covered by generic drugs as the proportion of prescriptions filled with a generic drug in a year for a specific drug.

We also identify all drugs in which both of the companies involved in a merger were selling the same drug (defined as drug/preparation/dose), meaning that we are able to also identify all mergers actively reducing competition, unless the FTC ordered corrective actions.

Because most drugs with an active patent are marketed only by a single labeler, we restricted our analytic sample to all drugs with a multisource generic available to procure the existence of multiple labelers across all studied drugs.

Table 2 shows summary statistics for all covariates and analyzed outcomes (during all period of study) by number of labelers in the market. Drugs in markets with less than five labelers report a higher AWP than generics in more competitive markets. Similarly, payments to providers are higher for drugs in markets with low and medium competition, about $97 and $91 per prescription, in comparison to markets with more than ten labelers, about $5 per prescription. Average consumer co-payment per drug also declines from $3.34 in low competitive markets to $0.71 in markets with ten or more labelers.

Notice also that across all types of markets, generics cover about 85.3% of the market, however, markets with more than ten labelers tend to have a higher proportion of generics covering the market in comparison to markets with less than five labelers, about 88% and 80% respectively. Finally notice that highly competitive markets are twice as big as markets with less than ten labelers in terms of sales volume (131 million versus 64 million).

Table 2. Descriptive Statistics by Number of Competing Labelers in Market.

Variable	Full Sample		Low Comp. 5 > Labelers		Medium Comp. 5 - 10 Labelers		High Comp. 10 < Labelers	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
AWP ($ US)	200.42	(19,493.12)	810.21	(46,986.16)	162.90	(3,264.44)	19.58	(299.72)
Payment ($ US)	48.25	(1,837.55)	96.97	(2,139.24)	91.46	(2,841.28)	4.61	(63.81)
Copay ($ US)	1.68	(12.39)	3.34	(15.11)	2.35	(18.40)	0.71	(3.08)
Num of Labelers/Drug	12.13	(7.63)	3.66	(1.44)	7.80	(2.26)	17.70	(6.61)
Num Therapeutic Subs	219.46	(181.43)	181.34	(175.02)	203.76	(184.77)	242.17	(178.19)
MA Generic/Generic	80.8%	(0.39)	59.9%	(0.49)	75.3%	(0.43)	91.2%	(0.28)
MA Branded/Generic	91.6%	(0.28)	76.9%	(0.42)	89.9%	(0.30)	97.6%	(0.15)
% Mkt Covered by Generics	85.3%	(0.15)	80.3%	(0.22)	83.1%	(0.14)	88.4%	(0.11)
Market Size (Million $ US)	98.66	(1,256.28)	63.74	(2,369.89)	65.31	(296.88)	131.44	(1,078.38)
N (Drug/Labelers/Years)	94,506		16,115		30,347		48,044	

Notes: Monetary values in US dollars of 2016. Payments are gross payments to a provider for a prescription; Copayment, payments made by the beneficiary to satisfy copayment or coinsurance; AWP, the average wholesale price charged by wholesales for the specific drug. Number of therapeutic substitutes for the drug at the generic ingredient level. Number of labelers per drug is the number of labelers marketing the same drug/strength/delivery method. MA stands for mergers or acquisitions. Generic drug indicator takes the value of one if the drug is a generic, zero if a branded drug.

3. Empirical Analysis

3.1. Descriptive Analysis

Before we proceed with our empirical econometric strategy, we conducted a descriptive analysis of the average change in prices for all the 1,886 drugs impacted by a horizontal merger. We compute the average annual change in prices over 2010-2017 for those drugs with less than five labelers; for drugs with between five and up to ten labelers, and for drugs with at least ten active labelers. We then categorized the experienced price increases into three groups, increases below the 10%, increases between 10% and 50%, and increases larger than 50%. As a result, we end up with a 3x3 matrix for price increases and market competition as depicted in Table 3.

Table 3. Changes in Average AWP after a Horizontal Merger by number of labelers.

	Less than 5 Labelers	5 - 10 Labelers	More than 10 Labelers
>50% Increase	53.16%	41.48%	30.05%
10%-50% Increase	35.91%	46.36%	58.89%
<10% Increase	10.90%	11.76%	11.05%

One would expect most of drugs to be along the diagonal of the matrix, as the price increasing effects of mergers on prices are expected to be stronger among drugs with a low number of providers. However, our descriptive analysis indicates that several drugs divert from this hypothesis, especially in the category with the most labelers.

As shown in Table 3, 30.05% of all drugs in competitive markets show price increases above 50% during the period of the study. Almost 42% of all drugs in markets with 5 to 10 labelers show price increases above 50%. These estimates however, do not assess causation nor are definitive evidence of a link between mergers and price increases, neither are we testing if market with higher number of labelers show lower price increases than markets with low number of labelers. Our aim with this description is to highlight that after horizontal mergers, many drugs in markets with more than five labelers show significant price increases. Moreover, during the period of study some key drugs with more than 10 labelers such as pioglitazone, ondansetron, pioglitazone and divalproex have

experienced price increases above 100% after experiencing a horizontal merger despite previous evidence suggesting that prices approach the marginal cost in market with at least eight competitors (Reiffen and Ward, 2005).

Similarly, other drugs with more than five active labelers, but with less than ten, such as ranitidine, hydralazine, modafinil, and valproic also reveal price increases above 100%.

These price changes are the ones identified in the medical literature as evidence of a strong association between horizontal mergers and price increases in the market for generic prescription drugs. A complete list of all drugs in each cell can be obtained from the authors upon request.

3.2. Econometric Strategy

One objective of our research is to identify the effect of horizontal mergers on the price of drugs with multisource generics available. In order to estimate this effect, we implement a differences-in-differences methodology. Thus for drug *j*, sold by labeler *n*, at time *t* we then estimate the following equation:

$$y_{tnj} = \gamma_t + \sum_{r=s-1}^{2010} \beta_r M_{rj}^{Pre} + \sum_{r=s}^{2016} \beta_r M_{rj}^{Post} + \sum_{r=s}^{2016} \lambda_r MA_{tnj} \times M_{rj}^{post} + \phi x_{tnj} + c_{nj} + u_{tnj} \quad (1)$$

where y_{tnj} refers to the outcome of interest (payment to providers, average wholesale price, and patient co-payment). The variable γ_t is a set of calendar year fixed effects. The variable MA_{tnj} is our merger indicator variable that takes the value of one for all *j* drugs, sold by labeler *n*, if labeler *n* was involved in a merger at time *s*. M_{rj}^{pre} and M_{rj}^{Post} are indicator variables for the time period relative to the time of the merger. Additionally, x_{tnj} is a vector of control covariates that include: proportion of the market covered by generic drugs, number of labelers, other than labeler *n*, selling drug *j*, number of substitutes for the drug at the therapeutic level,and market size measured by drug volume.

The variable c_{nj} is drug/labeler fixed effects. Finally, we also include an unobserved random error u_{tnj}. We estimate Equation 1 by fixed effects, we assume contemporaneous exogeneity $Cov(MA_{tnj}, utnj)$ as if $MA_{tnj} = 1$, $MA_{rnj} = 1$ for $r > t$. The main coefficients or interest are λ_r for the relevant periods with respect to the event.

Our identification strategy relies on forming a counterfactual based on the same drugs produced by labelers not impacted by mergers. This strategy prevents us to include in the control group drugs that may be impacted by different demand or cost shocks outside the merger. Including in the control group drugs in different therapeutic classes but not impacted by mergers will reduce the possibility of finding the effect of mergers on prices as these drugs may be impacted by other shocks outside mergers.

It is important to highlight that an alternative method to identify the effect of mergers on prices would rely on identifying overlapping in mergers. Under this premise, one should differentiate the effects of mergers when both acquirer and target sell drug j and when only one of the two firms sells drug j, separately. Basically, when one observes overlap the effect should be larger than when there is no overlap. Although this approach has been used in the retrospective studies of mergers in other industries, we find that this strategy is not feasible in our case for two main reasons. First, we consider that the effect on prices of mergers go beyond one specific drug but over all drugs produced by the labelers. Second, even when we tried this approach our sample size are too small to find precise estimates. In short, we decided that this approach would be better suit if one implements a case study approach rather than a study when all mergers are grouped and analyze using a difference-in-difference approach.

In addition to this approach, we also implemented an event analysis to estimate the effect that mergers have on prices on the spirit of Dobkin et al. (2018). This analysis yielded similar results to those presented here and are available upon request from the authors.

Before running the models, we verified the parallel trends assumption. That is, that prices in the control market

have an identical trend to prices in the treatment (merger) market in the pre-merger period. These results are also available from the authors.

4. Level 1 heading

4.1. Average effect of horizontal mergers

The results from our estimations are presented in Table 4. According to our estimates, in a fully adjusted model, drugs marketed by merging companies experienced an AWP increase of about 8.7% the year following the merger, compared with the prices observed during the pre-merger years. This increase in prices continued for up to five years after the merger.

Table 4. Differences in Differences Estimators.

Variable	Payments		Copayment		AWP	
	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
Time Post Merger						
M_0	0.014**	0.015**	0.013***	0.014***	0.025***	0.031***
	(0.006)	(0.006)	(0.004)	(0.004)	(0.008)	(0.008)
M_1	0.026***	0.030***	0.014***	0.016***	0.078***	0.087***
	(0.006)	(0.006)	(0.004)	(0.004)	(0.008)	(0.008)
M_2	0.035***	0.037***	0.014***	0.015***	0.143***	0.149***
	(0.008)	(0.008)	(0.005)	(0.005)	(0.010)	(0.010)
M_3	0.028***	0.029***	0.012*	0.012*	0.136***	0.137***
	(0.009)	(0.009)	(0.006)	(0.006)	(0.011)	(0.011)
M_4	0.038***	0.042***	-0.006	-0.008	0.134***	0.141***
	(0.014)	(0.014)	(0.010)	(0.010)	(0.018)	(0.018)
M_5	0.040***	0.043***	-0.003	-0.006	0.080***	0.081***
	(0.015)	(0.015)	(0.011)	(0.011)	(0.020)	(0.019)
Additional Covariates						
Num Therapeutic Subs		-0.020***		0.016***		-0.007
		(0.006)		(0.004)		(0.007)
Num of Labelers/Drug		-0.161***		-0.009		-0.125***
		(0.009)		(0.006)		(0.011)
MA Generic/Generic		-0.004		-0.043		-0.134
		(0.075)		(0.053)		(0.096)
MA Branded/Generic		-0.033		-0.109*		0.326***
		(0.082)		(0.058)		(0.104)
Generic Drug Indicator		-0.048		0.012		-0.001
		(0.034)		(0.024)		(0.043)
% Mkt Covered by Generics		0.037		0.316*		-0.993***
		(0.266)		(0.188)		(0.340)
Log (Mkt Size, $ US)		0.084***		0.025***		0.184***
		(0.002)		(0.002)		(0.003)
Year FE	Y	Y	Y	Y	Y	Y
N (Drug/Labelers/Years)	94,506	94,506	94,506	94,506	94,506	94,506

*Notes: Heterogeneous standard errors in parentheses clustered at the drug level. Significance levels: *p<0.10; **p<0.05; ***p<0.01. Payments are gross payments to a provider for a prescription; Copayment, payments made by the beneficiary to satisfy copayment or coinsurance; AWP, the average wholesale price charged by wholesales for the specific drug. Number of therapeutic substitutes for the drug at the generic ingredient level. Number of labelers per drug is the number of labelers marketing the same drug/strength/delivery method. MA stands for mergers or acquisitions. Generic drug indicator takes the value of one if the drug is a generic, zero if a branded drug.*

Similar to these estimates, our results with respect to payments to providers and individual's co payments also show a increase with respect to the pre-merger years. However, the magnitude of the estimates differ in magnitude with respect to those from AWP. Our results suggest that payment to providers increased from about 3% the year

following the merger to about 4.3% during the fourth and fifth year post-merger. All these results were statistically significant.

Unlike the case of AWP and payment to providers, our data suggests that individual's co-payments increased between 1.6% and 1.2% the three years following the merger, yet during years four and five after the merger, the effect of the merger on co-payments is not statistically different from zero. This result might suggest that a firm first reaction is to have higher co-payments right after a merger, but this trend is reversed once the firm adapts to the market.

As expected, the results from our covariates suggest that in general, AWP, payments to providers, and co-payments are negatively correlated with number of labelers in the market, and positively correlated with the value of the market.

Our estimates also suggest that the impact of mergers on a drug price depends on the type of merger affecting the drug's market. For example, while branded/generic mergers tend to be positively correlated with higher AWP's, they tend to be negatively correlated with people's co-payments. Unlike this result, our estimates suggest that a high proportion of a market covered by generics is associated with higher co-payment levels and lower average whole prices.

4.2. Heterogeneous Effects: Different levels of competition

We explore the impact that horizontal mergers have on the price and market structure of drugs in markets with different levels of competition prior to an event. For this purpose, we classify all drug into three different competition categories according to the number of active labelers working in each market before each merger.

The idea behind this analysis is to explore if the effect of horizontal mergers varies according to the level of competition pre-transaction (Shapiro, 2010; Carlton, 2010). The FTC considers the presence of five or less labelers in each market as a main variable to identify markets with oligopolistic or monopolistic structure and at high probability for price increases after the approval of a merger.

Table 5, Panel A, B, and C show the results of this analysis. In markets with less than five labelers, our results suggest that merging companies increased their AWP in about 4.9% the year following the merger, an up to 15% during year four post-merger, both of these results are statistically significant. Payments to providers experienced an increase of about 5.2% during the two years following the merger. There is only suggestive evidence that payments also experienced and increase later on, but these results are not statistically significant different from zero. With respect to co-payments, our estimates show that merging pharmaceuticals increase co-payments in about 2.6% the year following a merger, and that this results are statistically significant.

In Panel B, we show the estimates corresponding to markets with more than five but less than ten labelers. Our results show that drugs sold by merging companies increased average wholesale prices from about 8% and up to 13% the first four years after a merger. The estimates also suggest that these increases revert during year five, although this result is not statistically significant. In terms of payment to providers, we estimate an increase of about 3.2% only during the two years following the merger, this result is statistically significant at the 90%. With respect to co-payments, our estimates show that merging pharmaceuticals increase co-payments from 2.1% to about 2.7% the three years following a merger. These results are statistically significant at standard levels.

To finalize, Panel C presents our estimates for drugs in markets with more than ten labelers. Based on our estimates, AWP exhibit increases from about 8% to 14% up to five years following the merger, all of these estimates statistically significant at standard levels. In contrast with our previous estimates, we find no evidence of an increase in payments to providers and co-payments after a merger.

Table 5. Differences in Differences Estimators by Number of Competing Labelers in Market.

	Payments		Copayment		AWP	
Time to Merger	Model 1	Model 2	Model 1	Model 2	Model 1	0.029
			Panel A. Less than five labelers (N=16,115)			
M_0	0.028*	0.028*	0.021	0.022*	0.019	0.029
	(0.017)	(0.017)	(0.013)	(0.013)	(0.023)	(0.021)
M_1	0.051***	0.052***	0.026**	0.026**	0.041*	0.049**
	(0.017)	(0.017)	(0.013)	(0.013)	(0.023)	(0.022)
M_2	0.048**	0.054***	0.003	0.004	0.087***	0.100***
	(0.021)	(0.021)	(0.016)	(0.016)	(0.029)	(0.027)
M_3	0.034	0.026	0.006	0.002	0.083**	0.064**
	(0.025)	(0.024)	(0.019)	(0.019)	(0.034)	(0.031)
M_4	0.051	0.056	-0.042	-0.042	0.134***	0.149***
	(0.036)	(0.035)	(0.027)	(0.026)	(0.048)	(0.045)
M_5	0.038	0.044	-0.051	-0.052*	0.029	0.055
	(0.042)	(0.041)	(0.031)	(0.031)	(0.057)	(0.053)
			Panel B. More than five but less than ten labelers (N=48,044)			
M_0	0.006	0.008	0.018**	0.019**	0.019	0.027*
	(0.012)	(0.012)	(0.009)	(0.009)	(0.014)	(0.014)
M_1	0.027**	0.028**	0.023***	0.023***	0.080***	0.082***
	(0.012)	(0.012)	(0.009)	(0.009)	(0.014)	(0.014)
M_2	0.029**	0.032**	0.028***	0.027**	0.121***	0.133***
	(0.015)	(0.015)	(0.011)	(0.011)	(0.017)	(0.017)
M_3	-0.003	-0.001	0.020*	0.021*	0.115***	0.122***
	(0.017)	(0.017)	(0.012)	(0.012)	(0.020)	(0.020)
M_4	0.006	0.018	-0.000	0.001	0.060*	0.081***
	(0.027)	(0.027)	(0.019)	(0.019)	(0.031)	(0.031)
M_5	0.022	0.027	0.021	0.023	0.001	-0.007
	(0.029)	(0.029)	(0.021)	(0.021)	(0.034)	(0.034)
			Panel C. Mo re than ten labelers (N=30,347)			
M_0	0.008	0.009	0.012**	0.012**	0.026**	0.029***
	(0.008)	(0.008)	(0.005)	(0.005)	(0.011)	(0.011)
M_1	-0.000	0.002	0.005	0.006	0.073***	0.078***
	(0.008)	(0.008)	(0.005)	(0.005)	(0.011)	(0.011)
M_2	0.001	0.002	0.011*	0.011*	0.139***	0.140***
	(0.009)	(0.009)	(0.006)	(0.006)	(0.013)	(0.013)
M_3	0.017	0.017	0.010	0.009	0.123***	0.123***
	(0.011)	(0.011)	(0.007)	(0.007)	(0.015)	(0.015)
M_4	0.017	0.014	0.009	0.006	0.119***	0.112***
	(0.018)	(0.018)	(0.012)	(0.012)	(0.025)	(0.025)
M_5	0.030	0.026	-0.009	-0.012	0.086***	0.080***
	(0.019)	(0.019)	(0.013)	(0.013)	(0.027)	(0.027)

*Note: Number of observations at the drug/label/year. Heterogeneous standard errors in parentheses clustered at the drug level. Significance levels: * p<0.10; ** p<0.05; *** p<0.01. Payments are gross payments to a provider for a prescription; Copayment, payments made by the beneficiary to satisfy copayment or coinsurance; AWP, the average wholesale price charged by wholesales for the specific drug. N is the number of drug/year observations.*

In addition to exploring the effects of horizontal mergers in markets with different number of active labelers, we also wanted to explore the consequences of these events on markets with different levels of concentration as measured by the HH Index. The average HHI across drug markets in the sample is 0.43. This is high, considering the

US Horizontal Merger Guidelines hold that markets with an HHI above 0.25 are highly concentrated, so mergers among firms in these markets are likely to be anticompetitive. We divided all the drugs into two groups based on their pre-merger HH Index, one for all drugs with a pre-HHI above 0.25, and one for all drugs with a pre-merger HHI below 0.25. These results are presented in Table 6, panels A and B.

Table 6. Differences in Differences Estimators by Market Concentration.

	Payments		Copayment		AWP	
Time to Merger	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
Panel A. HHI above 0.23 (More Concentrated Markets)						
M_0	0.0132**	0.0138**	0.0136***	0.0117**	0.0279***	0.0436***
	(0.006)	(0.006)	(0.005)	(0.005)	(0.008)	(0.008)
M_1	0.0258***	0.0263***	0.0152***	0.0125***	0.0783***	0.0894***
	(0.007)	(0.006)	(0.005)	(0.005)	(0.008)	(0.008)
M_2	0.0340***	0.0329***	0.0165***	0.0084	0.1414***	0.1620***
	(0.008)	(0.008)	(0.006)	(0.006)	(0.010)	(0.010)
M_3	0.0218**	0.0161*	0.0121*	0.0030	0.1350***	0.1509***
	(0.009)	(0.009)	(0.007)	(0.007)	(0.012)	(0.012)
M_4	0.0344**	0.0372***	-0.0049	-0.0139	0.1290***	0.1560***
	(0.014)	(0.014)	(0.010)	(0.010)	(0.018)	(0.018)
M_5	0.0364**	0.0374**	-0.0050	-0.0105	0.0750***	0.0827***
	(0.016)	(0.016)	(0.011)	(0.011)	(0.020)	(0.020)
Panel B. HHI below 0.23 (Less Concentrated Markets)						
M_0	0.0232	0.0113	0.0100	0.0108	-0.0191	-0.0030
	(0.023)	(0.023)	(0.014)	(0.014)	(0.031)	(0.031)
M_1	0.0109	-0.0087	0.0033	0.0072	0.0521	0.0493
	(0.024)	(0.023)	(0.014)	(0.014)	(0.032)	(0.032)
M_2	-0.0040	-0.0154	-0.0115	-0.0152	0.1089***	0.1094***
	(0.029)	(0.029)	(0.018)	(0.018)	(0.039)	(0.039)
M_3	0.0639*	0.0604*	0.0095	0.0144	0.0577	0.0666
	(0.033)	(0.034)	(0.020)	(0.020)	(0.045)	(0.045)
M_4	-0.0033	0.0470	-0.0136	-0.0140	0.0895	0.0927
	(0.067)	(0.068)	(0.041)	(0.041)	(0.092)	(0.091)
M_5	0.0036	0.0584	0.0297	0.0364	0.0138	0.0390
	(0.071)	(0.071)	(0.043)	(0.043)	(0.096)	(0.096)

*Note: Number of observations at the drug/label/year. Heterogeneous standard errors in parentheses clustered at the drug level. Significance levels: * p<0.10; ** p<0.05; *** p<0.01. Payments are gross payments to a provider for a prescription; Copayment, payments made by the beneficiary to satisfy copayment or coinsurance; AWP, the average wholesale price charged by wholesales for the specific drug. N is the number of drug/year observations.*

As shown in Table 6, panel A, in more concentrated markets (pre-merger HHI above 0.25), the results show that AWP's go up between 8.9% and 15.6% during the years following the merger, when compared to non merging firms. Similarly, payment to providers experienced an increase of about 2.6% to 3.7% the years following the merger. When considering markets with an HHI below 0.25 (see Table 6, panel B), AWP and payments did not change during the post merger years except during year two for the case of AWP (about 10.9%), and about 6% during year three. All these estimates are significantly different from zero.

In summary, merging firms increase prices of drugs after a merger. Particularly if a drug is marketed by fewer labelers, or if the drug market is highly concentrated.

4.3. Heterogeneous Effects: Sales Volume

We also look at the effect of mergers on prices by 2010 level of sales volume (average whole sale price times total number of prescriptions). We divided all drugs into two groups, large and small markets, based on whether

the 2010 sales volume was above or below the mean for all markets in the industry. The results for this analysis are displayed in Table 7.

We estimate that drugs marketed by merging firms with large sales volume (See Panel A) experienced an AWP increase of about 14% the year following the merger, and continued to exhibit an increase of 25%, and 15% during years two and three post-merger. Payments to provider experienced an increase of about 5% and 7%, during year one and two following the merger. Our estimates also showed a 6% decrease in prices during year three. We find no effect on prices after year three. All of these estimates are significantly different from zero at standard levels. With respect to co-payments our the diff-in-diff estimators are not statistically different from zero.

Turning our attention to drugs with small sales volumes, the results presented in Table 7 panel B, show steady AWP increases after horizontal mergers. We estimate that the AWP of drugs sold by merging companies increased by 8% one year after the merger, about 15% two years post-merge, and about 15% during year three post-merger. Similarly, payments to providers experienced increases from about 1.7% to about 4% during the years following the merger. For the case of co-payments our estimators show that, compared to pre-merger levels, merging firms decrease co-payments in about 2.6% four years after a merger, this result is statistically significant different from zero at 95%.

Table 7. Differences in Differences Estimators by Size of Market ($ US Sales Volume).

	Payments		Copayment		AWP	
Time to Merger	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
			Large Market, Sales Volume> Mean			
M_0	0.0494**	0.0410*	0.0142	0.0133	0.0667***	0.0620***
	(0.023)	(0.023)	(0.016)	(0.016)	(0.024)	(0.024)
M_1	0.0542**	0.0505**	0.0231	0.0259	0.1466***	0.1413***
	(0.023)	(0.023)	(0.016)	(0.017)	(0.024)	(0.024)
M_2	0.0814***	0.0737***	0.0222	0.0113	0.2518***	0.2536***
	(0.028)	(0.027)	(0.020)	(0.020)	(0.029)	(0.029)
M_3	-0.0482	-0.0560*	-0.0079	-0.0123	0.1328***	0.1476***
	(0.032)	(0.032)	(0.023)	(0.023)	(0.034)	(0.033)
M_4	0.0247	0.0255	0.0526	0.0329	0.0567	0.0816
	(0.051)	(0.051)	(0.036)	(0.037)	(0.054)	(0.053)
M_5	0.0331	0.0273	-0.0948**	-0.0983**	0.0978	0.1173*
	(0.058)	(0.058)	(0.041)	(0.042)	(0.061)	(0.060)
			Small Market, Sales Volume<Mean			
M_0	0.0043	0.0052	0.0087**	0.0075*	0.0207**	0.0369***
	(0.006)	(0.006)	(0.004)	(0.004)	(0.008)	(0.008)
M_1	0.0183***	0.0173***	0.0090**	0.0060	0.0692***	0.0791***
	(0.006)	(0.006)	(0.004)	(0.004)	(0.009)	(0.008)
M_2	0.0223***	0.0214***	0.0069	0.0015	0.1304***	0.1469***
	(0.007)	(0.007)	(0.005)	(0.005)	(0.010)	(0.010)
M_3	0.0363***	0.0285***	0.0093	0.0013	0.1419***	0.1507***
	(0.009)	(0.009)	(0.006)	(0.006)	(0.012)	(0.012)
M_4	0.0365***	0.0402***	-0.0223**	-0.0260***	0.1521***	0.1710***
	(0.014)	(0.013)	(0.009)	(0.009)	(0.019)	(0.019)
M_5	0.0394***	0.0402***	0.0047	0.0014	0.0824***	0.0831***
	(0.015)	(0.015)	(0.010)	(0.011)	(0.021)	(0.021)

*Note: Number of observations at the drug/label/year. Heterogeneous standard errors in parentheses clustered at the drug level. Significance levels: * p<0.10; ** p<0.05; *** p<0.01. Payments are gross payments to a provider for a prescription; Copayment, payments made by the beneficiary to satisfy copayment or coinsurance; AWP, the average wholesale price charged by wholesales for the specific drug. N is the number of drug/year observations.*

4.4. Heterogeneous Effects: Type of merger

In this research we classify pharmaceutical companies into branded and generic based on their product catalog. This classification allows us to address certain concerns about how some merger combinations might increase prices. For example, a branded company merging with a generic one might prevent the entry generic rivals for certain drugs, or when two generic companies merge, the can actively increase prices, ether by increasing their presence in the pharmaceutical market or by decreasing the number of players among certain drugs.

We defined each company as branded if less than 25% of the products a firm has registered in the FDA's Orange Book have an Abbreviated New Drug Application (ANDA). A company is classified as generic if at least 75% of their registered products have ANDA status. A similar approach on defining pharmaceuticals into generic and brand using the number of ANDA's and NDA's have been previously used by Morton (2002).

The results of our analysis by type of merger are shown in Table 8 panel A and B. When looking only at drugs affected by branded-generic or generic-branded mergers, the AWP of drugs increased during the years after a merger by between 9% (the year after a merger) and 15.2% (four years after the merger), all of these results are statistically significant at the 95%. At the same time, we estimate that the average payment per prescription for drugs affected by one of this type of mergers showed and increase of about 2.3% to 4%. Similar results are found in drugs marketed by firms involved in a generic/generic type of merger.

Table 8. Differences in differences estimators: by Type of Merger affecting the Market.

	Payments		Copayment		AWP	
Time to Merger	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
	Panel A. Branded/Generic or Generic/Branded MA					
M_0	0.0398***	0.0125**	0.0116*	0.0142***	0.0111**	0.0241***
	(0.006)	(0.006)	(0.004)	(0.004)	(0.008)	(0.008)
M_1	0.0230***	0.0228***	0.0119***	0.0098**	0.0796***	0.0903***
	(0.007)	(0.006)	(0.005)	(0.005)	(0.008)	(0.008)
M_2	0.0264***	0.0251***	0.0117**	0.0061	0.1418***	0.1570***
	(0.008)	(0.008)	(0.005)	(0.006)	(0.010)	(0.010)
M_3	0.0291***	0.0254***	0.0103	0.0063	0.1409***	0.1466***
	(0.009)	(0.009)	(0.006)	(0.006)	(0.012)	(0.012)
M_4	0.0365***	0.0387***	-0.0041	-0.0112	0.1318***	0.1515***
	(0.014)	(0.014)	(0.010)	(0.010)	(0.018)	(0.018)
M_5	0.0391**	0.0400**	-0.0025	-0.0074	0.0786***	0.0781***
	(0.016)	(0.016)	(0.011)	(0.011)	(0.020)	(0.020)
	Panel B. Generic/Generic MA					
M_0	0.0086	0.0103*	0.0137***	0.0134***	0.0193**	0.0330***
	(0.006)	(0.006)	(0.004)	(0.004)	(0.008)	(0.008)
M_1	0.0196***	0.0202***	0.0105**	0.0087**	0.0788***	0.0850***
	(0.006)	(0.006)	(0.004)	(0.004)	(0.008)	(0.008)
M_2	0.0406***	0.0387***	0.0151***	0.0098**	0.1455***	0.1609***
	(0.007)	(0.007)	(0.005)	(0.005)	(0.010)	(0.009)
M_3	0.0378***	0.0324***	0.0189***	0.0134**	0.1385***	0.1494***
	(0.008)	(0.008)	(0.006)	(0.006)	(0.011)	(0.011)
M_4	0.0508***	0.0542***	0.0114	0.0097	0.1282***	0.1390***
	(0.014)	(0.014)	(0.010)	(0.010)	(0.019)	(0.019)
M_5	0.0348**	0.0424***	0.0141	0.0167	0.0729***	0.0765***
	(0.016)	(0.016)	(0.011)	(0.011)	(0.021)	(0.021)

*Note: Number of observations at the drug/label/year. Heterogeneous standard errors in parentheses clustered at the drug level. Significance levels: * p<0.10; ** p<0.05; *** p<0.01. Payments are gross payments to a provider for a prescription;*

Copayment, payments made by the beneficiary to satisfy copayment or coinsurance; AWP, the average wholesale price charged by wholesales for the specific drug. N is the number of drug/year observations.

5. Conclusion

This paper is motivated by anti-trust concerns raised from horizontal mergers in prescription drugs markets. Prices of some drugs, in particular generics drugs, were raising and the price increases overlap with the waves of horizontal mergers that happened during the period 2010-2015. Popular press and medical experts suggest mergers as a possible explanation for these price increases in the generic industry.

However, many economists in antitrust policy hold the view that horizontal mergers only harms consumers when a monopoly or close to monopoly arises after the merger. In most instances, horizontal mergers could benefit consumers, as they might allow firms to gain access to new markets, or achieve economies of scale (Williamson, 1968; Bork, 1978; Baer, 1996; Kovacic and Shapiro, 2000). Contrary to this view, we report that horizontal mergers in relatively competitive markets harm consumers in the case of drugs with multiple generic drugs available and present in the market. Our analysis indicates that publicly traded companies that experienced a merger with another public company during the period 2010-2017, compared to the level of prices a year before the merger, increased the prices of the drugs they sold in about 8% to 15% (or between 3% and 4% as measured by payment to providers) during the five years following a merger.

Recent FTC guidelines indicate the relevance of reviewing horizontal mergers with less than 5 producers as them may raise non-price competition practices. Our findings suggest that in the case of the drugs with multiple generics available, mergers affecting drugs with more than 5 labelers may raise the overall price of drugs after a transaction. We provide evidence for FTC about the importance of considering the type of acquired and acquirer companies involved in the transaction when evaluation mergers in this industry.

In addition, our results provide additional support for the Department of Justice and Federal Trade Commission to review if the involved companies in the horizontal mergers produce the same generic drugs. Our ex-post evaluation suggests that mergers that reduce number of labelers increase prices even controlling for pre-transaction levels of market competition and number of substitutes.

The results are consistent with previous findings of the ex-post effect of horizontal mergers in other industries. Yet, our findings are intriguing as the increases in prices in the generic industry are observed in apparently competitive markets. Future research should explore the role of collusion, and other firm's anti-trust behavior as possible explanation to our findings. Yet, our results should be taken with restraint as they suggest a trajectory of prices where prices go up during the first two years and then correct downward after third year post-merger.

In this paper, we decide to analyze all horizontal mergers and observed average changes in the outcomes of interest using a differences-in-differences estimator. Certainly, we should be cautious with our conclusion as we did not observe several consummated mergers involving privately owned pharmaceuticals; nor horizontal mergers not approved by FTC. Others should consider how a specific horizontal merger in the generic industry enforced at the margin impacts prices. This approach using a case study should focus on the prices of drugs when there is overlapping in production between the acquired and acquired and compared changes when there is no overlapping. This approach will shed light about possible mechanisms on how mergers may impact prices. We believe that findings from both types of approached will enrich our understanding of the effects of horizontal mergers on prices in the generic industry.

Funding Statement

This research was funded by the Laura and John Arnold Foundation. The funding sources had no role in the design and conduct of the study, analysis, or interpretation of the data; and preparation or final approval of the

manuscript.

Acknowledgments

We would like to thank Caleb Alexander, Ge Bai, Jeromie Ballreich, Joe Levy and Jodi Segal for their insightful comments on drafts of this work. The authors take sole responsibility for any remaining errors.

Conflict of interest

All the authors claim that the manuscript is completely original. The authors also declare no conflict of interest.

Author contributions

Conceptualization: Antonio Trujillo, Mariana Socal, Gerard Anderson; Investigation: Antonio Trujillo and Mariana Socal; Methodology: Antonio Trujillo and Mariana Socal; Writing – original draft: Antonio Trujillo, Mariana Socal, and Gerard Anderson.

Appendix

Table A1. Mergers and Acquisitions Cont'd. 2010-2015.

Year Completed	Acquiring Company Name	Type	Target Company Name	Type	Deal Value $ Million
2015	Shire PLC	B	NPS Pharmaceuticals Inc	B	5,139
2013	Actavis Inc	G	Warner Chilcott PLC	G	5,096
2011	Shionogi & Co Ltd	B	C&O Pharm Tech Ltd*	na	5,000
2014	Shire PLC	B	ViroPharma Inc	B	4,211
2014	Merck & Co Inc	B	Idenix Pharmaceuticals Inc*	O	3,828
2010	Biovail Corp	na	Valeant Pharmaceuticals Intl	M	3,717
2011	Pfizer Inc	B	King Pharmaceuticals Inc	B	3,566
2011	Grifols SA	G	Talecris Biotherapeutics Hldg	B	3,560
2015	Teva Pharmaceutical Industries	G	Auspex Pharmaceuticals Inc*	O	3,394
2014	Abbott Laboratories	M	CFR Pharmaceutical SA	na	3,334
2015	Sun Pharmaceutical Inds Ltd	G	Ranbaxy Laboratories Ltd	G	3,226
2012	Valeant Pharmaceuticals Intl	M	Medicis Pharmaceutical Corp	M	3,074
2015	AstraZeneca PLC	B	ZS Pharma Inc*	B	2,690
2014	Salix Pharmaceuticals Ltd	B	Santarus Inc	B	2,677
2012	Bristol-Myers Squibb Co	M	Inhibitex Inc*	O	2,524
2015	Endo International PLC	B	Auxilium Pharmaceuticals Inc	B	1,839
2010	Sanofi-Aventis SA	B	Chattem Inc	B	1,781
2014	Endo Health Solutions Inc	B	Paladin Labs Inc*	B	1,561
2014	Forest Laboratories Inc	B	Furiex Pharmaceuticals Inc*	B	1,436
2014	Mallinckrodt PLC	M	Cadence Pharmaceuticals Inc	M	1,341
2015	Horizon Pharma PLC	B	Hyperion Therapeutics Inc	B	1,012
2013	Allergan Inc	B	MAP Pharmaceuticals Inc*	O	944
2013	Otsuka Holdings Co Ltd	B	Astex Pharmaceuticals Inc*	O	886.9
2014	Jazz Pharmaceuticals PLC	B	Gentium SpA*	B	879.2
2010	Bristol-Myers Squibb Co	M	ZymoGenetics Inc	O	837.6
2015	Alexion Pharmaceuticals Inc	O	Synageva BioPharma Corp*	O	837.0
2015	BioMarin Pharmaceutical Inc	B	Prosensa Holding BV*	na	801.1
2014	Actavis PLC	G	Durata Therapeutics Inc*	B	799.8

2013	Cubist Pharmaceuticals Inc	B	Trius Therapeutics Inc*	B	786.6
2015	Roche Holding AG	B	Foundation Medicine Inc*	O	780.2
2013	Cubist Pharmaceuticals Inc	B	Optimer Pharmaceuticals Inc	B	775.5
2014	H Lundbeck A/S	B	Chelsea Therapeutics Intl Ltd*	B	647.6
2014	Akorn Inc	G	Hi-Tech Pharmacal Co Inc	G	602.0
2013	Cipla Ltd	G	Cipla Medpro South Africa Ltd	G	514.6
2011	Kyowa Hakko Kirin Co Ltd*	B	ProStrakan Group PLC	B	473.2
2011	Sanofi-Aventis SA	B	BMP Sunstone Corp*	M	438.7
2013	Valeant Pharmaceuticals Intl	M	Obagi Medical Products Inc	O	437.5
2013	AstraZeneca PLC	B	Omthera Pharmaceuticals Inc*	B	424.8
2011	Valeant Pharmaceuticals Intl	M	Sanitas AB*	na	389.4
2014	Pfizer India Ltd	B	Wyeth Ltd	B	365.6
2012	Nabi Biopharmaceuticals	B	Biota Holdings Ltd*	na	246.6
2014	Teva Pharmaceutical Industries	G	NuPathe Inc	B	213.1
2012	Sun Pharmaceutical Inds Ltd	G	DUSA Pharmaceuticals Inc	B	212.5
2012	Spectrum Pharmaceuticals Inc	B	Allos Therapeutics Inc	B	206.4
2015	Strides Arcolab Ltd	G	Shasun Pharmaceuticals Ltd*	B	182.0
2013	Perrigo Co	G	Velcera Inc*	na	160.0
2010	Endo Pharmaceuticals Holdings	B	Penwest Pharmaceuticals Co*	O	159.7
2011	Hikma Pharmaceuticals PLC	G	Societe de Promotion Phar SA*	na	111.2
2015	Sucampo Pharmaceuticals Inc	B	R-Tech Ueno Ltd*	B	100.0
2012	Hikma Pharmaceuticals PLC	G	Promopharm SA*	na	41.6
2011	Pfizer Inc	B	Icagen Inc*	O	40.1
2015	Midatech Pharma PLC	B	DARA Biosciences Inc	na	29.7
2011	Abbott India Ltd	M	Solvay Pharma India Ltd	G	26.3
2013	Pernix Therapeutics Holdings	B	Somaxon Pharmaceuticals Inc	B	25.0
2011	Paladin Labs Inc*	B	Labopharm Inc	B	20.8

Types of companies: B=Branded, G=Generic, M=Mix, O=Other (vaccines, food supplements, diagnosis), na=Not Available. Deal Value at time of announcement. ⍰ Companies without a claim in MarketScan.

References

Ashenfelter, O., Hosken, D., and Weinberg, M. (2014). Did Robert Bork Understate the Competitive Impact of Mergers? Evidence from Consummated Mergers. *The Journal of Law and Economics*, 57(S3), S67–S100. https://doi.org/10.1086/675862

Baer, W. J. (1996). Reflections on Twenty Years of Merger Enforcement under the Hart-Scott-Rondino Act. *Antitrust Law Journal*, 65, 825.

Bonaime, A. A., and Wang, Y. E. (2019). Mergers, product prices, and innovation: evidence from the pharmaceutical industry. *Available at SSRN 3445753*.

Bork, R. H. (1978). The Antitrust Paradox.

Carlton, D. W. (2007). The Need to Measure the Effect of Merger Policy and How to Do It. *Antitrust*, 22, 39.

Carlton, D. W. (2010). Revising the Horizontal Merger Guidelines. *Journal of Competition Law and Economics*, 6(3), 619–652.

Dafny, L. (2009). Estimation and Identification of Merger Effects: An Application to Hospital Mergers. *The Journal of Law and Economics*, 52(3), 523–550. https://doi.org/10.1086/600079

Dave, C. V., Kesselheim, A. S., Fox, E. R., Qiu, P., and Hartzema, A. (2017). High Generic Drug Prices and Market Competition: A Retrospective Cohort Study. *Annals of Internal Medicine*, 167(3),145–151. https://doi.org/10.7326/M16-1432

Dobkin, C., Finkelstein, A., Kluender, R., and Notowidigdo, M. J. (2018). The Economic Consequences of Hospital Admissions. *American Economic Review*, 108(2), 308–52. https://doi.org/10.1257/aer.20161038

Dylst, P., and Simoens, S. (2011). Does the Market Share of Generic Medicines Influence the Price Level? *Pharmacoeconomics*, 29(10), 875–882. https://doi.org/10.2165/11585970-000000000-00000

Farrell, J., Pautler, P. A., and Vita, M. G. (2009). Economics at the FTC: Retrospective Merger Analysis with a Focus on Hospitals. *Review of Industrial Organization*, 35(4), 369. https://doi.org/10.1007/s11151-009-9231-2

Focarelli, D., and Panetta, F. (2003). Are Mergers Beneficial to Consumers? Evidence from the Market for Bank Deposits. *American Economic Review*, 93(4), 1152–1172. https://doi.org/10.1257/000282803769206241

Gagnon, M.-A., and Volesky, K. D. (2017). Merger Mania: Mergers and Acquisitions in the Generic Drug Sector from 1995 to 2016. *Globalization and health*, 13(1), 62. https://doi.org/10.1186/s12992-017-0285-x

Garmaise, M. J., and Moskowitz, T. J. (2006). Bank Mergers and Crime: The Real and Social Effects of Credit Market Competition. *the Journal of Finance*, 61(2), 495–538. https://doi.org/10.1111/j.1540-6261.2006.00847.x

Granier, L., and Trinquard, S. (2010). Entry Deterrence and Mergers Under Price Competition in Pharmaceutical Markets. *Applied Economics*, 42(3), 297–309. https://doi.org/10.1080/00036840701604495

Haas-Wilson, D., and Vita, M. (2011). Mergers Between Competing Hospitals: Lessons from Retrospective Analyses. *International Journal of the Economics of Business*, 18(1), 1–4. https://doi.org/10.1080/13571516.2011.542947

Hosken, D. (2011). Ex-Post Merger Review: What Is It and Why Do We Need It. *Agenda March*.

Hosken, D., Silvia, L., and Taylor, C. (2011). Does Concentration Matter? Measurement of Petroleum Merger Price Effects. *American Economic Review*, 101(3), 45– 50.

Hosken, D. S., Olson, L. M., and Smith, L. K. (2018). Do Retail Mergers Affect Competition? Evidence from Grocery Retailing. *Journal of Economics & Management Strategy*, 27(1), 3–22. https://doi.org/10.1111/jems.12218

Hunter, G., Leonard, G. K., and Olley, G. S. (2008). Merger Retrospective Studies: A Review. *Antitrust*, 23, 34.

Joyce, G., Henkhaus, L. E., Gascue, L., and Zissimopoulos, J. (2018). Generic Drug Price Hikes and Out-Of-Pocket Spending for Medicare Beneficiaries. *Health Affairs*, 37(10), 1578–1586. https://doi.org/10.1377/hlthaff.2018.0628

Kadura, S. (2007). Is an Absolute Ban on Reverse Payments the Appropriate Way to Prevent Anticompetitive Agreements between Branded-and Generic-Pharmaceutical Companies. *Tex. L. Rev*, 86, 647.

Kim, E. H., and Singal, V. (1993). Mergers and Market Power: Evidence from the Airline Industry. *The American Economic Review*, 549–569.

Kovacic, W. E. (2000). Evaluating Antitrust Experiments: Using Ex Post Assessments of Government Enforcement Decisions to Inform Competition Policy. *Geo. Mason L. Rev.*, 9, 843.

Kovacic, W. E., and Shapiro, C. (2000). Antitrust Policy: A Century of Economic and Legal Thinking. *Journal of Economic Perspectives*, 14(1), 43–60.

Krishnan, R. (2001). Market Restructuring and Pricing in the Hospital Industry. *Journal of Health Economics*, 20(2), 213–237. https://doi.org/10.1016/S0167-6296(00)00076-X

Kwoka Jr, J. E. (2012). Does Merger Control Work: A Retrospective on US Enforcement Actions and Merger Outcomes. *Antitrust LJ*, 78, 619.

Lee, C.-Y., Chen, X., Romanelli, R. J., and Segal, J. B. (2016). Forces Influencing Generic Drug Development in the United States: A Narrative Review. *Journal of Pharmaceutical Policy and Practice*, 9(1), 26. https://doi.org/10.1186/s40545-016-0079-1

Luo, D. (2014). The Price Effects of the Delta/Northwest Airline Merger. *Review of Industrial Organization*, 44(1), 27–48. https://doi.org/10.1007/s11151-013-9380-1

Morton, F. M. S. (2002). Horizontal Integration Between Brand and Generic Firms in the Pharmaceutical Industry. *Journal of Economics & Management Strategy*, 11(1), 135– 168. https://doi.org/10.1111/j.1430-9134.2002.00135.x

Pautler, P. A. (2015). A Brief History of the FTC's Bureau of Economics: Reports, Mergers, and Information Regulation. *Review of Industrial Organization*, 46(1), 59–94. https://doi.org/10.1007/s11151-014-9430-3

Pires, T., and Trindade, A. (2018). Ex-Post Evaluation of Mergers in the Supermarket Industry. *Review of Industrial Organization*, 52(3), 473–496. https://doi.org/10.1007/s11151-017-9608-6

Reiffen, D., and Ward, M. R. (2005). Generic Drug Industry Dynamics. *Review of Economics and Statistics*, 87(1), 37–49.

Shapiro, C. (2010). The 2010 Horizontal Merger Guidelines: From Hedgehog to Fox in Forty Years. *Antitrust LJ*, 77, 49.

Silvia, L., and Taylor, C. T. (2013). Petroleum Mergers and Competition in the Northeast United States. *International Journal of the Economics of Business*, 20(1), 97– 124. https://doi.org/10.1080/13571516.2012.715275

Williamson, O. E. (1968). Economies as an Antitrust Defense: The Welfare Trade Offs. *The American Economic Review*, 58(1), 18–36.