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## The Unexpected Impact of Information-Sharing on US Pharmaceutical Supply-Chains

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This paper examines the introduction of information-sharing into the supply chains for pharmaceutical products in the United States. This introduction was unusual for several reasons. First, it was catalyzed from *outside* the industry, by a Securities and Exchange Commission (SEC) investigation into improper financial reporting by a single manufacturer. Second, it was initiated by pharmaceutical manufacturers *in order to keep distributor inventories low*. Third, although its effect on pharmaceutical distributors has been profound, evidence indicates that information-sharing has had *no* impact on pharmaceutical manufacturers' own inventory-management practices.

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Over the last twenty years, information-sharing has revolutionized supply-chain management. Indeed, it is now generally taken as a “given” that information-sharing in the supply chains for *any* product/service will inevitably bring about improved efficiency and/or effectiveness up and down the supply chain.

This paper examines the introduction of information-sharing into the supply chains for pharmaceutical products in the United States. This introduction was unusual because it was catalyzed from *outside* the industry, by a Securities and Exchange Commission (SEC) investigation into improper financial reporting by a single manufacturer.

This introduction was unusual in other ways, too: First, it was initiated by pharmaceutical manufacturers *in order to keep distributor inventories low*.

*“The impetus for the fee-for-service model came from the drug manufacturers, which were under ‘a lot of pressure to reduce their amount of inventory in the channel’ by the SEC and the FDA, said Larry Marsh, Managing Director of Lehman Brothers.” — Modern Healthcare, 9/6/2004*

Second, although its effect on pharmaceutical distributors has been profound, evidence indicates that information-sharing has had *no* impact on pharmaceutical manufacturers' own inventory-management practices.

This paper should be of interest to anyone interested in how *quickly* and *profoundly* a company's business model — in this case, the major pharmaceutical distributors' business model — changes and how its efficiency can increase if it is "forced" to carry significantly lower inventories. And, it should be an object lesson for anyone who believes that information-sharing will inevitably bring about improvements in efficiency and effectiveness up and down the supply chain.

## **BACKGROUND**

Relatively little has been published in the supply-chain/operations-management literature about healthcare-product supply chains, in general, or pharmaceutical supply chains, in particular. Burns' (2002) book is the most frequently-cited general reference. A 2005 report published by The Kaiser Family Foundation describes the organizations involved in the U.S. retail supply chain and the key financial relationships among them. Most other available

resources are website postings from industry experts and consulting companies; and these typically do not cite accessible databases. We offer the following background.

Although the development and manufacture of pharmaceuticals is typically complex, the physical distribution of pharmaceutical products is straightforward. According to a 2007 study by Booz, Allen, and Hamilton, nearly 80% of prescription drug volume flows from manufacturers to distributors (often called "wholesalers") and then either to providers (e.g., hospitals, clinics) or to retail pharmacies.

Pharmaceutical manufacturing is diverse in nature and international in scope. In the United States, the 10 largest pharmaceutical corporations, as measured by sales, accounted for almost 60% of sales in 2004 (The Kaiser Family Foundation, 2005). Brand-name pharmaceutical manufacturers generally experience large profit margins; e.g., between 1995 and 2008 the Top-5 manufacturers had an average aggregate profit margin of 18.5%.

Pharmaceutical distribution in the US is highly concentrated. Three companies — AmerisourceBergen, Cardinal Health, and McKesson — share about 90% of the market. Pharmaceutical distributors, on the other hand, generally experience small profit margins; e.g., during the same 1995-2008 period, the Top-3 distributors had an average aggregate profit margin of 1.2%.

More interesting, however, is the *source* of distributor profits. According to Adam Fein, Pembroke Consulting, in 2004:

*"...approximately 85% of wholesaler gross-margin dollars come from the buy side."*

Indeed, unlike distributors of most other products, who earn money on the "sell side", pharmaceutical distributors earn most of their gross margin from the *manufacturers* whose products they distribute.

There are many reasons for this, among them the buying power of large retail pharmaceutical chains, which dispense the majority of pharmaceuticals, and cost pressure on providers (e.g., hospitals) by third-party payers (e.g., Medicare, Medicaid, insurance companies). This cost pressure encouraged the development of healthcare group-purchasing organizations, which negotiate the prices that their (otherwise unaffiliated) provider-members pay for pharmaceuticals and other supplies.

### ***The Rise of Investment Buying***

Given little/no opportunity to earn gross margin from the sell side of their business, pharmaceutical distributors looked for ways to make money on the buy side; and pharmaceutical manufacturers provided a way for them to do so: steady price increases.

During the decade of the 1990's, manufacturers' price increases for the most widely-used drugs averaged 1% above inflation. Figure 1 provides data for 2002-2008: Note that manufacturers' annual increases for the most-widely used brand-name drugs ranged from 5.3 to 8.7% while inflation ranged from 1.6 to 3.8%. These steady and relatively predictable increases provided the opportunity for distributors to capture gross margin on the buy side: by "investment buying".

Under investment buying, distributors made money by purchasing large quantities of pharmaceuticals *in anticipation* of a manufacturer's price increase, often borrowing the funds to do so. Then, once the price increased, distributors were able to sell to their price-conscious

buyers at a very small mark-up — indeed, sometimes at a discount with respect to the new, higher price — and still earn a positive margin.

*" ... the rule of thumb at the time was that a 1% price increase paid for 1-month's supply "* — Trade Account Manager, Major Pharmaceutical Manufacturer

Investment buying became such a significant source of gross margin that, according to a manager at one of the Big-3 distributors, "The Big-3 all had teams of employees using mathematical models to forecast price increases".

Investment buying also provided pharmaceutical manufacturers the opportunity to manage sales by pushing product down to distributors; i.e., "channel stuffing". It also virtually guaranteed manufacturers that their distributors would never run out of the manufacturers' products, which might otherwise cause a lost sale.

There were, of course, disadvantages to both parties. For distributors, investment buying involved financial risk; i.e., "gambling" on a price increase; and some of these bets were wrong.

*The so-called "secondary market" for pharmaceuticals, which was originally used by larger distributors to sell to small distributors, evolved to become a market through which distributor overstocks were bought and sold. This secondary market provided an avenue through which counterfeit drugs entered the legitimate US pharmaceutical supply chain. But, this is another story.*

For manufacturers, investment buying meant some lost revenue (on the products purchased at the lower price), and significant volatility in distributor ordering. Presumably, this volatility required manufacturers to carry increased safety stocks.

Yet, the major disadvantage of investment buying, from the perspective of supply-chain coordination, was that it led to an environment of *no* information-sharing, sometimes *misinformation-sharing*, between the manufacturers and the distributors. According to a Manager in one of the top U.S.-based pharmaceutical distributors,

*"It was a game of cat-and-mouse: the distributors didn't want the manufacturers to know what they were selling and what they were holding, so that they could order whatever they wanted. The manufacturers, well, they wanted to manage their sales, but they didn't want to give away the farm."*

Hence, instead of sharing information, distributors went out of their way to *not* share inventory, customer-ordering, or shipping information with manufacturers.

Despite its disadvantages, the "end" of investment buying was catalyzed from *outside* the industry: By the Security and Exchange Commission (SEC).

In 2001, the SEC announced an investigation of Bristol Myers Squib (BMS). According to Fein (2005), BMS was:

*"...alleged to have had its wholesalers purchase excess inventory in 2000 and 2001 in order to meet sales and earnings projections...subsequent investigations forced BMS to restate its financial records from 1999 through 2002 and officially announce an end to forward (investment) buying by wholesalers in March, 2003....The company entered into a settlement with the SEC in August, 2004, that was reported to 'limits future sales to*

*wholesalers based on demand or on amounts that do not exceed approximately one month of inventory on hand."*

It is important to note, first, that channel stuffing is not, *per se*, illegal. Nor was BMS ever found guilty of anything. Instead, BMS reached a settlement with the SEC, agreeing to restate its financial reports, and agreeing to pay \$300 Million in fines and payments to investors. The company entered into a final settlement with the Securities and Exchange Commission in August, 2004 that was reported to "limit future sales to wholesalers based on demand or amounts that do not exceed approximately one month of inventory on hand" Fein (2005).

Although public attention was focused on BMS, in fact, most of the major pharmaceutical manufacturers participated in investment buying, and some were under scrutiny.

*"...(drug manufacturers were under) a lot of pressure to reduce their amount of inventory in the channel' by the SEC and the FDA, said Larry Marsh, managing director of Lehman Brothers. 'This is an indirect response to greater regulatory scrutiny over the drug industry, which came about when there was the recognition that channel-stuffing (stockpiling drug inventory) had become a fairly persistent practice.'"* — Modern Healthcare, 9/6/04

### ***The Rise of Fee-for-Service and Inventory-Management Agreements***

With the SEC investigation of BMS in the background, the pharmaceutical supply chain began to replace investment buying with a "fee-for-service (FFS)" model with Inventory-Management Agreements (IMAs).

Under a FFS/IMA model, pharmaceutical distributors receive fees directly from pharmaceutical manufacturers for the distribution services that the distributors provide. The details of these agreements are proprietary, but, according to insiders, FFS/IMAs have two parts: First, an Inventory Management Agreement (IMA); i.e., a schedule of incentives for the distributor to maintain *low* inventories. In other words, the *lower* the distributor's inventory the *larger* the distributor's discount on products purchased, provided that the distributor meets specific (high) service-level targets. Second, fees in exchange for information reported to the manufacturer (e.g., distributor days-on-hand inventory, daily orders and shipments to the distributor's customers) by the distributor.

Although it is difficult to determine exactly when FFS/IMAs were started, we believe that it was in the 2002-03 time frame; and, according to Fein (2005):

*"Industry estimates indicate that up to 70 percent of distribution volume was covered by IMAs by the end of 2004."*

According to a Vice-President of Marketing at McKesson one of the Big-3, 95% of McKesson's manufacturers were under IMAs by the end of 2004.

Note that although distributors continue to receive most of their gross margin from the buy side, they now receive that margin directly from the manufacturers (as discounts or fees) for their services. Indeed, under IMAs, distributors are rewarded for maintaining *lower inventories*. Last, but most relevant to one of our major findings: Since 2002-03, IMAs have been providing manufacturers with information about distributor inventories and their downstream customer orders. This is information that manufacturers did not receive in the days of investment buying, and information that *should be* very useful to manufacturers in managing their own inventories.

Next, we present the findings from our study of the impact of the FFS/IMAs on the pharmaceutical distributors and manufacturers. The evidence we provide is based on financial information from the 3 largest distributors (AmerisourceBergen, Cardinal, and McKesson), which account for approximately 90% of total US distributor dollar volume; and M3 (US Census Bureau) data on US pharmaceutical and medicine manufacturing inventory dollars and shipment dollars. Additional information is from annual surveys conducted by the Healthcare Distributors Management Association (HDMA). We also interviewed approximately one dozen pharmaceutical supply-chain executives.

## **OUR FINDINGS**

Inventory Management Agreements (IMAs) have had a profound effect on pharmaceutical distributors; and, the effect appears to have taken place in two steps. In step one, IMAs required distributors to reduce their inventories but still meet manufacturer-specified service-level targets. In order to do so, distributors improved their business processes. We will document the reductions and some of the improvements. These improvements facilitated step two: even further reductions in inventory and further increases in turnover: not only meeting, but exceeding the service-level targets that manufacturers had initially specified.

Supply-chain theory suggests two effects of IMAs on manufacturers: one in the short run, before manufacturers were able to take advantage of the information provided to them under IMAs; and one in the long run, once they were able to do so. In the short run, theory suggests that manufacturer inventories would either increase or decrease, the net effect depending on the magnitude of opposing influences (described below). The evidence is that manufacturer inventories increased slightly. In the long run, once manufacturers have been able to take advantage of information provided to them under IMAs, theory (and experience in other supply

chains) predicts reduced manufacturer inventories (and increased turnover). The evidence is that manufacturer inventories have continued to increase. Although there are several possible reasons for this increase, we believe that manufacturers have not taken advantage of the information being shared with them, either because they are ignorant about the opportunity to reduce their inventories, or because they don't care.

### ***The Impact of IMAs on Pharmaceutical Distributors***

Inventory Management Agreements (IMAs) have had a profound effect on pharmaceutical distributors; and, the effect appears to have taken place in two steps. First, distributors were required to dramatically reduce their inventories. They did so. Figure 2, an extension of Exhibit 2 in Fein (2005), displays the annual changes in revenue and inventories at the Big-3 pharmaceutical distributors between 2001 and 2009. Note that in 2001, when investment buying was still largely in place, inventories increased more than sales. In every year since (except 2007), inventories increased less than sales, and in 2005 and 2009 they decreased. Figure 3 displays the aggregate inventory turnover at the Big-3 distributors. Note that between 2001 and 2004, turnover increased from 7.4 to 9.5.

Common sense (and the theory of efficient markets) suggests that in order to accomplish a significant reduction in inventory in the 2001-2004 interval, distributors *must* have improved their business processes. Schwarz (1998) codifies these notions using the Information/Control/Buffer (ICB) Portfolio paradigm. Under the ICB Portfolio paradigm, every management system consists of 4 elements (information, decision-making, implementation, and buffering). Each of these four elements has quality characteristics. Everything else being equal, the better the information, decision-making, and implementation (e.g., the more accurate for forecast, the

faster the implementation), the smaller the buffers (e.g., inventory) required to manage at any fixed level of customer service. Correspondingly, if inventories are forced to be lower, then information, decision-making, and/or implementation must become better.

According to our sources, this is what occurred.

*"McKesson adopted SAP starting in 2002. This system including tracking inventory at the SKU level"* — Vice President of Marketing, McKesson

During this same time period, AmerisourceBergen adopted internal systems to incentivize improved efficiency in order picking. Many distributors also installed new IT systems for better inventory management.

These improved business processes — and, perhaps, a refocusing of management attention away from "gambling" on manufacturer price-increases towards their core competence — brought about step two: even further reductions in inventory and increased efficiency. Take another look at Figure 3, now focusing on the 2004-2009 interval, after IMAs had already been widely adopted by the industry: inventory turnover increased from 9.5 to 13.5! Figure 4 displays increasing distributor average fill-rate over the same time interval. And, in terms of out-of-stocks: Note the decreasing distributor out-of-stocks and the increasing percentages of out-of-stocks due to *manufacturer problems*, despite higher levels of inventory at the manufacturers.

Figure 5 displays the impact of IMAs at the distributors in a different way. It displays the changes in total inventory at the Big-3 distributors over three time intervals. On the left, note (shaded area) that distributor inventory increased \$1,386 Million between 2001 and 2004. Assuming the same inventory turnover in 2004 as in 2001, inventory *should* have increased \$6,901. This is a savings of \$5,515 Million. Similarly, between 2004 and 2009 distributor inventory increased \$485 Million. Assuming the same inventory turnover in 2009 as in 2001,

inventory *should have* increased \$11,342 Million: a savings of \$10,857 Million. Hence, the distributors' inventory saving between 2001 and 2009 is \$16,371 Million.

### ***The Non-Impact of Information-Sharing on Pharmaceutical Manufacturers***

Next, we examine the impact of information-sharing on pharmaceutical manufacturers. Supply-chain theory suggests two effects: one in the short run (i.e., 2001-2004), before manufacturers were able to take advantage of the information provided to them under IMAs; and one in the long run (e.g., 2004-2009), once they were able to do so.

In the short run, several influences must have been at work. First, everything else being equal, in order to provide the same level of service to providers, the reduction of distributor inventories would necessitate *some* increase in manufacturer inventories; i.e., a shift in supply-chain inventory from the distributors up to the manufacturers. Yet, this shift provides some risk-pooling, so the shift should not be expected to be one-for-one. On the other hand, given the volatility of distributor ordering under investment buying, theory would predict that manufacturers should be able to reduce their safety stocks under FFS/IMAs, since distributor orders should be smaller, more frequent, and, hence, more predictable. In summary, theory suggests that manufacturer inventories should either increase or decrease, the net effect depending on the magnitude of these opposing influences. In the long run, once manufacturers have been able to take advantage of the detailed information provided to them under IMAs and the reduced volatility of distributor orders, supply-chain theory would predict reduced inventories and increased turnover.

Figure 6 displays what did happen. It is a plot of aggregate inventory turnover at US pharmaceutical manufacturers between 2001 and 2009. It does display a decrease in turnover

(i.e., an increase in manufacturer inventories) in 2004 (7.8) compared to 2002 and 2003 (8.1 and 8.3, respectively), indicating a short-run shift in supply-chain inventory from the distributors to the manufacturers. More important, overall, the trend has been a *decrease* in turnover; i.e., an increase in manufacturer inventories. Hence, there is no evidence that manufacturers have taken advantage of the information being provided to them under IMAs to lower their inventories (based on improved forecasting, better production scheduling, etc.). Indeed, those inventories have increased!

Figure 7 provides an alternative perspective. Between 2001 and 2004 total manufacturer inventory increased \$3,529 Million. Assuming the same inventory turnover in 2004 as in 2001, inventory should have increased only \$3,362 Million: a *loss* of \$167 Million. Similarly, starting in 2004, manufacturer inventory increased to \$2,306 Million by 2009. Assuming the same inventory turnover in 2004 and 2009 as in 2001, inventory should have increased only \$1,773 Million: a *loss* of \$533 Million. Finally, assuming the same inventory turnover in 2009 as in 2001, inventory should have increased only \$5,135 Million instead of \$5,835 Million: a *loss* of \$700 Million.

Figure 8 provides a supply-chain view, by combining Figures 5 and 7. Supply-chain inventory (manufacturer plus distributor) inventory increased \$4,915 Million between 2001 and 2004. Based on inventory turnovers in 2001, this increase should have been \$10,263 Million, a saving of \$5,348 Million. Finally, based on 2001 inventory turnovers, between 2001 and 2009, the pharmaceutical supply chain has enjoyed an inventory reduction of \$15,671 Million, or \$15.7 Billion, \$16.4 Billion in savings at the distributors and a \$700 Million increase at the manufacturers.

*Evidently, manufacturers have failed to take advantage of the information provided to them by the distributors in order to improve their production planning and reduce their inventories.*

So, are manufacturers using this information for *other* purposes? Based on our interviews, the answer is "yes". First, it is used on an aggregate basis to forecast quarterly sales for financial forecasting.

*"We are using IMA information to forecast day-by-day orders from the distributors, and is using this information to prepare financial forecasts (e.g., monthly and quarterly sales and income), to provide better explanation to analysts regarding our financial statements "* — Supply-Chain Director, Major Pharmaceutical Manufacturer

It is reported that manufacturers also use IMA-provided information about specific large provider and retail accounts for sales/promotional purposes. Indeed, an executive of one provider chain reported the manufacturers are offering *providers* the opportunity to do investment buying!

Nonetheless, the question remains: Given that manufacturers *aren't* using the information about downstream orders and inventories in order to manage their own inventories better, then *why not?*

It is well known that pharmaceutical manufacturing often involves long cycle times, large fixed lot sizes, and “delays” for quality assurance. Consequently, according to one consultant interviewed, it isn’t unusual for forecasts to be blocked out 12-18 months in advance, and for production schedules to be frozen 6 months in advance. Another consultant suggested

that some manufacturers understand the potential of supply-chain management to reduce inventories and improve profits, but that they don't know how to take advantage of this information.

Indeed, the *production* supply chain for pharmaceuticals is relatively complex, making it more difficult to utilize the information. However, another explanation, more blunt, yet probably more accurate, is that most manufacturers don't think of supply-chain management as a priority and probably have not paid much attention to it. An internal supply-chain consultant for a well-known brand-name manufacturer offered the opinion that "our inventories just aren't that large".

Although some manufacturers do operate with smaller inventories than others, in 2009, the top-5 pharmaceutical manufacturers (Pfizer, Merck, Johnson&Johnson, Astrazeneca, and BMS) reported an aggregate inventory investment of \$28.8 Billion, or 17.2 percent of current assets and 49.0 percent of earnings before interest and taxes (EBIT). Looked at another way, using an inventory-holding cost rate of 20%, these manufacturers incurred aggregate inventory-holding costs of \$5.8 Billion, or 9.8% of EBIT.

Given the rise in importance of supply-chain management in other industries and the uncertain future profitability of pharmaceutical manufacturing, this leads to the question: Why don't pharmaceutical manufacturers pay more attention to supply-chain management? One expert offered the opinion that, from a public-relations perspective, pharmaceutical manufacturers don't want to be seen as limiting supply in order to increase prices. But, other industries have demonstrated the ability to lower inventories and maintain or improve supply, given better information.

Finally, is it possible that pharmaceutical manufacturers *are* paying attention to supply-chain management, but that it just has not (yet) had an impact? One consultant mentioned that

some manufacturers are starting to look at the potential of supply-chain management in terms of information sharing.

In summary, although there are several possible reasons for the increase in manufacturer inventories, we firmly believe that pharmaceutical manufacturers are forsaking the opportunity to improve their production planning and reduce their inventories — potentially substantial reductions — either because they are ignorant of the opportunity or because they just don't care. Given the tremendous pressure on pharmaceutical manufacturers to improve their long-term profitability, perhaps it is time for them to add supply-chain management to marketing and product-development as a competitive priority.

### **OPPORTUNITIES FOR SUPPLY-CHAIN RESEARCHERS**

Although our results "find fault" with the priorities and/or abilities of pharmaceutical manufacturers, there is plenty of "fault" to go around. In particular, supply-chain researchers have largely ignored the supply chains for healthcare products. Or, like us three years ago, assumed that healthcare-product supply chains are similar to those for consumer or industrial products. In fact, these supply chains are quite unusual, as described by Schwarz (forthcoming), both in terms of the organizations involved (e.g., group purchasing organizations) and the business processes (e.g. investment buying).

Pharmaceutical supply chains, in particular, are quite complex, on both the input/manufacturing and the output/distribution side. To illustrate: Each step of the manufacturing process is typically complex, with very long set-up times (e.g., weeks), and subject to rigorous quality control. Different steps in the production process are often performed in different countries, based partly on familiar notions of plant loading, but also sensitive to taxes and financial considerations. One consultant that we interviewed suggested that, in view of this

complexity, manufacturer inventories are simply the result of a *feasible* plan; i.e., that inventories or inventory-related costs are not in the planner's objective function. There are many opportunities for learning and research on the input/manufacturing side of pharmaceutical supply chains.

There are also many opportunities for learning and supply-chain research on the distribution/logistics side of pharmaceutical supply chains, where our work has been. At the macro level, there are questions to be answered in terms of supply-chain design. For example, should a pharmaceutical manufacturer use the existing wholesaler intermediary or distribute direct to providers (e.g., hospitals) as some medical-device manufacturers do? Should a manufacturer manage its own inventory and logistics, as most do today, or outsource it to a 3PL (as Pfizer recently did to United Parcel Service)? In terms of the existing supply chain, how should Inventory Management Agreements (IMAs) and fee-for-service (FFS) contracts be designed, and how can manufacturers take best advantage of the information already available to them (which, it seems, they are not using)? More important, how *might* IMAs and FFS be structured in order to, possibly, coordinate the supply chain?

In 2010, the Association for Healthcare Resource & Materials Management (AHRMM), a personal membership group of the American Hospital Association (AHA), announced the creation of a new research consortium that is focused on health-sector supply-chain research. More information is available at "<https://achscr.groupsie.com/login>".

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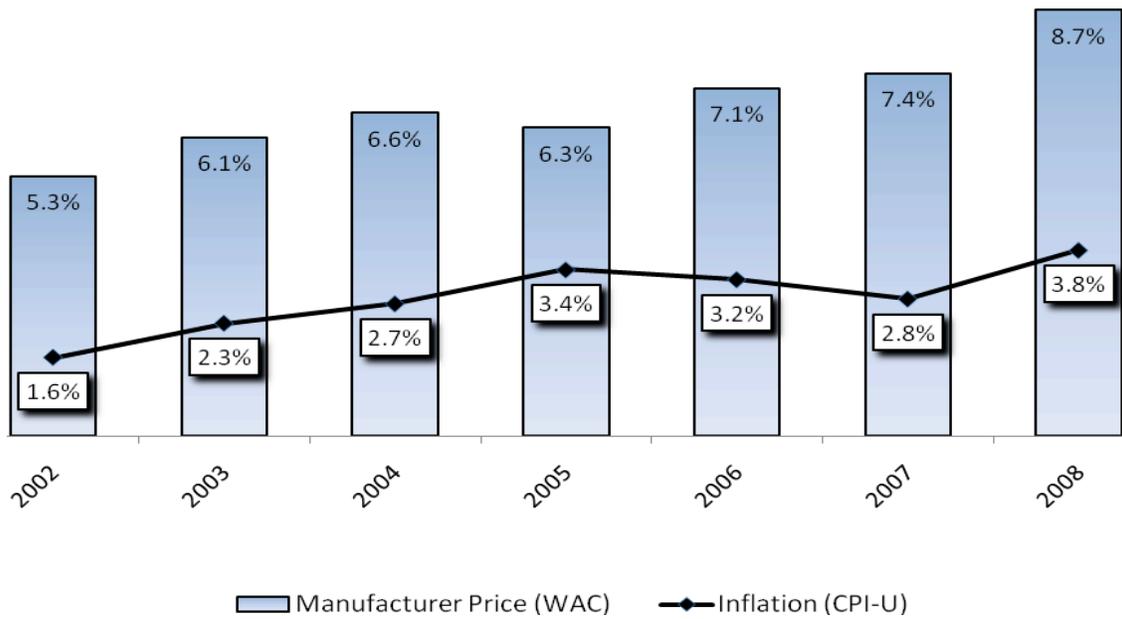


Figure 1: Average Annual Percentage Change in Manufacturer Prices for Widely Used Brand Name Prescription Drugs (2002-2008)\*

\*Data Source: AARP Public Policy Institute, Rx Watchdog Report 2008 Year-End Update

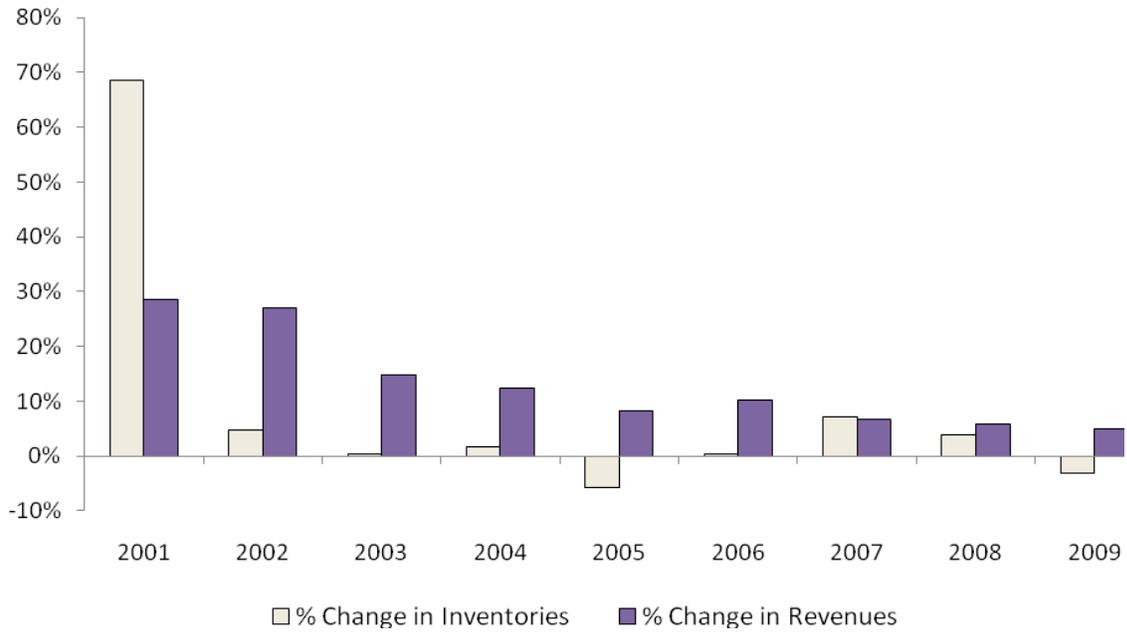


Figure 2: Annual % Changes in Revenues and Inventories at Top 3 Distributors (2001-2009)\*

\*Based on December filings of AmerisourceBergen, McKesson, and Cardinal Health.

Data Source: Compustat INVTQ and SALEQ variables

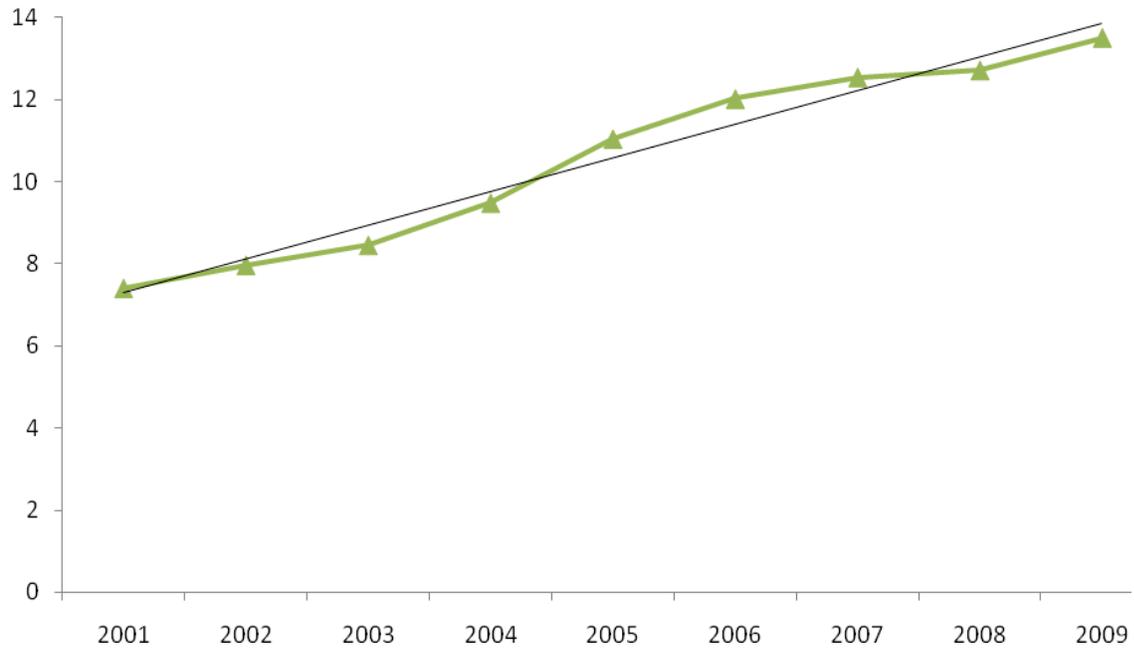


Figure 3: Inventory Turnover at Top 3 Distributors (2001-2009)\*

\*Based on quarterly filings of AmerisourceBergen, McKesson, and Cardinal Health.

Data Source: Compustat INVTQ and SALEQ variables

\*Aggregate inventory turnover was calculated by dividing combined revenue by combined average inventory in the calendar year. Data was collected for the companies' quarterly reports.

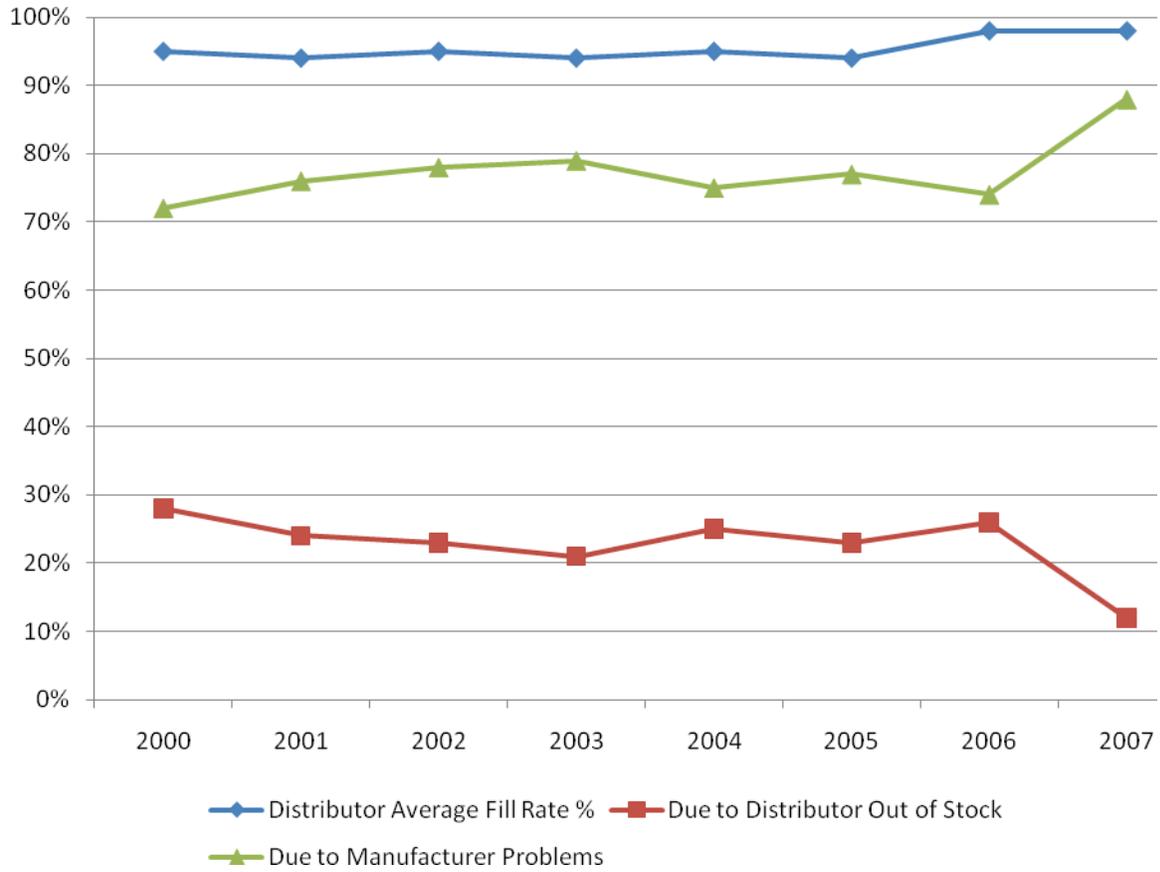


Figure 4: Distributor Fill Rate and Reasons for Inability to Ship\*

\*Data Source: 2000-2010 HDMA Annual Factbooks

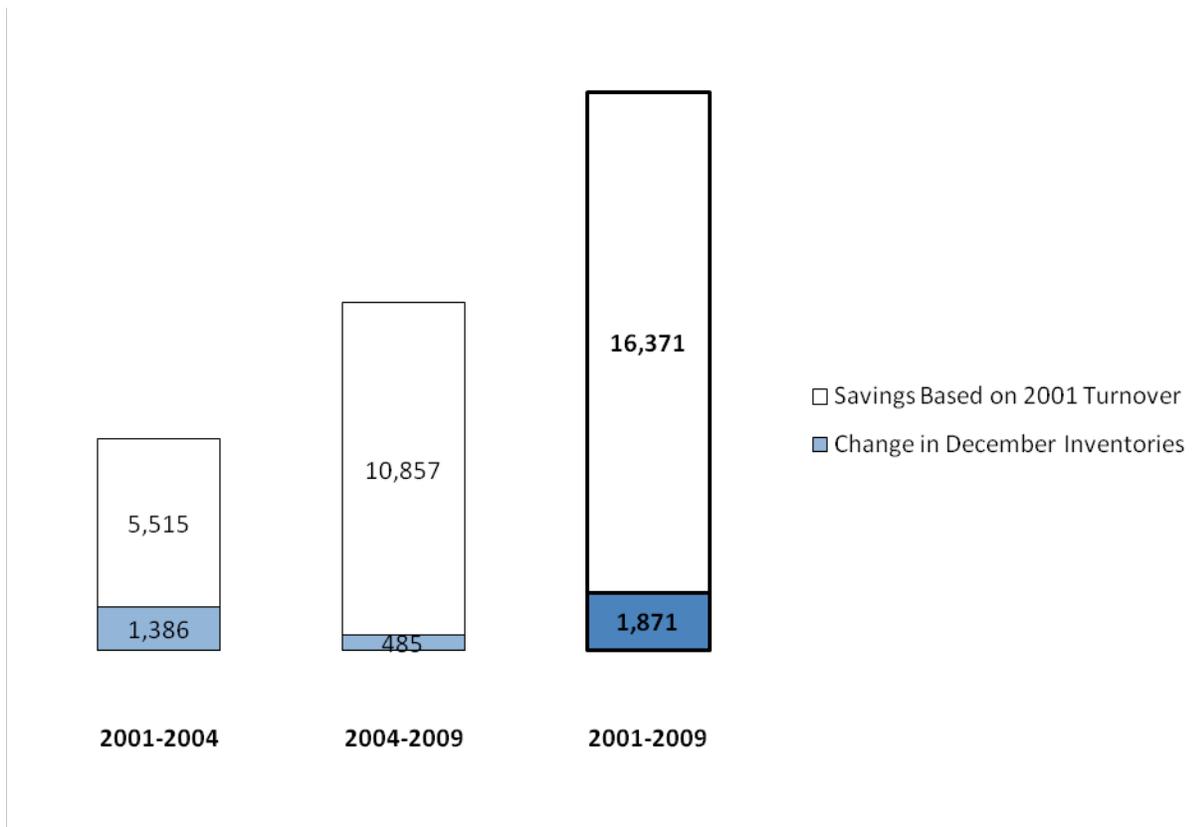


Figure 5: Inventory Changes and Savings at Top 3 Distributors\*

\*Based on quarterly filings of AmerisourceBergen, McKesson and Cardinal Health.

Data Source: Compustat INVTQ and SALEQ variables

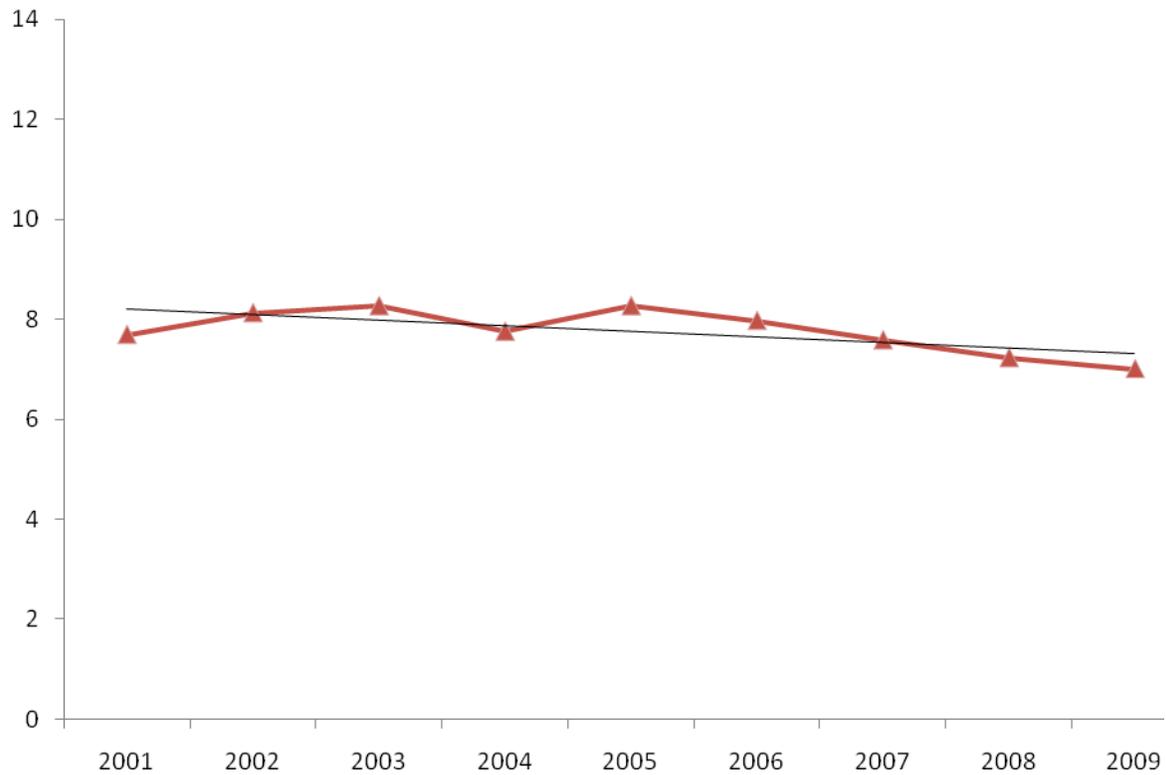


Figure 6: Inventory Turnover at Manufacturers (2001-2009)\*

\*Data Source: US Census Bureau Manufacturers' Shipments, Inventories and Orders M3 Report

\*Aggregate manufacturer inventory turnover was calculated by dividing the total shipment value in any calendar year by the average inventory throughout the same year. Data was collected from the US Census Bureau Manufacturers' Shipments, Inventories and Orders M3 Report (A25BVS: shipment values, A25BTI: total inventory).

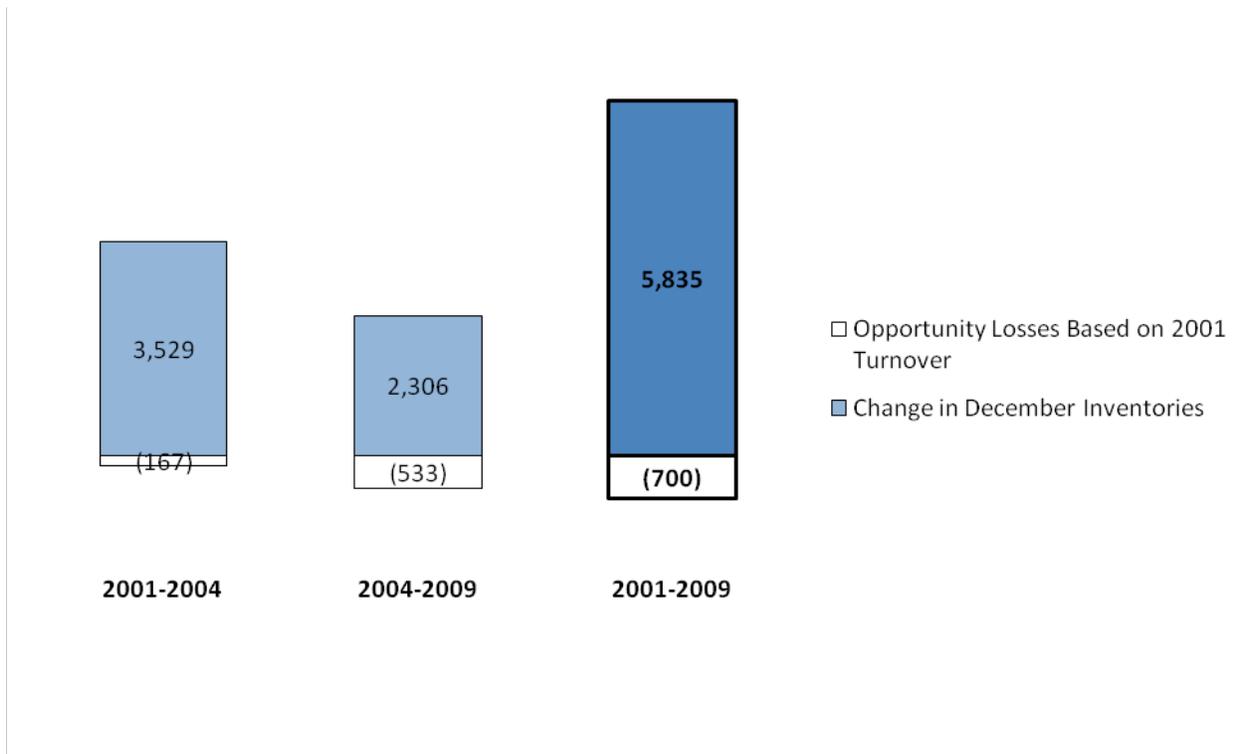


Figure 7: Inventory Changes and Opportunity Losses at Manufacturers\*

\*Data Source: US Census Bureau Manufacturers' Shipments, Inventories and Orders M3 Report

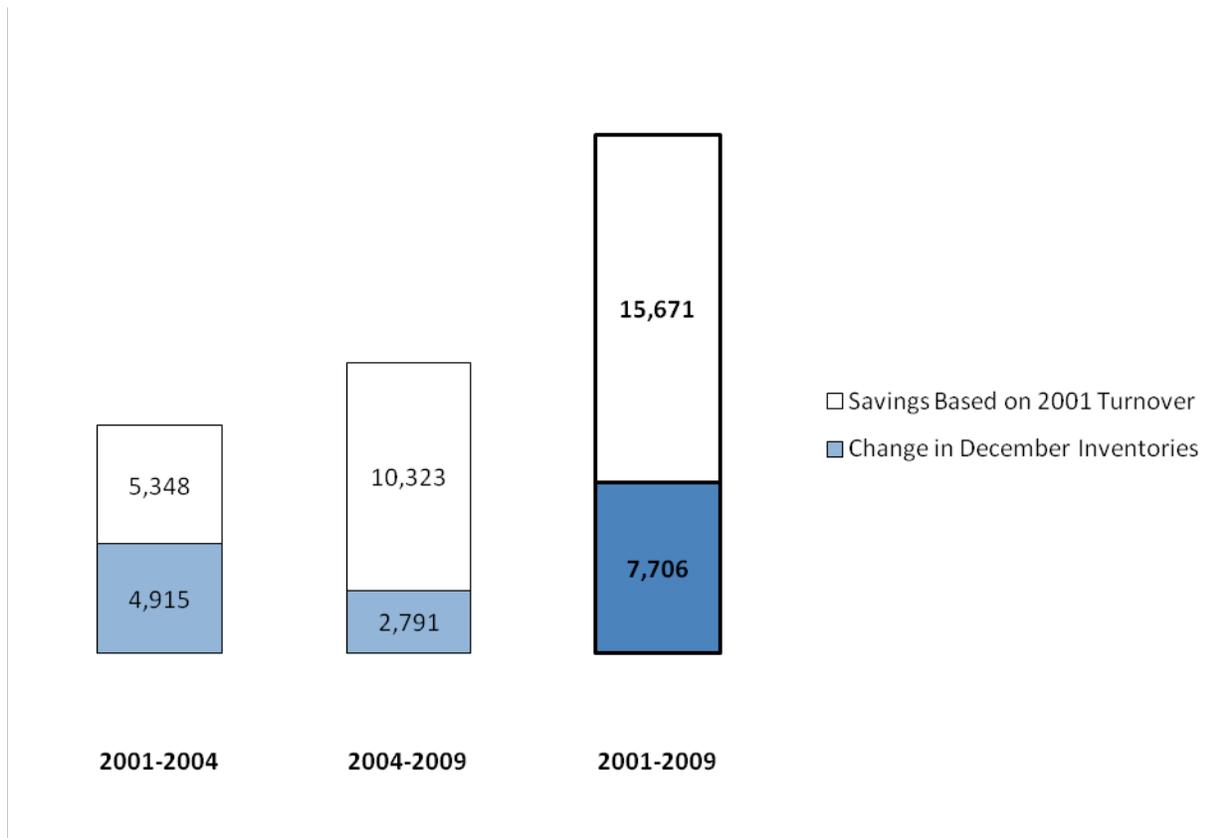


Figure 8: Supply Chain Inventory Changes and Savings\*

\*Data Source: US Census Bureau Manufacturers' Shipments, Inventories and Orders M3 Report, and quarterly filings of AmerisourceBergen, McKesson and Cardinal Health.