

# Number of Manufacturers and Generic Drug Pricing From 2005 to 2017

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Several studies have quantified drug price inflation over the past decade, finding that although brand name and specialty drugs experienced the largest price increases, generic prices also increased over time.<sup>1,2</sup> Rising generic drug prices have been attributed to the relatively low competition present in most generic markets—the average generic is only supplied by 2 manufacturers,<sup>1</sup> and generic drug prices are not responsive to competition until at least 3 manufacturers have entered the market.<sup>3-5</sup> However, prices of widely used generic drugs supplied by numerous manufacturers have recently experienced abrupt increases, in some cases triggering allegations of price fixing.<sup>6,7</sup>

We quantified how 12-month changes in prices of all generic drugs available from 2005 to 2016 changed with the number of generic manufacturers supplying each drug, and we also evaluated the incidence of abrupt price increases across the study period. We hypothesized that price increases would be higher for generic drugs supplied by a lower number of manufacturers.

## METHODS

### Data Sources

We obtained monthly wholesale acquisition costs (WACs) for all National Drug Codes (NDCs) available from 2005 to 2016 from AnalySource (reprinted with permission by First Databank, Inc) and annual counts of pharmacy claims from the University of Pittsburgh Medical Center (UPMC) Health Plan over the same time frame. WACs represent the list price from a manufacturer to a wholesaler or a direct purchaser and do not account for any type of manufacturer rebate or discount. An NDC is a unique and universal 10-digit number that identifies human drug products in the United States. UPMC Health Plan is a health insurer offering a variety of insurance products to more than 3.2 million members in Pennsylvania and parts of Ohio, West Virginia, and Maryland. Consequently, UPMC Health Plan offers a representative expression of medication use in an insured population. We standardized annual counts of pharmacy claims for each NDC, as if enrollment had remained constant since 2005.

## ABSTRACT

**OBJECTIVES:** To evaluate how changes in generic drug prices and the incidence of abrupt price increases varied with the number of manufacturers supplying each drug.

**STUDY DESIGN:** Analysis of 2005 to 2016 monthly wholesale acquisition costs (WACs) and University of Pittsburgh Medical Center Health Plan counts of pharmacy claims for National Drug Codes (NDCs) for generic drugs.

**METHODS:** Each year, NDCs were categorized according to the number of manufacturers offering each combination of active ingredient and dosage form: 1 to 3, 4 to 7, and more than 7. For every month from January 2006 to January 2017, we estimated the 12-month change in WAC (eg, 12-month change in January 2006 was calculated as the difference in WAC between January 2006 and January 2005, divided by the WAC in January 2005), before and after weighting each NDC by counts of pharmacy claims. We evaluated the proportion of NDCs that had large price increases, greater than 20%, 50%, 100%, and 500% within a year.

**RESULTS:** Before 2010, price changes were higher for drugs supplied by a lower number of manufacturers; however, after 2010, prices increased sharply, and drugs supplied by 4 to 7 manufacturers showed increases similar to or higher than those supplied by 1 to 3. In 2013, prices increased by an average of 29% for drugs supplied by 1 to 3 and 4 to 7 manufacturers, and 10% for more than 7. Price changes increased after weighting by counts of pharmacy claims, demonstrating that price increases disproportionately affected widely used drugs. The proportion of NDCs from drugs supplied by 1 to 3 manufacturers that doubled in price within a year was 3.6 times higher in 2012 to 2015 than in 2005 to 2009 (4.6% vs 1.3%, respectively).

**CONCLUSIONS:** Increases in generic drug prices are concerning because they affected widely used drugs and suggest that generic drug prices may be increasingly insensitive to competition.

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## Study Sample

Using data provided by First Databank, we identified all NDCs for generic drugs with WAC information available any time from 2005 to 2016. Generics entering the market within this time frame were included in the study sample starting the first year when their list price was available. The sample included 24,944 NDCs representing 1851 combinations of active ingredient and dosage form. Each year, NDCs were categorized according to the number of generic manufacturers—1 to 3, 4 to 7, and more than 7—offering each combination of active ingredient and dosage form in January. For example, flecainide tablets were supplied by 3 manufacturers in 2006 to 2008, 4 in 2009 to 2011, 6 in 2012 to 2014, 8 in 2015, and 9 in 2016. Consequently, NDCs for flecainide tablets were categorized under the 1 to 3 manufacturer group in 2006 to 2008, the 4 to 7 group in 2009 to 2014, and the more than 7 group in 2015 and 2016. We selected 3 as a cutoff because the FDA expedites review of generic drug applications in markets served by 3 or fewer manufacturers.<sup>8,9</sup>

## Analysis

For every month from January 2006 to January 2017, we estimated the 12-month change in WAC for each NDC. For example, the 12-month change measured in January 2006 was calculated as the difference in WAC between January 2006 and January 2005, divided by the WAC in January 2005. This is the reason why, although we had 2005 to 2016 data, we report 12-month changes in WAC for 2006 to 2016. Because our results could be disproportionately affected by rarely used drugs with large price increases, we further calculated the average 12-month change after weighting each NDC by the count of pharmacy claims from UPMC Health Plan in the respective year. Finally, we calculated and reported the average of the 12-month change in WAC for every year of the study period.

To assess the association between number of manufacturers and price changes while controlling for other factors that can affect price changes,<sup>10,11</sup> we constructed a linear mixed model. The linear mixed model regressed 12-month change in WAC for each NDC against indicator variables for year, for groups defined by number of manufacturers, route of administration, therapeutic classes (list in the [eAppendix Methods](#) [eAppendix available at [ajmc.com](#)]), and interactions between the variables for number of manufacturers and for years. To account for the correlation in price changes between NDCs for a given product, we specified random intercepts for generic names. An autoregressive covariance structure was used to model the correlation between repeated observations for each NDC. We constructed a second version of this linear mixed model by weighting each NDC by the count of pharmacy claims from UPMC Health Plan in the respective year.

Finally, using the 12-month change in WAC measured in January of every year, we calculated the proportion of NDCs that had abrupt

## TAKEAWAY POINTS

- ▶ Before 2010, changes in prices of generic drugs were higher for drugs supplied by a lower number of manufacturers. However, after 2010, price changes increased abruptly, and drugs supplied by 4 to 7 manufacturers showed increases similar to or even higher than those supplied by 1 to 3 manufacturers.
- ▶ In 2013 and 2014, price changes averaged 29% and 24%, respectively, for drugs supplied by 1 to 3 manufacturers, 29% and 28% for 4 to 7 manufacturers, and 10% and 15% for more than 7 manufacturers.
- ▶ Recent increases in generic drug prices are concerning because they affected multisource, widely used drugs. Rising generic drug prices may be due not only to insufficient market competition but also to the increasing insensitivity of prices to competition.

price increases, which we defined as increases greater than 20% within a year. We further quantified the proportion of NDCs that had even higher price increases (ie, greater than 50%, 100%, and 500%) within a year.

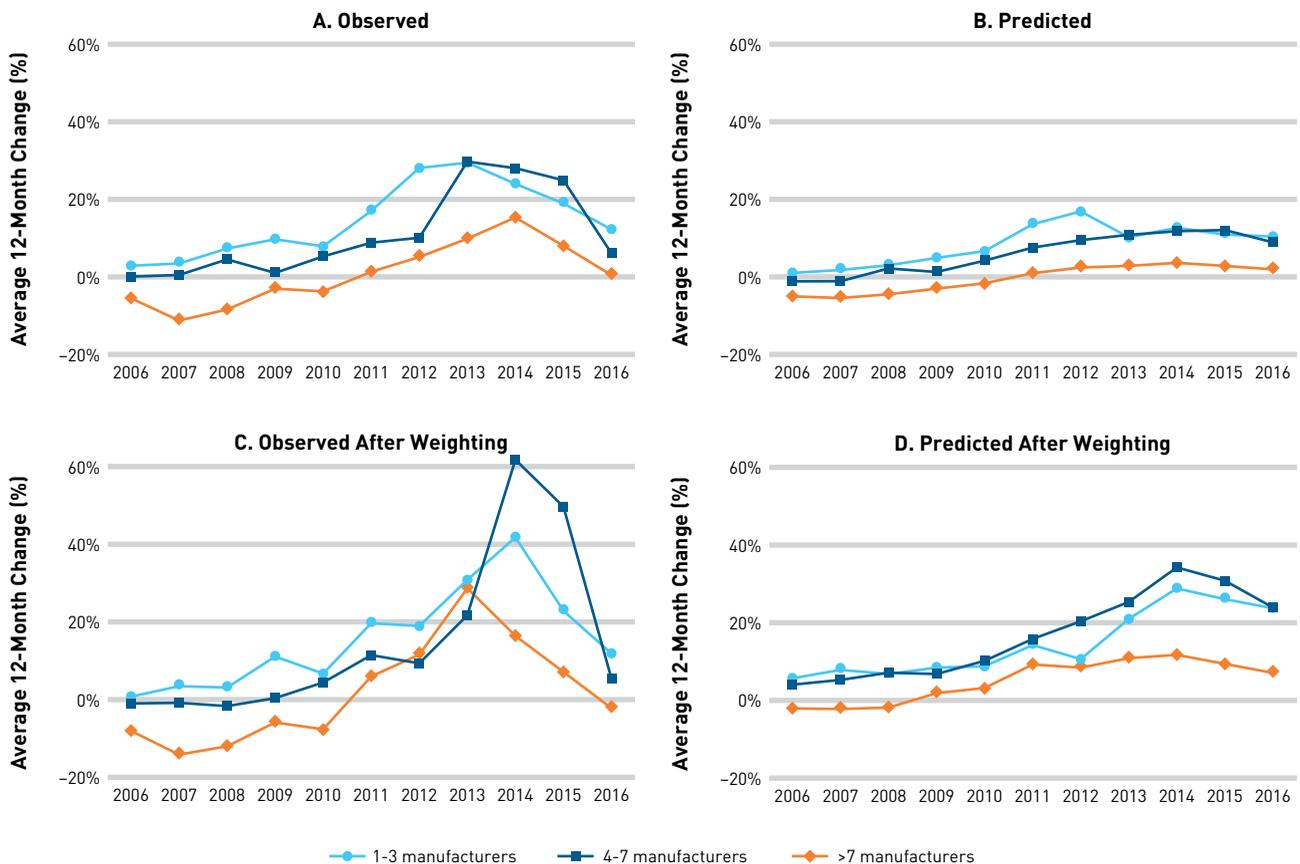
## RESULTS

Before 2010, average 12-month price changes were consistently higher for drugs supplied by a lower number of manufacturers ([Figure 1](#)). Specifically, average 12-month price changes were at least 3 percentage points higher for drugs supplied by 1 to 3 manufacturers than those supplied by 4 to 7, and price changes were negative for those supplied by more than 7. For instance, in 2008, the average 12-month price change was 7% for drugs with 1 to 3 generic manufacturers, 4% for 4 to 7 manufacturers, and -8% for more than 7 manufacturers. However, after 2010, average 12-month price changes increased sharply for all groups, and drugs supplied by 4 to 7 manufacturers showed price increases similar to or even higher than those supplied by 1 to 3 ([Figure 1](#)). Drugs supplied by more than 7 manufacturers presented lower average price increases than those supplied by 7 or fewer, yet they exceeded 10% in 2013 and 2014. For instance, in 2013 and 2014, 12-month price changes averaged 29% and 24%, respectively, for drugs supplied by 1 to 3 manufacturers, 29% and 28% for those supplied by 4 to 7 manufacturers, and 10% and 15% for those supplied by more than 7. The magnitude of these estimates increased when we weighted NDCs by counts of pharmacy claims ([Figure 1](#)).

Results from mixed models were consistent with these observations ([eAppendix Table](#)): Average 12-month price changes in 2007 to 2010 did not significantly differ from those observed in 2006; however, price changes in 2011 to 2016 were significantly higher compared with 2006 ( $P < .01$ ). The effect of the number of manufacturers on price was different in 2012 and 2013 compared with 2006, but not in the remaining years ([eAppendix Table](#)). To facilitate interpretation of the results from these models, [Figure 1](#) shows the price changes predicted by linear mixed models. In 2006 to 2011, predicted price changes were consistently higher for drugs supplied by a lower number of manufacturers; however, from 2012 to 2013, predicted price changes were similar for drugs supplied

## TRENDS FROM THE FIELD

**FIGURE 1.** Observed and Predicted 12-Month Price Changes by Year, 2006-2016



NDC indicates National Drug Code; WAC, wholesale acquisition cost.

\*The left-side panels show the observed average 12-month change in WACs of generic drugs available in 2005 to 2016, before (panel A) and after (panel C) weighting each NDC for counts of pharmacy claims. The right-side panels (B and D) show 12-month changes in WACs predicted by linear mixed models. In constructing the linear mixed model that produced the predictions displayed in panel D, each NDC was weighted by the number of pharmacy claims filled in the respective year.

by 4 to 7 manufacturers and those supplied by 1 to 3 (Figure 1). The magnitude of the predicted estimates for price changes increased when each NDC was weighted by counts of pharmacy claims, and predicted price changes for drugs supplied by 4 to 7 manufacturers in 2012 to 2015 exceeded those for drugs supplied by 1 to 3 (Figure 1).

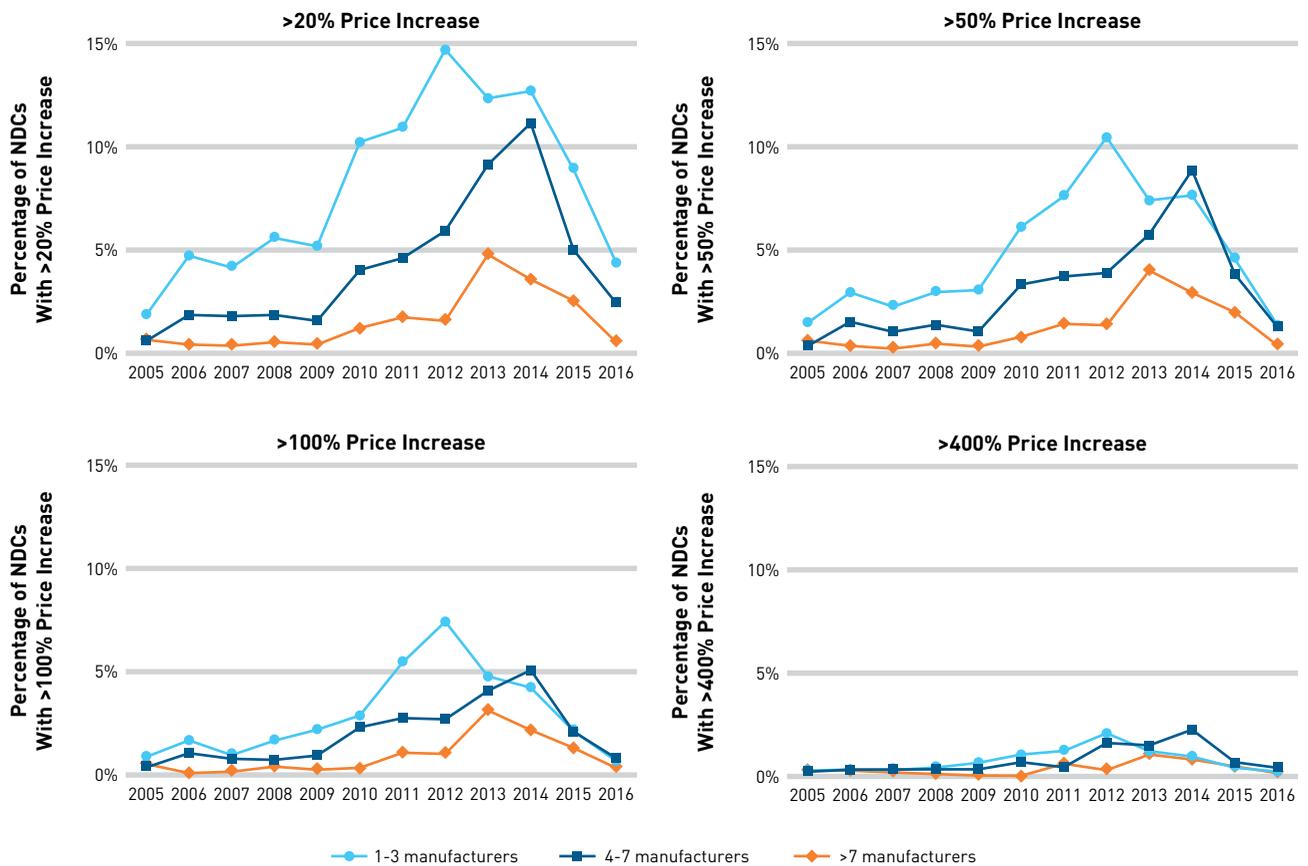
The proportion of NDCs experiencing abrupt price increases showed a similar trend (Figure 2). In 2005 to 2009 the proportion that experienced price increases of more than 20% within a year included around 4% of NDCs from drugs supplied by 1 to 3 manufacturers, 1.5% of those supplied by 4 to 7, and 0.4% of those supplied by more than 7. In this time period, an average of 1.3% of NDCs from drugs supplied by 1 to 3 manufacturers, 0.7% for 4 to 7, and 0.01% for more than 7 doubled in price within a year. After 2010, the proportion of NDCs experiencing abrupt price increases raised considerably: In 2012 to 2015, an average of 4.6% of NDCs from drugs supplied by 1 to 3 manufacturers, 3.4% for 4 to 7, and 0.15% for more than 7 doubled in price within a year. In other words, the proportion of NDCs that

doubled in price within a year was 3.6 times higher in 2012 to 2015 than in 2005 to 2009 for drugs supplied by 1 to 3 manufacturers, and 5.1 times higher for those supplied by 4 to 7. NDCs from drugs supplied by 1 to 3 manufacturers experienced particularly abrupt increases in 2012: As many as 14.7% experienced a price increase of more than 20%, 7.4% doubled in price, and 2.0% quintupled. NDCs from drugs supplied by 4 to 7 manufacturers presented the strongest increases in 2014: 11.1% experienced a price increase of more than 20%, 5.0% doubled in price, and 2.2% quintupled. In 2016, the proportion of NDCs experiencing abrupt price increases decreased to levels similar to those observed in 2005 to 2009.

## DISCUSSION

Before 2010, the increased competition associated with a greater number of manufacturers consistently resulted in lower price increases. However, in 2012 to 2015, price increases were similar or

**FIGURE 2.** Proportion of NDCs Experiencing Abrupt Price Increases, 2005-2016\*



NDC indicates National Drug Code.

\*The figure shows the proportion of NDCs that experienced price increases greater than 20%, 50%, 100%, and 400% between January of the given year and January of the following year. For instance, in 2005, the price of 1.8% of NDCs from drugs supplied by 1 to 3 manufacturers increased by more than 20%. As explained in the Methods section, this was measured using the relative difference in price between January 2006 and January 2005.

even higher for drugs supplied by 4 to 7 manufacturers compared with those supplied by 1 to 3, and were as high as 25%. In this time period, increases in prices of drugs supplied by more than 7 manufacturers averaged 10%. In addition, when NDCs were weighted by utilization, prices increased more dramatically, demonstrating that price increases disproportionately affected widely used drugs. The proportions of NDCs offered by 1 to 3 and by 4 to 7 manufacturers that doubled in price within a year were 3.7 and 5.1 times higher, respectively, in 2012 to 2015 than in 2005 to 2009.

Our findings add to the existing literature because they demonstrate that large increases in prices of off-patent drugs have not been limited to single-source drugs used in rare conditions,<sup>12</sup> but have also affected commonly used multisource drugs. These price increases are particularly concerning because they can have a large impact on spending, as illustrated by our estimates that account for the relative utilization of drugs. With generic drugs supplied by 4 to 7 and more than 7 manufacturers experiencing average increases

of 25% and 10%, respectively, in 2012 to 2015, our results suggest that rising prices of generic drugs may be due not only to limited competition in the generic market,<sup>1</sup> but also to the increasing lack of sensitivity of generic drug prices to competition.

Although our study did not assess the reasons behind this increasing insensitivity of prices to competition, the high price increases observed in 2012 to 2015 could reflect the occurrence of several cases currently under investigation for alleged price collusion.<sup>6</sup> Alternatively, they could be related to the so-called 2012 patent cliff, when several blockbuster brand name drugs—including atorvastatin, clopidogrel, olanzapine, quetiapine, escitalopram, montelukast, esomeprazole, and methylphenidate—lost patent protection.<sup>13</sup> Specifically, manufacturers may have increased generic drug prices because they had fewer opportunities to generate revenue through 180-day exclusivity periods after the end of the patent cliff. Regardless of the underlying reasons, the sharp increase in the incidence of abrupt price increases indicates distorted pricing dynamics in the

## TRENDS FROM THE FIELD

pharmaceutical market during this time period. However, we found that trends in price changes stabilized after 2015. The reason for price stabilization is also unclear, although it could be due to increased social and political pressure or the filing of several complaints alleging collusion in rising prices of generic drugs.<sup>6</sup>

Future research should further evaluate whether the price trends observed in 2012 to 2015 for generic drugs are isolated and whether the price stabilization observed after 2015 is maintained over time. This will clarify whether competition in the generic market is enough to maintain low inflation rates or whether the implementation of policy solutions designed to cap inflation is needed.

### Limitations

First, in our analyses, we used WACs as pricing estimates, which do not account for manufacturer discounts or rebates. Nevertheless, list prices are often used to provide directional information about drug prices, and uninsured or underinsured patients are often exposed to these prices. Additionally, our focus on generic drugs also reduces the likelihood of the impact of rebates. Second, we used counts of pharmacy claims from UPMC Health Plan to weight each NDC by its relative utilization. The use of data from only 1 insurance carrier limits the generalizability of our results; however, the use of weights was necessary to confirm that the observed average increases in prices were not driven by disproportionate increases in prices of rarely used drugs.

## CONCLUSIONS

We observed double-digit increases in prices of all generic drugs in 2012 to 2015, regardless of the number of manufacturers. Our results signal market failures in the generic drug market and warrant the consideration of policy strategies to increase the sensitivity of generic drug prices to competition.<sup>14</sup> ■

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## **eAppendix Methods.** Therapeutic Classes Classification

National Drug Codes (NDCs) were classified into therapeutic classes using the uniform system classification (USC).

Nervous System Acting Drugs include therapies for neurological or neuromuscular disorders (USC 20000), parasympathetic drugs (USC 63000), psychotherapeutic drugs (USC 64000), and sedatives and hypnotics (USC 67000). Nervous system acting drugs was chosen as reference for analyses because it was the therapeutic class with the higher prevalence.

Analgesics and anesthetics include USC categories 02000 and 04000.

Anti-infective agents include Amebicide/trichomacides/antibacterials (USC 01000), antihelmintics (USC 07000), systemic anti-infectives (USC 15000), antimalarials (USC 16000), biologic vaccines (USC 27000), anti-fungal agents (USC 38000), tuberculosis therapy (USC 74000), and antivirals (USC 82000).

Antineoplastic agents included USC category 30000.

Antirheumatic Agents and Immunomodulators include antarthritics (USC 09000) and immunologic agents (USC 86000).

Cardiovascular or Respiratory Agents include hemostatic modifiers (USC 11000), respiratory therapy (USC 28000), cardiac agents (USC 29000), vascular agents (USC 31000) and diuretics (USC 41000)

Enzymes and Blood Factors include USC categories 43000 and 48000.

Gastrointestinal and Genitourinary Agents include USC categories 23000 and 24000.

Metabolic and Endocrine Disorders Therapies include anti-obesity therapies (USC 18000), bile therapy (USC 26000), antihyperlipidemic agents (USC 32000), diabetes therapy (USC 39000), hormones (USC 52000), and thyroid therapy (USC 72000).

Musculoskeletal and Sexual Dysfunction Disorders Therapies include USC categories 59000 and 85000.

**eAppendix Table.** Results from Linear Mixed Models.

	Not weighted		Weighted*	
	Coefficient	P-value	Coefficient	P-value
Intercept	-0.01134	0.6409	-0.0382	0.4734
Year				
2006	Ref.		Ref.	
2007	0.01098	0.2687	0.03558	0.0381
2008	0.02199	0.0898	0.01703	0.4341
2009	0.03975	0.0062	0.03196	0.2037
2010	0.05301	0.0007	0.02915	0.2952
2011	0.1299	<.0001	0.1143	<.0001
2012	0.1647	<.0001	0.07091	0.019
2013	0.08715	<.0001	0.1461	<.0001
2014	0.1074	<.0001	0.2273	<.0001
2015	0.09142	<.0001	0.2018	<.0001
2016	0.0798	<.0001	0.1619	0.0001
Number of Manufacturers				
1-3	Ref.		Ref.	
4-7	-0.01158	0.5235	-0.00789	0.7401
>7	-0.03094	0.1608	-0.00376	0.8863
Year*Number of Manufacturers				
2007*4-7 MFR	-0.0016	0.9123	-0.01365	0.5262
2007*>7 MFR	-0.01374	0.3953	-0.03464	0.1105
2008*4-7 MFR	0.01853	0.3141	0.01451	0.5893
2008*>7 MFR	-0.00263	0.8974	0.006912	0.7986
2009*4-7 MFR	0.000425	0.9831	0.02367	0.4291
2009*>7 MFR	0.004656	0.8342	0.03528	0.2441
2010*4-7 MFR	0.01253	0.5503	0.05176	0.1102
2010*>7 MFR	0.007523	0.7463	0.06009	0.0663
2011*4-7 MFR	-0.02873	0.1763	0.0171	0.6057
2011*>7 MFR	-0.04163	0.0791	0.04909	0.1413
2012*4-7 MFR	-0.05	0.0193	0.1014	0.0035
2012*>7 MFR	-0.05708	0.0171	0.09755	0.005
2013*4-7 MFR	0.04178	0.0515	0.08279	0.0194
2013*>7 MFR	0.03504	0.1453	0.05822	0.1016
2014*4-7 MFR	0.02717	0.2193	0.07556	0.0463
2014*>7 MFR	0.02431	0.3208	-0.00933	0.8042
2015*4-7 MFR	0.04394	0.0515	0.06533	0.1112
2015*>7 MFR	0.03227	0.1932	-0.00856	0.8322
2016*4-7 MFR	0.03258	0.1697	0.05768	0.2178
2017*>7 MFR	0.03413	0.182	0.003855	0.9325
Route of Administration				
Oral	Ref.		Ref.	

Injectable	-0.02228	0.293	-0.03886	0.6343
Other	0.02457	0.1478	0.03237	0.2429

Supplemental Table 1 cont.

	Not weighted		Weighted	
	Coefficient	P-value	Coefficient	P-value
<b>Therapeutic Class</b>				
Nervous system acting drugs	Ref.		Ref.	
Analgesics and anesthetics	0.000698	0.9853	0.05186	0.5709
Anti-infective agents	0.008234	0.7856	0.2883	0.0001
Antineoplastic agents	-0.05968	0.2101	-0.07027	0.6296
Antirheumatic agents and immunomodulators	0.01275	0.7812	0.08685	0.3966
Cardiovascular or respiratory agents	-0.0491	0.399	0.007732	0.9093
Enzymes and blood factors	0.183	0.2397	0.2269	0.476
Gastrointestinal and genitourinary agents	-0.02272	0.5633	-0.0224	0.8044
Metabolic and endocrine disorders therapies	0.0413	0.1964	0.07455	0.334
Musculoskeletal and sexual dysfunction disorders	-0.0491	0.399	-0.06222	0.6584

\*Each national drug code was weighted by the count of pharmacy claims from UPMC Health Plan in the respective year.