Impact of Mergers and Acquisitions on Supply Chain Performance

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Acknowledgements

Abstract

This thesis consists of three essays that examine the impact of mergers and acquisitions on supply chain performance. In the first essay, we analytically study the effects of upstream and downstream mergers on suppliers, retailers and consumers, in an oligopolistic market. We start with a benchmark case where mergers do not generate any synergy. By assuming that firms compete in Bertrand or Cournot fashion, we compare the effects of an upstream merger with a downstream one. We find that upstream (respectively, downstream) mergers always benefit the merging firms, while adversely affecting their dependent downstream (respectively, upstream) supply chain partners; non-dependent suppliers and non-dependent retailers also benefit from such horizontal mergers. Moreover, an upstream merger is more detrimental to consumers than a downstream merger. We then analyze three extended models: (i) In a case where mergers generate synergies through economies of scale at both levels, merging firms still benefit while non-merging competitors suffer a loss in profit. (ii) If the synergy comes as a result of economies of scope, then an upstream merger benefits not only the merging suppliers but also the related downstream retailers; a downstream merger benefits all the firms in the merging industry and upstream unrelated suppliers. (iii) If market demand is uncertain, then each firm's optimal strategy will depend on the value of parameters.

The second essay is an empirical investigation of the effects of horizontal mergers and acquisitions on the merging firms' performance. Our focus is the inventory-related per-

formance of merging firms at an aggregate level, although the effects on other operating performance measures, e.g., profitability, are also discussed. By using accounting panel data from Compustat database and the data on horizontal M&As in manufacturing, wholesale and retail sectors from SDC Platinum database, we study how the merging firms' (one-year) post-merger inventory performance metrics compare to their (one-year) pre-merger ones. The analysis is conducted on two different levels. The first examines the effects on absolute performance, with the second analyzing the effects on relative performance (compared to the industry average level). Subsequently, we extend our study to test the longer term effects of mergers (two-year post-merger), and also compare the performance of merging firms to "similar" non-merging competitors. Lastly, we perform a multivariate regression analysis and find that days-of-supply and gross profit margin are the two most salient factors that affect the success of M&As.

In the third essay, we again empirically study an issue that complements the second essay. Specifically, we evaluate the merging firms' performance after vertical mergers and acquisitions. We find that after the vertical integration, the acquiring firms' operational performance actually deteriorates in the first year after the transaction. The negative effect lessens over time and it normally takes at least two years for those merged firms to catch up with their matching rivals. Looking at five years performance after vertical mergers, we find that merging firms do not gain significant competitive advantage over the industry average.

Résumé

Cette thèse se compose de trois essais qui examinent l'impact des fusions et acquisitions sur la performance des chaînes d'approvisionnement. Le premier essai est consacré à l'étude des effets d'une fusion en amont et en aval sur les fournisseurs, les détaillants et les consommateurs dans un marché oligopolistique. Nous commençons par un cas de référence où les fusions ne génèrent pas de synergie. Nous comparons les effets d'une fusion en amont à celle en aval dans le cas d'une concurrence à la Bertrand ou à la Cournot. Nous constatons que les fusions en amont (aval) bénéficient toujours les entreprises fusionnantes, tandis qu'elles nuisent à leur partenaires dans la chaîne d'approvisionnement en aval (amont). Ces fusions horizontales profitent aussi aux concurrents. Par ailleurs, les fusions en amont sont plus préjudiciables pour les consommateurs que les fusions en aval. Par la suite, nous analysons trois différents cas: (i) lorsque les fusions génèrent des synergies grâce à des économies d'échelle, aussi bien en amont qu'en aval, ces fusions bénéficient aux entreprises fusionnantes alors que leur concurrents non fusionnants voient leur profits baisser. (ii) Si la synergie est le résultat des économies d'envergure, alors les fusions en amont profitent non seulement aux fournisseurs fusionnants mais aussi aux détaillants dans la chaîne d'approvisionnement. On note aussi que ces fusions nuisent à d'autres fournisseurs alors qu'elles bénéficient à d'autres détaillants. Quant aux fusions en aval, elles bénéficient aux entreprises qui fusionnent et leurs concurrents et aux fournisseurs pour les concurrents, tandis que le bénéfice de leurs fournisseurs diminue. Du point de vue des consommateurs, une fusion en amont est préférable

à celle en aval. (iii) Si la demande du marché est incertaine, alors la stratégie optimale de chaque entreprise dépendra de la valeur des paramètres.

Le deuxième essai consiste en une étude empirique des effets des fusions et des acquisitions horizontales sur la performance des entreprises fusionnantes. Nous nous intéressons principalement aux mesures relatives à l'inventaire tout en considérant d'autres mesures des performances opérationnelles. En utilisant des données de panel extraites de la base de données Compustat et des données sur les fusions et acquisitions horizontales dans le secteur manufacturier, commerce de gros et de détail disponibles dans la base de données SDC Platinum, nous étudions comment la performance (annuelle) après la fusion se compare à la performance (annuelle) avant la fusion. L'analyse est effectuée à deux niveaux différents. Nous examinons d'abord les changements dans la performance absolue. Par la suite, nous étudions la performance relativement à la moyenne du secteur. Nous étendons ensuite notre étude pour tester les effets à long terme (deux ans après la fusion) des fusions, et aussi comparer la performance des entreprises fusionnantes à celle des concurrents similaires non fusionnants. En plus, une analyse de régression multi-variée est effectuée afin d'identifier les facteurs de performance qui affectent significativement la rentabilité des entreprises fusionnantes.

Dans le troisième essai, nous évaluons la performance des entreprises fusionnantes suite à des fusions et acquisitions verticales. Nous constatons qu'avec l'amélioration de l'intégration verticale, la performance opérationnelle de l'acquéreur s'est détériorée dans la première année qui suit la transaction. L'effet négatif diminue au fil du temps et il faut normalement au moins deux ans à ces entreprises fusionnantes pour rattraper leurs rivaux. Concernant la performance dans les cinq ans qui suivent les fusions verticales, nous constatons que les entreprises fusionnantes ne gagnent pas un avantage concurrentiel significatif sur la moyenne du secteur.

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Chapter 1

Introduction to Mergers and Acquisitions

Mergers and acquisitions (M&As)[1] have become a popular strategy for businesses to expand their operations around the globe. Even after the financial crisis broke out in August 2007, M&As continue to be a core strategy for companies. For example, according to Thomson Reuters Corp., in the full-year 2010, the value of global mergers and acquisitions rose 22.9% from 2009, the strongest full-year period for M&A since the crisis. The fundamental role of M&A activities is to enable firms to adjust more effectively to new challenges and opportunities. Some of the potential advantages of mergers and acquisitions include increased revenues and market share, improved profitability, and higher enterprise values (Weston and Weaver (2004)). However, not every M&A has positive outcome; some of them end up as failures resulting in disruption in business operations, loss of value, and erosion of market share. A lot of this positive as well as adverse effect is seen in the context of inventory management performance. The work in this thesis is motivated by the growing trend of mergers and acquisitions as well as the increasing importance of inventory management. Our purpose is

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[1]In this thesis we use the terms mergers and acquisitions interchangeably.

to contribute to the understanding of how mergers and acquisitions affect the merging firms' inventory related performance.

1.1 Merger Types

Mergers are often classified into three distinct types: horizontal, vertical, and conglomerate. A horizontal merger occurs when two firms in similar type of production, distribution or area of business are brought under one management. For example, in 2009 two pharmaceutical companies, Pfizer and Wyeth, combined in a $68 billion megamerger. After a horizontal merger, competition in the market is reduced because the firms that merged were formerly competing with each other for business. Costs can also be reduced because functions that were duplicated can now be combined.

A vertical merger is a combination of two firms that have a buyer-seller relationship. Vertical mergers may take two basic forms: forward or backward. A forward vertical merger occurs when a company combines with one of its downstream distributors or retailers where its products are sold, for example Disney's acquisition of American Broadcasting Company (ABC) in 1996. Disney is a leading provider of family entertainment while ABC is a broadcasting company with news, cable, and entertainment networks. The deal is a forward vertical integration because Disney purchases a distribution network for its products. A backward vertical merger is where a company a company acquires an upstream supplier that produces some of the inputs used in the production of its products, for example American Technology's acquisition of HST Inc. American Technology is a high-tech producer of branded components while HST is a designer and manufacturer of technologically advanced components for branded consumer products. This deal is considered a backward vertical integration because American Technology uses HST as an outsourced manufacturer of its main components. Generally speaking, after a vertical merger, the integrated firm is expected to

achieve a lower transaction costs, better synchronize the supply and demand along the chain of products, and improve the ability to monopolize market throughout the supply chain.

A conglomerate merger combines companies producing unrelated products or services, i.e., the two firms are not competitors and do not have a buyer-seller relationship. Conglomerate mergers are often a consequence of diversification strategies. This often happens when an acquirer tries to expand into other fields of business activity. For example, Philip Morris, one of the nations largest tobacco firms, acquired Kraft in 1988 for $13.44 billion[2]. Because a conglomerate merger is one between two strategically unrelated firms, it is unlikely that the economic benefits will be generated for the target or the acquirer. As such, conglomerate mergers seldom occur today (Barney and Hesterly 2008), and will not be a part of this dissertation.

1.2 Merger & Acquisition Waves in History

Recovering from the economic crisis in 2007, the value of global mergers and acquisitions (M&A) totaled US$2.4 trillion during the full-year 2010, a 22.9% increase from comparable 2009 levels and the strongest full-year period for M&A since 2008 [3]. In the recent history, M&A specialists have identified five periods of high merger activity, often called merger waves, in the last century. These periods have typically occurred in cyclical patterns: periods of intense merger activity have been followed by intervening periods of relatively fewer mergers.

The first wave occurred after the depression of 1883, peaked between 1898 and 1902, and ended in 1904. The mergers of the first wave were predominantly horizontal combinations, and the affected industries became highly concentrated. The second merger wave, between

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[2]Philip Morris's stockholders voted to change the corporation's name to the Altria Group in 2002.

[3]According to Thomson Reuters Full-Year 2010 Global Investment Banking Review For Mergers And Acquisitions And Capital Markets Activity.

1916 and 1929, began during World War I and continued until the stock market crash of October 29, 1929. Mergers of the second merger wave were characterized by oligopolies rather than monopolies. There were more vertical mergers than horizontal mergers in the second wave (Gaughan (2007)). The third merger wave (1966-1969) was characterized by mergers among unrelated companies, also known as conglomerate mergers, while the unique characteristic of the fourth wave (1983-1986) is the significant rise of hostile mergers.

During the fifth merger wave in the late 90's, merger activity in the United States and worldwide rose to unprecedented levels. An environment of sustained economic growth and rising stock prices facilitated these transactions. Toward the end of 2000, the economic climate shifted and the economy showed only small growth during the first quarter of 2001. The volume of merger activities declined quarter by quarter. Excess capacity in a number of industries had developed, and sales and profit disappointments began to widen. In such an economic environment, the economic role of mergers and related activities expanded until the global financial crisis in 2007. Note that the term "mergers and acquisitions" encompasses a widening range of activities, including joint ventures, licensing, spinoffs, equity carve-outs, tracking stocks, restructuring, alliances, and other corporate interactions such as network relationships (Weston and Weaver 2004). Since all of these activities are more or less related to firms' operations and supply chain management, and to the best of our knowledge, there is no comprehensive study investigating the effect of mergers in a supply chain context, we make the first attempt to address this issue.

1.3   Outline of the thesis

This thesis makes the following contributions to the literature. First, it compares the different impact of upstream and downstream horizontal mergers. Second, it presents two frameworks to quantify the merger-induced synergies: the cost reductions come from econ-

omy of scale, and the joint replenishment benefit from economy of scope. While traditional M&A research has been done in the fields of economics and finance, few studies in supply chain and operations management have looked into the issues involved in M&As. This research enriches the literature from this perspective. Third, this thesis empirically examines the effects of horizontal as well as vertical mergers and acquisitions on merging firms and their primary competitors' inventory-related performance. Our work represents a first attempt in understanding inventory implications of M&As at an aggregate level. Event study and multivariate regression have been adopted for analysis, that reveals some of the key characteristics of effects of M&As on operations related performance.

Specifically, in this thesis, we focus our attention on two types of mergers: horizontal and vertical. We first construct theoretical models to analyze the effects of horizontal mergers on merging firms, their non-merging rivals, and other related companies in the supply chain under different scenarios. We start with a benchmark case where mergers do not create synergies, and assume that firms compete in prices (in a Bertrand fashion). By comparing the effects of an upstream merger with a downstream merger, we show that both upstream and downstream mergers benefits the merging entities, while adversely affecting their related downstream and upstream supply chain partners; not directly dependent suppliers and retailers also benefit from mergers. Moreover, an upstream merger is more detrimental than a downstream merger to consumers. These results carry over to the situation where firms compete in quantity (in a Cournot fashion). We then analyze three extended models: (i) mergers generate synergy through economies of scale and lead to cost reductions; (ii) the merger-induced synergy comes as a result of economies of scope; and (iii) firms are facing uncertain demand.

We show that (i) In a case where mergers generate synergies through economies of scale, at both levels, merging firms still benefit, while non-merging competitors suffer a loss in profit. (ii) If the synergy comes as a result of economies of scope, then an upstream merger

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benefits not only the merging suppliers but also the related downstream retailers, outside suppliers suffer while outside retailers still benefit; a downstream merger benefits all the firms in the merging industry and upstream unrelated suppliers, while upstream related suppliers' profit decreases. From consumers' perspective, an upstream merger is preferable than a downstream one. (iii) If market demand is uncertain, then each firm's optimal strategy will depend on the value of parameters.

To investigate how exactly the horizontal mergers affect firms performance, in the second essay, we study empirically how the (one-year) post-merger performance compares to that of the (one-year) pre-merger level. The horizontal mergers and acquisitions events have been collected in manufacturing, wholesale and retail sectors from SDC Platinum database, and the firms' accounting panel data are available from COMPUSTAT database. The analysis is conducted at two different levels. We first examine changes in absolute performance. Relative performance compared to the industry average is studied next. We then extend our study to test the longer term effects of mergers (two-year post-merger), and also compare the performance of merging firms to similar non-merging competitors. In addition, a multivariate regression analysis is performed to identify the performance factors that significantly affect merging firms' profitability.

In the third essay, we again empirically study an issue that complements the second essay. Specifically, we evaluate the merging firms' performance after vertical mergers and acquisitions. We find that after the vertical integration, the acquiring firms' operational performance actually deteriorates in the first year after the transaction. The negative effect lessens over time and it normally takes at least two years for those merged firms to catch up with their matching rivals. Looking at five years performance after vertical mergers, we find that merging firms do not gain significant competitive advantage over the industry average.

The remainder of this thesis is organized as follows. In Chapter 2, we review two streams of literature relevant to theories of horizontal mergers - economics and supply chain manage-

ment. In Chapter 3 we study the theoretical effects of upstream and downstream mergers on suppliers, retailers and consumers. Chapter 4 is an empirical investigation of the effects of horizontal mergers and acquisitions on the merging firms' performance. In Chapter 5, we evaluate merged firms' performance after vertical mergers and acquisitions. In Chapter 6 we provide concluding remarks, and describes our ongoing and future work.

Chapter 2

Theoretical Models in Horizontal Mergers: A Literature Review

In this chapter, we review two streams of literature relevant to horizontal mergers - economics and supply chain management. In the economics field, extensive research has been carried out to study the effect of horizontal mergers on merging firms as well as their non-merging competitors in the same industry, but most of them only consider the impact of mergers on those firms in the merging industry. Firms are assumed to compete either in price (Bertrand fashion) or in quantity (Cournot fashion), and under different types of competitions, horizontal mergers can have distinctly different effect on price, output, and profit. In addition, there are a few studies that looked into the mergers in a two-level supply chain, which are closely related to my work. In what follows, we categorize the extant literature into four groups based on the type of competitions: one level mergers under Cournot competition, one level mergers under Bertrand competition, comparison between Cournot and Bertrand mergers, and mergers in a two-level supply chain. In supply chain management stream, since there are very few papers studying horizontal mergers, we primarily focus on recent research on one level horizontal *coalition*.

2.1   Economics Stream

2.1.1   Mergers under Cournot (quantity) competition

Linear demand

Much of the economic literature on horizontal mergers examines the effects of mergers on the market price, profits, and social welfare, assuming that firms produce a homogeneous product and compete on quantity (Cournot Game). The seminal work of Salant et al. (1983) shows that in the context of a symmetric Cournot oligopoly with linear demand and costs, mergers are not profitable unless more than 80 percent of the firms collude. Subsequently, Perry and Porter (1985) reveal that the incentive to merger depends upon a complex resolution of two forces: first, a merger results in a price increase; second, the output of the merged firm declines relative to that of its partners prior to the merger. The price increase resulting from mergers benefits all firms in the merging firms' industry, and it can often be sufficient to compensate for the output reduction of the merged firm and increase profits. Similar to Perry and Porter (1985), Farrell and Shapiro (1990) and McAfee and Williams (1992) also use Cournot models to study the welfare effects of horizontal mergers. Farrell and Shapiro (1990) show that in general, mergers raise prices if they do not generate synergy and "firms with large market share must achieve impressive synergies or scale economies if their merger is to reduce price". They point out an important effect of merger in Cournot fashion is the reallocation of output to competitors, and due to this effect, a merger can be welfare improving even when a merger generates no synergies. McAfee and Williams (1992) focus on some more specific aspects by assuming increasing marginal cost, and conclude that for a merger to be welfare-enhancing, there must be a non-merging firm whose market share exceeds the sum of the pre-merger shares of the merging firms. In other words, welfare-enhancing mergers do not increase the market share of the largest firms.

Non-linear demand

The above papers all analyze the impact of mergers on marginal cost under the linear demand assumption. Keeping the constant-marginal cost assumption while relaxing the assumption of linear demand, Cheung (1992) concludes that if the merging firms' market share is less than 50%, then the profit falls for the merging parties. In addition, Faulí-Oller (1997) and Hennessy (2000) show there is greater scope for profitable mergers in Cournot industries when the inverse demand function is convex. Furthermore, the profitability of a real-world merger may derive from sources assumed away in these models, including cost reductions or other synergy gains in businesses of the merging firms other than those producing the anticompetitive effects. For instance, if a merger in such a Cournot industry reduces the marginal costs of the merging firms by a sufficient amount, the merging firms have an incentive to increase output post-merger, leading to lower prices and increases in total as well as consumer welfare. See Froeb and Werden (1998) for the derivation of this 'sufficient amount' (which leaves consumer surplus unchanged compared to the pre-merger state).

Incomplete information

Stennek (2003) modifies the assumptions of the Cournot model from a different angle, by introducing incomplete information between firms about each other's marginal costs. He shows that, with private information, the market is inefficient in allocation of production between firms. As a result, a merger may increase efficiency due to the pooling of information. Such information synergies may be large enough for price to fall and consumers to benefit from the merger. Amir et al. (2009) also show that the informational asymmetry created by mergers always works in favor of the merged firm, which outperforms its rivals even in the situation where their costs are all equal.

Stackelberg-Cournot game

In contrast to the assumption of simultaneous decision making in a Cournot-Nash market, several authors consider mergers in a Stackelberg-Cournot setting in which leader firms first make decisions about output quantity, then the remaining firms, as Stackelberg followers, decide upon their best response quantities. Under such conditions, a merger may change the point of time of firms' decision making. Daughety (1990) considers a case of Stackelberg market with m leaders and $n - m$ followers, and shows that a leader-generating merger can be socially desirable. The increase in asymmetry results in an increase in competition, and leads to greater aggregate output and greater welfare. However, mergers that simply reduce the number of followers without increasing the number of leaders reduce social welfare. Huck et al. (2001) further analyze this framework in three different cases: a) two leaders merge; b) two followers merge; and c) one leader and one follower merge and stay as a leader. They show that two leaders (followers) merger is profitable if there are only two leaders (followers) in the original market, while a merger between a leader and a follower is always profitable.

2.1.2 Mergers under Bertrand (price) competition

In addition to those Cournot merger models, there are other papers dealing with the Bertrand merger model, where firms compete on prices by selling differentiated products which are substitutable.

Linear demand

Under Bertrand competition with differentiated products, Deneckere and Davidson (1985) find mergers of any size are beneficial, and increasingly profitable in the sense that large mergers yield higher profits than smaller ones. This is in contrast to the results that mergers tend to be disadvantageous in quantity-setting games. They also show that prices increase

after a merger in their linear demand model with symmetric competition.

Non-linear demand

Werden and Froeb (1994) analyze Bertrand mergers in the context of constant marginal cost and logit demand, which generally is motivated by a random utility model of consumer choice. They provide the necessary conditions for Bertrand-Nash equilibrium and show that if there are no internal efficiencies generated by the merger, except for fixed cost savings or output reallocation, then the prices of all products in the industry will increase after the merger; the magnitudes of the price increases are dependent on the market share of the different products.

Moreover, Werden (1996) introduce a practical way to compute the exact marginal cost reductions that assure an enhancement of consumer welfare from a differentiated product merger, which provides a robust and practical method for determining whether a particular merger enhances consumer welfare. Froeb et al. (2005) also investigate the mergers in Bertrand oligopoly and show that both the price effects of mergers and the pass-through reductions in marginal cost to consumers depend on the curvature of demand.

2.1.3   Comparison between Cournot and Bertrand competition

Generally speaking, no matter firms compete in a Cournot or Bertrand fashion, a horizontal merger without cost benefit or synergy will lessen competition in the merging industry, and will make the merging firms more powerful but 'less aggressive' than the original independent firms. This affects the non-merging rivals' actions quite differently. Under the Cournot competition, lowering one firm's output quantity will increase the output of other firms, which is harmful to the first firm. While under the Bertrand competition, increasing one firm's price triggers a price increase from the rivals, which is beneficial to the original firm.

Linear demand

For a general comparison between the Bertrand competition and Cournot competition, Gal-Or (1988) shows that with the linear and stochastic demand, at the Cournot equilibrium, the merger may impose an informational disadvantage on each firm that colludes, thus reducing even further the incentives to merge. However, at the Bertrand equilibrium, each merging firm always benefits from a larger informational advantage than non-merging firms. Hence, demand uncertainty provides a stronger incentive to merge if firms compete in prices. McElroy (1993) develops conditions for all prices to rise after a merger and shows that mergers cannot increase welfare in linear models under either Bertrand or Cournot competition.

Non-linear demand

Vives (1984) and Singh and Vives (1984) show, in a duopoly model, that if goods are substitutes, then Bertrand competition results in lower profits for firms, higher consumer surplus and higher overall welfare than Cournot competition. With unknown common demand, Vives (1984) demonstrates that sharing information about demand uncertainty is a dominant strategy with Bertrand competition and concealing is a dominant strategy with Cournot competition. Given that the demand structure is symmetric and Cournot and Bertrand equilibria are unique, Vives (1985) shows that with linear demand, the Bertrand price is always lower than the Cournot price; with nonlinear demand, the Bertrand price is lower than the Cournot price under fairly general conditions.

2.1.4 Mergers in two-level supply chains

Most of previous papers focus on the effects of mergers on the merging industry or the consumers. While few works have studied the effects of mergers on the firms in the different levels, i.e. the effects on the merging firms' upstream or downstream industry. In this

subsection, we review three type of models that analyze the impact of mergers in a two-level supply chain system: the bilateral duopoly model, the bilateral oligopoly model, and the two-level system with a monopoly.

Bilateral duopoly model

The bilateral duopoly model means there are two levels of industry in the market - upstream and downstream, and within each level there are two firms competing with each other. Therefore, whenever there is a horizontal merger, it shifts the competitive structure of the industry from duopoly to monopoly. Focusing on the contract between upstream suppliers and downstream retailer, Horn and Wolinsky (1988) apply a bargaining model to analyze a merger from duopoly to monopoly under Cournot competition operating with a wholesale price contract. They show that with substitutable products, a monopoly supplier is more profitable than two independent suppliers. With a single supplier, the profit of a downstream monopoly is less than the total profit of two retailers. In contrast, when firms bargain over two-part tariff contracts, Milliou and Petrakis (2007) show the exact opposite result: in the absence of any efficiency gains, the merging upstream firms has lower incentives to increase the wholesale prices than a separate upstream firm. The explanation behind these results is under two-part tariff contracts, downstream production is subsidized while it is not such a case under wholesale price contracts.

Horizontal mergers reduce the number firms in market but do not necessarily reduce the number of products. Inderst and Shaffer (2007) analyze mergers in the bilateral duopoly system, and they focus on the impact of mergers on product variety. The monopoly retailer may continue to buy from two previous suppliers or it may choose buy from only one of the suppliers. They show that a single-sourcing policy could increase the competition between suppliers by reducing their differentiation, and hence benefit the consolidated retailer.

M'Chirgui and Hichri (2006) also show that in a duopoly supply chain where downstream firms compete in a Cournot fashion with differentiated products while upstream suppliers compete in a Bertrand fashion with homogenous products, whether or not a downstream merger is profitable depends on the degree of final product differentiation.

Although the above papers study the impact of mergers in a two-level system, they only analyze the mergers in one level and fail to compare the difference if the mergers take place in different levels. Fumagalli and Motta (2001) is the first paper to compare the effects of horizontal mergers at two levels. They study a bilateral Cournot duopoly model in which there are two manufacturers in the upstream and two retailers in the downstream, and show that a downstream monopolist is more detrimental to the entire welfare than an upstream monopolist if the vertical contract between a manufacturer and a retailer is unobservable, while if contracts are observable then both monopolists are equally detrimental to welfare.

Bilateral oligopoly model

One major limitation of duopoly model is that a horizontal merger will lead to a monopoly, which is oftentimes prohibited in the real world. Furthermore in most of industries, there are more than two firms in the market, therefore a two-firm merger does not create a monopoly market. To the best of our knowledge, there is only one paper studying the effect of horizontal mergers under the bilateral oligopoly setting. By assuming there are three firms in both upstream and downstream, Lommerud et al. (2005) discuss how a downstream merger influence the input prices charged by upstream suppliers in a Cournot oligopoly model. They show that a downstream merger reduces the merging firms' input prices, while the non-merging firm's input price change depends on the degree of product differentiation and suppliers' preferences. They also identify the conditions under which a downstream merger is profitable for the participants.

Two level system with a monopoly

Froeb and Tschantz (2006) and Faulí-Oller and Bru (2008) also study the effects of merger within a two level system, but they assume that there is a oligopoly market at one level and a monopoly firm at the other level. Froeb and Tschantz (2006) consider a supply chain with a downstream monopoly retailer supplied by competing manufacturers. In their model, the effect of a upstream merger depends on nature of the wholesale price contract between the manufacturers and the retailer. Under two-part tariff contract, Faulí-Oller and Bru (2008) show that given the monopolistic power of the upstream supplier is high enough, any size of mergers between n downstream firms are profitable.

Table 2.1 provides a classification of the most related Economic literature about horizontal mergers based on the aforementioned six characteristics: competition type, product type, merger level, number of firms in merging industry, demand pattern, and cost structure.

Table 2.1: Horizontal Mergers in Economic Literature

Author	Year	Competition	ProductType	Level	NumofFirms	Demand	Cost
Salant et al.	1983	Cournot	homogeneous		n	linear	linear
Perry and Porter	1985	Cournot	homogeneous		n	linear	quadratic
Farrell and Shapiro	1990	Cournot	homogeneous		n	general	general
Daughety	1990	C-Stackelberg	homogeneous		n	linear	linear
Cheung	1992	Cournot	homogeneous		n	linear	linear
McAfee and Williams	1992	Cournot	homogeneous		n	linear	quadratic
Fauli-Oller	1997	Cournot	homogeneous		n	convex[1]	linear
Froeb and Werden	1998	Cournot	homogeneous		n	linear	linear
Hennessy	2000	Cournot	homogeneous		n	convex[1]	linear
Huck et al.	2001	C-Stackelberg	homogeneous		n	linear	-
Stennek	2003	Cournot	homogeneous		2	linear	stochastic
Huck et al.	2004	Cournot	homogeneous		n	linear	linear
Deneckere and Davidson	1985	Bertrand	differentiated		n	linear	linear
Werden and Froeb	1994	Bertrand	differentiated		n	logit	linear
Werden	1996	Bertrand	differentiated		n	linear	linear

[1]inverse demand function

Author	Year	Competition	ProductType	Level	NumofFirms	Demand	Cost
Froeb et al.	2005	Bertrand	differentiated		n	concave	linear
Singh and Vives	1984	B&C	differentiated		2	linear	NA
Vives	1984	B&C	differentiated		2	linear stoc	NA
Vives	1985	B&C	differentiated		n	general	NA
Gal-Or	1988	B&C	differentiated		n	linear stoc	NA
McElroy	1993	B&C	homogeneous		n	linear	linear
Horn and Wolinsky	1988	Cournot	differentiated	Up/Down	2x2	linear	linear
Fumagalli and Motta	2001	Cournot	homogeneous	Up/Down	2x2	concave	linear
M'Chirgui and Hichri	2006	Cournot	homogeneous	Down	2x2	linear	linear
Inderst and Shaffer	2007	Cournot	homogeneous	Down	2x2	general	linear
Milliou and Petrakis	2007	Cournot	differentiated	Up	2x2	linear	linear
Froeb et al.	2006	Bertrand	differentiated	Up	2x1	linear	linear
Fuauli-Oller and Bru	2008	Cournot	homogeneous	Down	1xn	linear	linear
Lommerud et al.	2005	Cournot	differentiated	Down	3x3	linear	linear

2.2 Supply Chain Management Stream

Although there is an extensive literature on horizontal mergers within economics and finance, surprisingly, very little attention have been received in the supply chain management literature. Researchers in supply chain management area are usually more interested in the role of cooperation among competing agents. In recent years, a lot of attention has been paid to the applications of game theory in supply chain management. Interested readers can see Cachon and Netessine (2004) for a comprehensive review. Our work is related to three different streams of research. First, our work is related to the literature that examines the successive oligopoly model, where at each level of supply chain, there are a small number of firms competing with each other. Corbett and Karmarkar (2001) investigate a supply chain network consisting of several tiers of decision-makers who compete within a tier. Under the assumption of identical linear production cost functions, they determine the number of entrants in each tier under Nash equilibrium. Carr and Karmarkar (2005) also study competition in multi-echelon supply chains with an assembly system structure. They apply price-only contracts to achieve quantity coordination, i.e., the production quantity of each upstream supplier equals that of the downstream manufacturer who uses the suppliers' outputs as its own input. In our model, we will consider a supply chain with two levels, and analyze the optimal strategy for each firm at both levels.

Second, many authors apply a cooperative game-theoretic framework to analyze the formation of "coalition" among supply chain agents and their impact. This is somewhat similar to the idea of horizontal mergers. While in these models, the involved firms not only seek to maximize their joint profits, but also consider the profit allocation and stability of the alliance. Granot and Sošić (2005) develop a model of three retailers where their products may be substitutable. In their work, each firm may form alliances with none, one, or two other firms. A firm joining a coalition reduces its cost, but it also reduces the cost

of other coalition members. In addition, coalition members benefit at the expense of firms left outside the coalition. They also apply the concept of *Largest Consistent Set*(LCS) as a stability criterion to determine the farsighted stable coalition structures.[2] Nagarajan and Sošić (2007) study dynamic alliance formation among agents in competitive markets. They consider price competition among n agents selling substitutable products and facing both deterministic and stochastic demand. The agents may form coalitions, which lead to an increase in price for both coalition members and non-coalition members. The authors also show that prices increase with the size of the coalition, and the non-coalition players generate larger profits than those in a coalition. All these results are consistent with our findings in the case of mergers without synergies. Granot and Yin (2008) analyze two contracting schemes between an assembler and n independent suppliers. In a push system, suppliers set price first, then the assembler orders. In a pull system, the assembler offers a wholesale price to each supplier first, suppliers then determine their production quantity. Our model is somewhat similar to their push system, instead of a single assembler, we assume there are also n retailers in the downstream market. In the case of upstream mergers, we show that the industry's total profit is decreasing in the number of merging firms, while in their system, the assembler's profit, suppliers' total profit and the consumer surplus are decreasing in the number of coalitions, which means the profit is maximized as all the suppliers join the coalition.

Finally, there are few papers consider the cost advantage or operational synergies created by mergers or coalitions. Gupta and Gerchak (2002) use a newsvendor model framework to quantify operational synergies in a merger. They define the net benefit form operational

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[2]The concept of LCS is first introduced by Chwe (1994). It is a solution concept which applies to environments in which coalitions form freely without binding contracts, act publicly, and are farsighted. This concept has been used by Nagarajan and Bassok (2004), Granot and Sošić (2005), and Sošić (2006) in operations literature, to examine the coalition stability in various supply chains.

synergies as the difference between the maximum amount that a bidder should pay and the target's market value, and show that bidder firm's characteristics (such as size, flexibility of capacity, and demand patterns) have a significant impact on the target's value and the value of operational synergy. But there are no inventory decisions considered in their model. In contrast, we analyze mergers with operational synergy in an Economic Order Quantity (EOQ) model in which firms optimize both the selling price and the stocking level. We also assume that merged firms could benefit from the merger-induced synergy through a joint replenishment policy.

Chapter 3

Theoretical Analysis of Horizontal M&As

3.1 Introduction

Can horizontal mergers and acquisitions be profitable? This is a long-standing debate in the economics and finance literatures. From the merging firms' perspective, managers usually expect improvements in market share and profit, and they often cite improved productive efficiency as the primary source of gains behind the deals. For example, improved efficiency in production and distribution could arise from greater realization of economies of scale, elimination of overlapping facilities, and so on. In a seminal paper by Salant et al. (1983), they show that in a model with homogeneous products under Cournot competition, only merges that almost lead to a monopoly in the market would be profitable. Deneckere and Davidson (1985) use a model similar to that of Salant et al. (1983), but with (symmetrically) differentiated products and Bertrand competition. With linear demand they find that mergers are always profitable. On the other hand, anti-trust authorities are more concerned about the benefits and harms to consumers. Horizontal mergers may not only increase the merged

firms' market power vis-à-vis their suppliers, but also increase the concentration in merging firms' industry and thereby create more unfavorable prices for downstream customers.

However, depending on the nature of business, mergers between different types of firms might have different impact on the whole supply chain. If downstream retailers are able to cut their operational costs through mergers, they will have the incentive to reduce the price and increase the sales, which would also benefit the final consumers and improve the social welfare. For example, after the purchase of the consumer online service of CompuServe Corp., America Online Inc. (AOL) boosted its subscriber base to over 10 million, which allowed it to lower its prices to better compete with the upstarts (Gale Encyclopedia of E-Commerce 2002). On the other hand, if upstream manufacturers are seeking to increase their bargaining power vis-à-vis retailers through an upstream merger, like the merger between Greencore Group Plc and Northern Foods Plc in November 2010 to improve their bargaining power with supermarkets (Finbarr Flynn 2010), then downstream retailers might increase the prices for the final consumers.

Our paper contributes to existing literature by addressing the following questions: whether upstream or downstream mergers are more likely to have an adverse impact on welfare. To do so, we first construct a two-level oligopoly model where *three* upstream firms supply *three* downstream retailers. The equilibrium outcome of such a situation, with three oligopolistic vertical chains, is symmetric. Then, by allowing firms merge at the same level, we analyze the horizontal mergers with different sizes and compare the changes in price, output quantity, and expected profit for each firm in both levels, as well as the welfare for the whole system. By comparing upstream mergers with downstream ones, we find that horizontal mergers always benefit all the firms in the merging firms' industry. For an upstream merger, non-merging firms will improve their profit even more than the merging firms, while for a downstream merger, merging firms improve their profitability more than non-merging firms. We analyze horizontal competition under both Bertrand and Cournot framework, and results

are very similar.

Then, we extend our analysis in three directions: (i) we analyze the case in which mergers generate synergies to merging firms through economies of scale; (ii) we adopt the Economic Order Quantity (EOQ) framework to capture the synergy generated by economies of scope, and (iii) we relax the assumption of deterministic demand. Our paper is also the first one to study the effects of mergers in an EOQ framework. We show that in the presence of the operational synergies, a merger does not necessarily raise the output price for all the firms in the merging industry. If upstream firms merge and gain synergies from operational processes, the downstream industry can also benefit from the merger. On the other hand, if downstream firms merge, the generated synergies do not improve all the upstream firms' profit.

The rest of the chapter is organized as follows. The next section presents a Bertrand merger model is presented. We conduct empirical experiments to illustrate our theoretical results. In section 3.3, we study the mergers in a Cournot fashion and compare the results with the Bertrand case. Then we extend our analysis to three cases: mergers with economies of scale, mergers with economies of scope, and mergers with uncertain demand in section 3.4, 3.5 and 3.6 respectively. In the final section, summary of the results and concluding remarks is provided. Proofs of all propositions are provided in the appendix.

3.2 Mergers under Bertrand Competition

3.2.1 Model framework

Consider a system of n upstream suppliers and n downstream retailers. Each supplier produces and sells a differentiated product to end customers through an exclusive retailer. Products are substitutable and for simplicity assumed to have the same production cost c.

In such a system, there are two levels of competition. In the horizontal dimension, downstream retailers compete with each other in a Bertrand-Nash fashion, and upstream suppliers also play a Bertrand-Nash game. Moreover, within each vertical supply chain, firms engage in a Stackelberg competition; the supplier is the Stackelberg leader and the retailer is the follower. In the base model, we assume that retailers compete with each other on price only. We will analyze the equilibrium prices and profits arising before and after a merger occurring either in the upstream level or in the downstream one.

Let $\boldsymbol{p} = (p_1, ... p_n)$ be the price vector in which p_i is the retail price of product i, for $i = 1, 2, ..., n$. Demand for each product depends not only on its own retail price and also on the prices of its rivals:

$$d_i(\boldsymbol{p}) = \frac{1}{n}(1 - p_i + \frac{e}{(n-1)} \sum_{j \neq i}^{n} p_j), \tag{3.1}$$

where $e \in (0, 1)$ captures the degree of substitutability among products. This demand function is similar to those used by Lommerud et al. (2005) and Nagarajan and Sošić (2007), the difference is we add a scaling factor $1/n$ to ensure that the total market size only depends on the average price on the market. Hence, the total demand is

$$D(\boldsymbol{p}) = \sum_{i=1}^{n} d_i(\boldsymbol{p}) = 1 - (1-e) \frac{\sum_{i=1}^{n} p_i}{n}.$$

In order to investigate the effects of merger in a general case where m out of n suppliers or retailers merge, for any $m = 2, ..., n$, we start with the pre-merger stage where no suppliers or retailers merge, i.e., $m = 1$, then we will discuss the post-merger scenarios and compare the differences among the optimal strategies and profits for each player.

3.2.2   Pre-Merger Equilibria

We start with the case where there is no merger activities, i.e., $m = 1$. Each firm in this system chooses the optimal strategy independently to maximize its own expected profit. So

for each retailer R_i, given a wholesale price w_i, he would choose a retail price p_i to maximize the expected profit:

$$\pi_{Ri}(\boldsymbol{p}) = (p_i - w_i)d_i(\boldsymbol{p}) = (p_i - w_i) \cdot \frac{1}{n}(1 - p_i + \frac{e}{(n-1)} \sum_{j \neq i}^{n} p_j). \tag{3.2}$$

It is easy to verify that $\pi_{Ri}(\boldsymbol{p})$ is twice continuously differentiable and strictly concave. The first order condition gives:

$$\frac{\partial \pi_{Ri}(\boldsymbol{p})}{\partial p_i} = 1 - 2p_i + \frac{e}{(n-1)} \sum_{j \neq i}^{n} p_j + w_i = 0, \quad \forall i = 1, ..., n. \tag{3.3}$$

The above equation defines retailer i's best response function $p_i = p_i(w_i, \boldsymbol{p}_{-i})$, where $\boldsymbol{p}_{-i} \triangleq \{p_j | \forall j \neq i\}$ is the $(n-1)$-tuple of prices decided by other retailers. Since each retailer's best response p_i depends not only on its own wholesale price w_i but also on other retailers' selling prices $\boldsymbol{p}_{-i}$, we need to solve n retailers' problems simultaneously to find the Nash equilibrium solution $p_i(\boldsymbol{w})$, where $\boldsymbol{w} = (w_1, ..., w_n)$ is the wholesale price vector and each w_i is decided by supplier i, for $i = 1, ...n$. Correspondingly, the retail price vector is a function of wholesale price vector $\boldsymbol{p} = \boldsymbol{p}(\boldsymbol{w})$.

Knowing the retailer's optimal response, and demand accordingly, suppliers as the Stackelberg leaders, maximize their expected profits by choosing the optimal wholesale price, where the profit for each supplier i is given by.

$$\pi_{Si}(\boldsymbol{w}) = \max_{w_i} \ (w_i - c)d_i(\boldsymbol{p}). \tag{3.4}$$

Simultaneous solution yields the equilibrium prices w_i^*. Substituting back into $p(w)$, we get $p_i^* = p_i(\boldsymbol{w}^*)$ as the equilibrium retail prices. Denote π_{Ri}^* and π_{Si}^* as the equilibrium profit for each retailer and supplier, respectively.

To analyze the effects of mergers on consumers and aggregate welfare, we also define the

consumer surplus(CS) and the entire social welfare(SW) as follows:

$$CS = \sum_{i=1}^{n} \frac{1}{2} d_i (p_{max} - p_i), \tag{3.5}$$

$$SW = \sum_{i=1}^{n} \pi_{Si} + \sum_{i=1}^{n} \pi_{Ri} + CS, \tag{3.6}$$

where $p_{max} = 1/(1-e)$ is defined as the null price (i.e., the price at which the demand would fall to zero).

The following proposition characterizes the optimal strategies for each players and the corresponding profits. The proofs for all propositions are provided in the Appendix.

Proposition 1 *In the pre-merger equilibrium, the equilibrium wholesale price, retail price, demand for each product, supplier's and retailer's individual profit, consumer surplus and social welfare are as follows:*

$$w_i^* = \frac{2(n-1) + e + (2(n-1) - (n-2)e - e^2)c}{4(n-1) - (3n-5)e - 2e^2}, \tag{3.7}$$

$$p_i^* = \frac{6(n-1) - 3(n-2)e - 2e^2 + (2(n-1) - (n-2)e - e^2)c}{(2-e)(4(n-1) - (3n-5)e - 2e^2)}, \tag{3.8}$$

$$d_i^* = \frac{2(n-1) - (n-2)e - e^2 - (2(n-1) - (3n-4)e + (n-3)e^2 + e^3)c}{n(2-e)(4(n-1) - (3n-5)e - 2e^2)}, \tag{3.9}$$

$$\pi_{Si}^* = \frac{[2(n-1) + e - (2(n-1) - (2n-3)e - e^2)c]}{n(2-e)(4(n-1) - (3n-5)e - 2e^2)^2}$$

$$\cdot [2(n-1) - (n-2)e - e^2 - (2(n-1) - (3n-4)e + (n-3)e^2 + e^3)c], \tag{3.10}$$

$$\pi_{Ri}^* = \frac{[2(n-1) - (n-2)e - e^2 - (2(n-1) - (3n-4)e + (n-3)e^2 + e^3)c]^2}{n(2-e)^2[4(n-1) - (3n-5)e - 2ne^2]^2}, \tag{3.11}$$

$$CS^* = \frac{(1 - (1-e)c)^2(2(n-1) - (n-2)e - e^2)c)^2}{2(1-e)(2-e)^2(4(n-1) - (3n-5)e - 2e^2)^2}, \tag{3.12}$$

$$SW^* = \frac{(2(n-1) - (n-2)e - e^2)(1 - (1-e)c)^2}{2(1-e)(2-e)^2(4(n-1) - (3n-5)e - 2e^2)^2}$$

$$\cdot [14(n-1) - (19n-26)e - (17-6n)e^2 + 4e^3]. \tag{3.13}$$

It can be verified that in such a two-level oligopoly system, the wholesale price, retail price and individual demand are all decreasing in the number of firms n, and so is the expected

profit for each supplier and retailer. However, the total market demand, consumer surplus and social welfare are increasing in n, which implies that from a consumer or a social planner's perspective, it would be better to encourage more competition in the market (more firms in each level).

3.2.3 Post-Merger Equilibrium

In a general situation, when there are m out of n firms that participate in a horizontal merger, we can separate firms into two groups: *insiders* (the m merging firms) and *outsiders* (the $n - m$ non-merging firms). If the merger occurs in the downstream level, for those suppliers who sell their products to the merging retailers, we call them *inside suppliers*, and for those who sell the products to the non-merging retailers, we call them *outside suppliers*. For an upstream merger, we define inside and outside retailers/suppliers in a similar fashion. However, if $m = n$, i.e., all of the suppliers/retailers merge to form a monopoly, then there will be no outsiders in either level. Therefore, we shall first examine this special case of merger to a monopoly.

Monopoly Supplier

Suppose all n suppliers are going to merge and form a monopoly in the upstream level. Instead of maximizing the individual profit, they will try to find an optimal wholesale price set to maximize the total profit. Their problem becomes:

$$\max_{w_1,\ldots,w_n} \; \pi_S^{MS} = \sum_{i=1}^{n}(w_i - c)d_i(\boldsymbol{p}(\boldsymbol{w})).$$

Since the downstream level does not change after an upstream merger, retailers' profit functions are the same as in (3.2). The equilibrium strategies and profits are given the following proposition:

Proposition 2 *If the upstream suppliers merge to create a monopoly, then the equilibrium wholesale price, retail price, demand for each product, supplier's and retailer's individual profit are as follows: (The superscript MS stands for Monopoly Supplier.)*

$$w_i^{MS} = \frac{1 + (1-e)c}{2(1-e)}, \tag{3.14}$$

$$p_i^{MS} = \frac{3 - 2e + (1-e)c}{2(1-e)(2-e)}, \tag{3.15}$$

$$d_i^{MS} = \frac{1 - (1-e)c}{2n(2-e)}, \tag{3.16}$$

$$\pi_{Si}^{MS} = \frac{(1 - (1-e)c)^2}{4n(1-e)(2-e)}, \tag{3.17}$$

$$\pi_{Ri}^{MS} = \frac{(1 - (1-e)c)^2}{4n(2-e)^2}, \tag{3.18}$$

$$CS^{MS} = \frac{(1 - (1-e)c)^2}{8(1-e)(2-e)^2}, \tag{3.19}$$

$$SW^{MS} = \frac{(7 - 4e)(1 - (1-e)c)^2}{8(1-e)(2-e)^2}. \tag{3.20}$$

The above proposition shows that when there is a monopoly supplier in the upstream level, the equilibrium wholesale price and retail price does not depend on the number of retailers in the downstream, which implies that the total equilibrium market demand is independent on the number of retailers. The individual equilibrium demand facing each retailer is just $1/n$ share of the total.

Monopoly Retailer

Now suppose all of n retailers merge and form a monopoly in the downstream. In this case, retailers will try to find an optimal retail price set in order to maximize their total profit. For any given wholesale price vector $\boldsymbol{w}$, their problem becomes:

$$\max_{p_1,\dots,p_n} \pi_R^{MR} = \sum_{i=1}^{n} (p_i - w_i) d_i(\boldsymbol{p}(\boldsymbol{w})),$$

where $d_i(\boldsymbol{p}(\boldsymbol{w}))$ is given by (3.1), and the supplier's problem is the same as (3.4). Solving the two level problems yields the following results:

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Proposition 3 *If the downstream retailers merge to monopoly, then the equilibrium whole-sale price, retail price, demand for each product, supplier's and retailer's individual profit are as follows: (The superscript MR stands for Monopoly Retailer.)*

$$w_i^{MR} = \frac{1+c}{2-e}, \tag{3.21}$$

$$p_i^{MR} = \frac{3-2e+(1-e)c}{2(1-e)(2-e)}, \tag{3.22}$$

$$d_i^{MR} = \frac{1-(1-e)c}{2n(2-e)}, \tag{3.23}$$

$$\pi_{Si}^{MR} = \frac{(1-(1-e)c)^2}{2n(2-e)^2}, \tag{3.24}$$

$$\pi_{Ri}^{MR} = \frac{(1-(1-e)c)^2}{4n(1-e)(2-e)^2}, \tag{3.25}$$

$$CS^{MR} = \frac{(1-(1-e)c)^2}{8(1-e)(2-e)^2}, \tag{3.26}$$

$$SW^{MR} = \frac{(7-4e)(1-(1-e)c)^2}{8(1-e)(2-e)^2}. \tag{3.27}$$

Similar to the case with a monopoly supplier, when there is a monopoly retailer in the downstream, neither the equilibrium wholesale price nor the equilibrium retail price depends on the number of suppliers in the upstream level. Again, the total equilibrium market demand is independent on the number of firms, and each retailer faces $1/n$ of the total.

Comparing these two monopoly cases, we can conclude that no matter the monopoly firm is at which level (upstream or downstream), the demand for all products and retail prices are the identical. As a result, the total profit, consumer surplus and social welfare are identical too. The only difference between a upstream monopoly and a downstream monopoly is that in the former case, the wholesale price is higher. In other words, the integrated suppliers could get a bigger slice of the profit pie than the sum of all separate suppliers.

So far, we have shown two special cases of merger (merger to monopoly). However, for a general n and any $1 < m < n$, it is difficult to obtain closed form expressions for these equilibrium decisions and profits. In order to analyze the cases where the size of merger is

between 1 and n, we will set $n = 3$ and analyze the different scenarios of merger in the next section.

3.2.4 Three firms in each echelon (n=3)

Suppose there are three suppliers (S_1, S_2, S_3) in the upstream level and three retailers (R_1, R_2, R_3) in the downstream level. The structure of this system before merger looks as shown below:
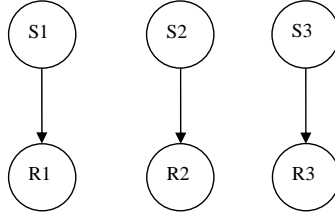
Figure 3.1: Pre-merger market structure

According to the general demand function (3.1), the individual demand for each product is: $d_i(\boldsymbol{p}) = \frac{1}{3}(1 - p_i + \frac{e}{2}\sum_{j\neq i}^{3} p_j)$, and the total market demand is $D = \sum_{i=1}^{3} d_i(\boldsymbol{p}) = 1 - \frac{(1-e)}{3}\sum_{i=1}^{3} p_i$. Since we have already discussed the optimal strategies in the pre-merger and the merger to monopoly case, here we only analyze the situation where two out of three firms merge. The expressions for $m = 1$ and $m = 3$ cases can be deduced by substituting $n = 3$ in proposition 1, 2 and 3.

Two suppliers merger

If supplier S1 and S2 merge, then these two merging suppliers can choose the optimal wholesale prices to maximize their joint profit, while other firms still maximize their own profits.

Since the downstream retailers still operate independently, their profit functions are as in (3.2). Let the superscript $s12$ denote the case where supplier S1 and S2 merge. The retailer
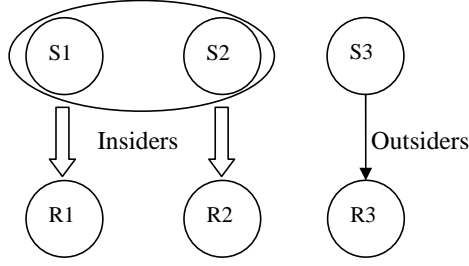
Figure 3.2: Two suppliers merger

i's profit is:

$$\pi_{Ri}^{s12} = \max_{p_i} \ (p_i - w_i)d_i(\boldsymbol{p}).$$

For the merging supplier S1 and S2, their problem becomes:

$$\pi_{S12}^{s12} = \max_{w_1,w_2} \ (w_1 - c)d_1(\boldsymbol{p}(\boldsymbol{w})) + (w_2 - c)d_2(\boldsymbol{p}(\boldsymbol{w})).$$

And for the outside non-merging supplier S3, the problem is:

$$\pi_{S3}^{s12} = \max_{w_3} \ (w_3 - c)d_3(\boldsymbol{p}(\boldsymbol{w})).$$

Two retailers merger

If retailer R1 and R2 merge, the structure of the whole supply chain is as follows:
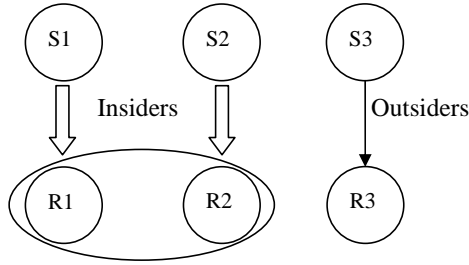
Figure 3.3: Two retailers merger

The merged retailers maximize the joint expected profit by selecting p_1 and p_2:

$$\pi_{R12}^{r12} = \max_{p_1,p_2} \ (p_1 - w_1)d_1(\boldsymbol{p}(\boldsymbol{w})) + (p_2 - w_2)d_2(\boldsymbol{p}(\boldsymbol{w})).$$

while outside retailer maximizes its own individual profit, denoted as π_{R3}^{r12}.

Three firms mergers summary

Although we have used a simple example ($n = 3$) to conduct analysis, the analytical expressions for those optimal parameters are rather complex. For the sake of brevity, we do not show the detailed results. Instead, we use the following proposition to summarize and compare the effects of four different mergers.

The following table compares the optimal prices and profits for each firm under different scenarios of mergers. The superscript $*$, $s12/r12$, and $s123/r123$ stand for the pre-merger case, the supplier/retailer 1 and 2 merger case, and all the three suppliers/retailers merger case, respectively. For detailed expressions on these equations please refer to the Appendix.

Proposition 4 *When firms compete in Bertrand fashion, the following relationships in Table 3.1 hold true.*

Table 3.1: Three firms merger under Bertrand competition

Comparison	
Wholesale price	$w^{r123} \leq w_{in}^{r12} \leq w^* \leq w_{out}^{s12} \leq w_{out}^{r12} \leq w_{in}^{s12} \leq w^{s123}$
Retail price	$p^* \leq p_{out}^{r12} \leq p_{out}^{s12} \leq p_{in}^{r12} \leq p_{in}^{s12} \leq p^{s123} = p^{r123}$
Demand	$d^{r123} = d^{s123} \leq d_{in}^{s12} \leq d_{in}^{r12} \leq d^* \leq d_{out}^{r12} \leq d_{out}^{s12}$
Supplier's profit	$\pi_S^{r123} \leq \pi_{Sin}^{r12} \leq \pi_S^* \leq \pi_{Sin}^{s12} \leq \pi_{Sout}^{r12} \leq \pi_{Sout}^{s12} \leq \pi_S^{s123}$
Retailer's profit	$\pi_R^{s123} \leq \pi_{Rin}^{s12} \leq \pi_R^* \leq \pi_{Rout}^{r12} \leq \pi_{Rout}^{s12} \leq \pi_{Rin}^{r12} \leq \pi_R^{r123}$
Total profit	$\pi^{r123} = \pi^{s123} \leq \pi^{s12} \leq \pi^{r12} \leq \pi^*$

We first summarize the effect of an upstream merger($s12$) to the different players in two categories. For those inside firms, when two suppliers merge, there is less competition in the upstream level; so, the merging suppliers would charge a higher wholesale price. Due to double marginalization, the retail prices increase as well, resulting in lower demand for inside retailers. The expected profit of the merging suppliers increases after merger due to the higher profit margin, while their respective retailer's expected profit decreases, due to the loss of profit margin and demand.

For those outside firms, because there is less competition in the upstream market, the non-merging supplier can also charge a higher wholesale price. Consequently her retailer increases the retail price. Although all the retailers suffer from a margin decrease, because the price for outside retailer is still lower than those for the inside retailers, they benefit from the increasing demand and earn a higher profit.

If we compare the results of insiders with outsiders, the inside suppliers have a higher wholesale price because of the higher market power, which also leads to a higher retail price, and lower demand for the inside retailers. The merging suppliers get a larger profit margin but lose demand, while the non-merging suppliers obtain both a larger margin and a higher demand, so non-merging supplier's profit is higher than the merging ones. Although all the retailers suffer from a margin decrease, the inside retailers face a smaller demand while the outside retailer gets a higher demand, so the outside firms always get a higher demand than the inside firms.

Let us now consider a downstream merger between two retailers ($r12$). In this case downstream firms face less competition after mergers. The merging retailers tend to charge a higher price to maximize their joint profit. However, in order to restrain the effects of market power and prevent the merging retailers from raising price too high, the inside suppliers intend to lower the wholesale price. Thus, the inside retail price is still increasing but not as much as in the upstream merger case ($s12$). Consequently, the merging retailers get higher expected profits while the inside suppliers are worse off after the downstream merger.

The outside retailer also benefits from less competition in the downstream level and tends to charge a higher price. But since his price is lower than the merging retailers, the non-merging retailer faces a higher demand after merger. Taking advantage of the increased demand, the upstream outside supplier increases the wholesale price to improve her profit. Similar to the case where two suppliers merge, the expected profits for both outside retailer and supplier increase after merger. For both outside suppliers and retailers, they would

prefer an upstream merger over an downstream one, because the more intense downstream competition will bring them a higher profit.

When comparing the performance of insiders and outsiders in the downstream merger case, we find that the inside merging retailers have a higher price than the outside non-merging retailer, due to the higher market power. Accordingly, their demand is lower. Since the inside suppliers have to reduce wholesale prices to stimulate demand while outside supplier does not, wholesale price is lower for the insiders. As for the profit, merging retailers get a higher profit than the non-merging retailer because of the larger profit margin. Inside suppliers get a lower profit because of the big loss in both wholesale price and demand, while outside supplier indirectly benefits from the downstream merger.

Lastly, as we have discussed before, in both merger-to-monopoly cases ($s123$ and $r123$), the downstream retailers will raise the selling price to the highest level (the monopoly price), and the demand falls to lowest level. The monopoly supplier benefits from the largest profit margin and gains the high possible profit, while their retailers suffer from the big loss of demand and get the lowest profit. For the monopoly retailer, since he can push the wholesale price down to the lowest level, he gets the highest possible profit, while the separate suppliers only get the minimum level of profit. Note that no matter upstream monopoly or downstream monopoly, the retail prices only can be raised to the same monopoly level, so the demand and total market profit are the same under these two cases.

From the merging firms' industry point of view, since a horizontal merger reduce the competition, it always improves the total profit for the merging industry. However, if the merger happens in the other level (upstream or downstream), then the non-merging industry suffers from a loss in total demand and its total profit decreases as more firms merge in the other industry. As for the entire system, the loss of profit to the non-merging industry exceeds the gain from the merging industry, so the entire system achieves the maximum profit in the case where no firms merge, and is worse off as the number of merging firms

increases.

3.2.5 Numerical experiments and insights

We have analyzed the effects of mergers in different scenarios with $n = 3$. In this section, we perform numerical experiments to investigate the effects of mergers with different sizes. Suppose there are ten firms in each echelon, i.e., $n = 10$. Therefore, the size of horizontal mergers can be varied from 2 to 10. In addition, we assume $e = 0.5$ and $c = 0.1$. The qualitative results remain valid for other values of e and c. The numerical results are shown in Figure 3.4.
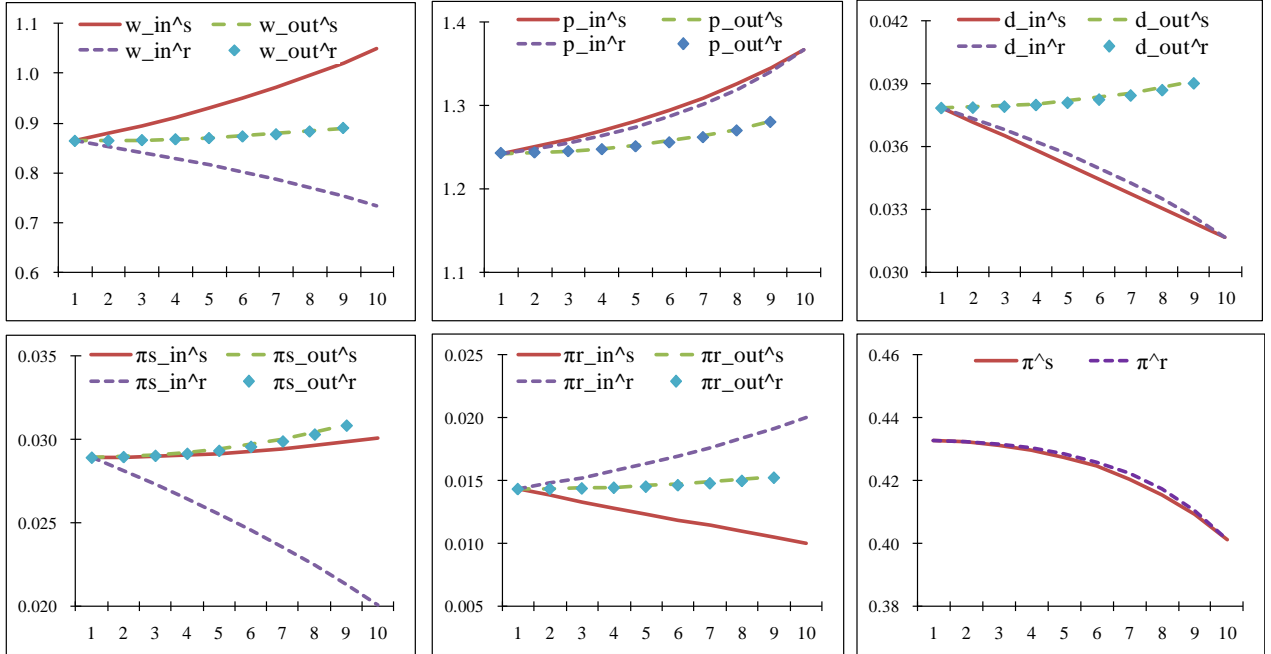
Figure 3.4: Effects of mergers with different sizes

Wholesale price

When more suppliers merge, there is less competition in the upstream level. Both inside and outside suppliers could raise the wholesale price as the number of merging firms, m,

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increases. Since the merging firms have bigger market power, the wholesale price for the inside suppliers is higher than that for outside suppliers.

When more retailers merge, they gain a greater market power and tend to keep increase the retail price. The inside suppliers suffer from the decrease in demand and have to reduce the wholesale price to induce a higher demand, so the wholesale price for the inside suppliers are decreasing in m. For the outside suppliers, since retailers merger brings them a higher demand, they would slightly increase the wholesale price to squeeze more profit.

Retail price

No matter in an upstream or a downstream merger, the retail price will always increase in the number of merging firms. When suppliers merge, the effect of market power in the upstream is transferred to the downstream, so all the retail prices increase and inside retailers have to raise the price higher than the outside retailers. When retailers merge, the price for merging retailers is always higher than the non-merging ones because they have a greater market power.

If we compare the retail prices when merger occurs in different level, it is interesting to see that, although there is less competition in the downstream level when retailers merge, the retail price for every retailer is always higher when suppliers merge, expect for the two extreme case ($m = 1$ and $m = n$). This is because if retailers merge, the inside suppliers, as Stackelberg leader, mitigate the effects of increased downstream market power by reducing the wholesale price. While if suppliers merge, inside retailers, as Stackelberg follower, can not relieve the effects of increased upstream market power.

Demand

The demand curves shown in Figure 3.4 are quite intuitive. Because the inside retailers' price is increasing in m and is always higher than the outside retailers' price, the demand

for the inside firms is decreasing in m. On the other hand, for the outside retailers, although they also raise their prices when m increases, due to the increased price gap between inside and outside retailers, their demand is increasing in m.

If we compare the demand for outside retailers under different mergers, it is interesting to see that under an upstream merger, outside retailers have both higher demand and a higher price than under a downstream merger. This two-fold improvement comes from the price advantage over inside retailers. Since the inside retailers charge a higher price in an upstream merger than in a downstream merger, more customers switch to the outside retailers. This effect dominates the effect of increased price and generates more demand for outside retailers than in a downstream merger case.

Supplier's expected profit

From a supplier's perspective, she prefers an upstream merger but stays out of it, where she could gain the highest demand and profit. In fact, as long as a supplier is not getting involved in a downstream merger, she could always benefit from a horizontal merger. Because being an inside supplier is the only case where both the profit margin and demand decrease after merger. If a supplier could stay outside a merger, then both her profit margin and demand will be higher. While if the supplier is inside of an upstream merger, then her profit margin goes up but the demand declines, so the expected profit still increases but not as much as for the outside non-merging suppliers.

Retailer's expected profit

Different from a supplier, the best situation for a retailer is to engage in a downstream merger. This is because the merging retailer could get the largest profit margin and the highest expected profit, although the demand will be a little lower. If a retailer stays out of a merger, then both his profit margin and demand goes up, which implies the outside

retailer could always be better off no matter the merger occurs at which lever. The worst case for a retailer is being involved in a suppliers merger. Suffered from the loss in both his margin and demand, the retailer' profit will decrease as more suppliers merge.

Consumer surplus and Social welfare

From a consumer or social planner's perspective, we find that a horizontal merger is always harmful. No matter in upstream or downstream, as the size of merger increases, the retail prices go up. Given a specific size of merger, a suppliers merger is worse than a retailers merger because retailers will set their prices even higher.

3.3   Mergers under Cournot competition

Instead of Bertrand competition, the downstream retailers could also compete in a Cournot fashion. To see if our previous results still hold in a Cournot competition, we now assume that retailers compete in output quantities instead of prices. Therefore, the retail price is a function of quantity. Since the products are substitutable, the price for each product depends on not only its owe output, but also the output of its rivals, $p_i = 1 - q_i - e\sum_{j\neq i} q_i$. The game within each supply chain is Stackelberg, supplier sets wholesale price as a leader, and retailer chooses the output quantities as a follower. Each party optimizes their decisions to maximize their own profit:

$$\pi_{Ri}^c = \max_{q_i}\ (p_i - w_i)q_i,$$

$$\pi_{Si}^c = \max_{w_i}\ (w_i - c)q_i, \quad \forall i.$$

Let us consider the three firms case; so, there are five possible scenarios of mergers: 1) no firms merge, 2) two suppliers merge, 3) two retailers merge, 4) three suppliers merge, and 5) three retailers merge. The way to solve these problems is very similar to those Bertrand

competition cases. So, for the sake of conserving space, we skip the technical details here and concentrate on the comparison of results.

Proposition 5 *When firms compete in Cournot fashion, the following relationships in Table 3.2 hold true.*

<div align="center">

Table 3.2: Three firms merger under Cournot competition

</div>

	Comparison
Wholesale price	$w^{r123} \leq w_{in}^{r12} \leq w^* \leq w_{out}^{r12} \leq w_{out}^{s12} \leq w_{in}^{s12} \leq w^{s123}$
Retail price	$p^* \leq p_{out}^{r12} \leq p_{out}^{s12} \leq p_{in}^{r12} \leq p_{in}^{s12} \leq p^{r123} \leq p^{s123}$
Output quantity	$q^{s123} \leq q^{r123} \leq q_{in}^{s12} \leq q_{in}^{r12} \leq q^* \leq q_{out}^{r12} \leq q_{out}^{s12}$
Supplier's profit	$\pi_S^{r123} \leq \pi_{Sin}^{r12} \leq \pi_S^* \leq \pi_{Sin}^{s12} \leq \pi_{Sout}^{r12} \leq \pi_{Sout}^{s12} \leq \pi_S^{s123}$
Retailer's profit	$\pi_R^{s123} \leq \pi_{Rin}^{s12} \leq \pi_R^* \leq \pi_{Rout}^{r12} \leq \pi_{Rout}^{s12} \leq \pi_{Rin}^{r12} \leq \pi_R^{r123}$
Total profit	$\pi^{s123} \leq \pi^{r123} \leq \pi^{s12} \leq \pi^{r12} \leq \pi^*$

Table 3.2 shows the comparison of the optimal prices, quantity and profits of different merger cases when the downstream retailers compete in a Cournot fashion. When we compare this table with the one in the Bertrand model (table 3.1), we shall see they are very similar. The difference in wholesale price is that the relation $w_{out}^{r12} \leq w_{out}^{s12}$ is reversed in the Bertrand model. The retail price under upstream monopoly is higher than the one under downstream monopoly, and the output quantity is lower under upstream monopoly. As to the total market profit and consumer surplus and social welfare, the upstream monopoly is more detrimental, if downstream retailers compete on quantity.

3.4 Mergers with Economies of Scale

Synergy is the magic force that allows for enhanced cost efficiencies of a business, which may come as a result of economies of scale or economies of scope. In this section, we study the case where mergers generate cost efficiencies to the merging firms via economies of scale. Suppose

all the retailers incur some operational cost c_{ri} and suppliers still incur the production cost c_{si}. In the pre-merge stage, because firms are symmetric, $c_{ri} = c_r$ and $c_{si} = c_s$ for all i. After a merger, since the merging firms gain larger market power, now we consider a situation where there exists some cost benefit of merger for those merging firms.

Denote β the cost deduction factor of merger, and $\beta \in (0,1)$. If m suppliers merge, then the production cost for these m suppliers are $c_s^{sm} = \beta^{m-1}c_s$, the costs for outside suppliers and downstream retailers remain the same. Similarly, if m retailers merge, then the operational cost for these m retailers are $c_r^{sm} = \beta^{m-1}c_r$, and costs for outside retailers and upstream suppliers remain the same.

3.4.1 $n{=}3$

Suppose there are three retailers in the downstream. The individual demand faced by each retailer is

$$d_i = \frac{1}{3}(1 - p_i + \frac{e}{2}\sum_{j\neq i}^{3} p_j).$$

Each retailer's objective is to maximize his expected profit function:

$$\Pi_{Ri} = (p_i - w_i - c_r)d_i. \tag{3.28}$$

And each supplier's problem is:

$$\Pi_{Si} = (w_i - c_s)d_i. \tag{3.29}$$

Solve the F.O.C. of (3.28) with respect to p_i, then substitute into d_i and solve the F.O.C for (3.29) to find

$$w_i^* = \frac{4 + e + (4 - e - e^2)c_s - (4 - 3e - e^2)c_r}{2(4 - 2e - e^2)}$$

$$p_i^* = \frac{12 - 3e - 2e^2 + (4 - e - e^2)c_s + (4 - e - e^2)c_r}{2(2 - e)(4 - 2e - e^2)}$$

$$d_i^* = \frac{4 - e - e^2 - (4 - 5e + e^3)c_s - (4 - 5e + e^3)c_r}{6(2 - e)(4 - 2e - e^2)}$$

3.4.2 Effect of merger with cost benefits

Similar to the previous section, we study the scenarios where 2 or 3 firms merge at either upstream or downstream level. We first determine the optimal strategy for each firm under different scenarios, then examine the impact of the cost reduction factor, β, on those optimal strategies. The results are summarized in Table 3.3 and we discuss the intuition behind these results next.

Table 3.3: Impact of decreasing β

	Upstream merger		Downstream merger	
	Inside firms	Outside firms	Inside firms	Outside firms
Wholesale price	↘	↘	↗	↘
Retail price	↘	↘	↘	↘
Demand	↗	↘	↗	↘
Supplier's profit	↗	↘	↗	↘
Retailer's profit	↗	↘	↗	↘

Wholesale price

If there is a cost reduction for the merging suppliers, they have incentive to lower the wholesale price to induce a higher order. As a outside supplier, to prevent market share loss, they have to lower the wholesale price too. But because there is no cost reduction for outside suppliers, their wholesale price will be higher.

When retailers merge, the operational cost for the merging retailers is lower, so they reduce the retail price accordingly to induce higher demand. For the involved upstream suppliers, knowing their downstream partners have a higher demand, they increase the wholesale price to improve the profit. For the outside suppliers, because of the reduced demand, they lower the wholesale price to the non-merging retailers.

Retail price

With the benefit of cost reduction, merging retailers will have the incentive to lower the price to improve their demand. Outside non-merging retailers also reduce their price to compete with merging firms. So under a downstream merger with economics of scale, all the retail prices decrease. And because of the cost reduction generated by merger, the inside retail price is lower than the outside retail price.

On the other hand, if an upstream merger generates cost reduction to the merging suppliers, because both merging and non-merging upstream suppliers will lower the wholesale price, all the downstream retailers will reduce the retail price accordingly. Since the merging suppliers' wholesale price is lower than the non-merging suppliers, the downstream inside retailers have a lower retail price than their outside competitors.

Demand

As we discussed before, in both upstream and downstream merger case, all the retail prices decrease as β decreases, and inside retailers always have a lower price than those outside retailers. Due to such a price advantage, inside retailers receive a higher demand after mergers; while outside retailers' demand decrease.

Supplier's expected profit

In both upstream and downstream merger cases, as β decreases, the inside suppliers enjoy a bigger profit margin and market demand, so their profit increase. For the outside suppliers, because of the cost disadvantage, both their demand and profit decrease.

Retailer's expected profit

Similar to their upstream partners, as long as a horizontal merger generates cost reduction to merging parties, the inside retailers always enjoy a higher profit margin and demand, so their expected profits increase after a merger. Outside retailers suffer from a loss in both profit margin and demand, so their expected profits decrease after merger.

3.5   Mergers with Economies of Scope

As another source of synergy, companies may improve their operations via economies of scope. The merger wave in the United States today is, in part, an attempt to create scope economies. Pharmaceutical companies frequently combine forces to share research and development expenses to bring new products to market. Panzar and Willig (1981) use the term "Economies of Scope" to describe a basic and intuitively appealing property of production: cost savings which result from the scope (rather than the scale) of the enterprise. According to them, there are economies of scope where it is less costly to combine two or more product lines in one firm than to produce them separately.

In this section, we use the newsvendor model framework to capture the economies of scope created by horizontal mergers. In developing this model, we make the following assumptions:

A1. Retailer retains the ownership of his inventory by paying supplier in full when order is delivered.

A2. Supplier produces/orders the product at an infinite rate.

Demand for each product is $d_i = \frac{1}{n}(1 - p_i + \frac{e}{n-1}\sum_{j\neq i} p_j)$. The holding cost per unit for suppliers and retailers are h_s and h_r respectively, and the order setup cost are k_s and k_r.

Pre-merger

We begin with retailer's problem. Each retailer chooses a retail price p_i and an order quantity Q_i to maximizes his expected profit:

$$\pi_{Ri} = (p_i - w_i)d_i - \frac{d_i}{Q_i}k_r - \frac{1}{2}h_r Q_i.$$

For any given p_i, π_{Ri} is maximized by $Q_i^*(p_i) = \sqrt{2k_r d_i / h_r}$, where $d_i = \frac{1}{n}(1 - p_i + \frac{e}{n-1}\sum_{j \neq i} p_j)$. Substituting into π_{Ri} results in

$$\pi_{Ri} = (p_i - w_i)d_i - \sqrt{2k_r h_r d_i}. \tag{3.30}$$

Solve three first order conditions $\frac{\partial \pi_{Ri}}{\partial p_i} = 0$ simultaneously, we have the retailer's best pricing strategy $p_i^*(w)$.

Substitute $p_i^*(w)$ into d_i and Q_i, then suppliers optimize their profits by choosing wholesale price w_i and stocking multiplier m_i:

$$\pi_{Si} = (w_i - c)d_i - \frac{d_i}{m_i Q_i}k_s - \frac{1}{2}h_s(m_i - 1)Q_i. \tag{3.31}$$

Since m_i is an integer and it is easy to verify that π_{Si} is concave in m_i, the optimal m_i should be the smallest integer which satisfies

$$\pi_{Si}(m_i + 1) < \pi_{Si}(m_i).$$

Therefore,

$$m_i^* = \min\{m \in \mathbb{Z}^+ | m(m+1) \le \frac{k_s h_r}{k_r h_s}\}. \tag{3.32}$$

Substitute m_i^* into (3.31) and solve the FOCs for suppliers with respect to w_i, we can find w_i^*.

Then substitute w_i^* back into retailer's strategies, we have the optimal p_i^*, d_i^* and Q_i^*, which are identical across i.

Note that we were not able to show the value of these optimal parameters since there is no closed-form expression for m_i^*. However, we will use numerical examples to compare these results under different scenarios.

m suppliers merge

Now we consider the merging case. Suppose m out of n suppliers $S_1,...,S_m$ merge, for the downstream retailers, the structure of their profit function does not change, so the optimal strategies $p_i^*(w)$, $d_i^*(w)$ and $Q_i^*(w)$ are the same as in the pre-merger stage.

In the upstream industry, since the merging suppliers will try to maximize their joint profit after the merger, we add the following assumption to capture the operational synergy associated with the merger:

A3. Merging suppliers/retailers would combine their separated fulfillment/procurement activities into one process to improve the efficiency of the merged system.

For the merging suppliers, from the pricing perspective, now they choose w_i's to maximize their expected profit function (under equilibrium the optimal wholesale price $w_i^{sm} = w_j^{sm}$, $\forall i \neq j$ and $i,j \in \{1,...,m\}$). While from the operational perspective, merging suppliers could pool inventory and make consolidated shipments to jointly replenish their m retailers (since the involved retailer $R_1,...R_m$ will have the same cycle length). So the profit function for merging suppliers becomes:

$$\pi_{Si}^m = \sum_{i=1}^m (w_i - c)d_i - \frac{\sum_{i=1}^m d_i}{m\sum_{i=1}^m Q_i}k_s - \frac{1}{2}h_s(m-1)\sum_{i=1}^m Q_i. \qquad (3.33)$$

And the profit function for outside supplier is still:

$$\pi_{Si}^{nm} = (w_i - c)d_i - \frac{d_i}{mQ_i}k_s - \frac{1}{2}h_s(m-1)Q_i.$$

Note: here we use m instead of m_i because $m_i^* = \min\{m \in \mathbb{Z}^+ | m(m+1) \leq \frac{k_s h_r}{k_r h_s}\}$, for all i.

Because of the different optimal strategies for suppliers in different groups, we can also divide the downstream retailers into two groups: inside retailers (in the same supply chain

with those merging suppliers) and outside retailers (or other retailers). As the demand function for each retailer does not change, the inside retailers will have the identical price, demand, order quantities, and expected profit under equilibrium, and outside retailers will also share the same optimal strategies.

m retailers merge

In the downstream industry, if m out of n retailers R_1,...,R_m merge, then for the merging retailers, from the pricing perspective, now they choose p_i's to maximize their joint expected profit (under equilibrium the optimal retail price $p_i^{rm} = p_j^{rm}$, $\forall i \neq j$ and $i, j \in \{1, ..., m\}$). While from the operational perspective, merging retailers could share warehouse and manage the replenishment process to reduce costs. So the profit function for merging retailers becomes:

$$\pi_{Ri}^m = \sum_{i=1}^{m}(p_i - w_i)d_i - \frac{\sum_{i=1}^{m} d_i}{\sum_{i=1}^{m} Q_i}k_r - \frac{1}{2}h_r \sum_{i=1}^{m} Q_i, \tag{3.34}$$

and the profit function for outside retailer remains:

$$\pi_{Ri} = (p_i - w_i)d_i - \frac{d_i}{Q_i}k_r - \frac{1}{2}h_r Q_i.$$

For the upstream suppliers, they still maximize their individual profit by selecting w_is, and the profit function are the same as in the pre-merger stage. But because of downstream retailers' different strategies, inside and outside suppliers will have different strategies as well.

3.5.1 Effects of mergers - Numerical results

In order to analyze the effects of mergers on supply chain's performance, we first conducted numerical experiments to determine the optimal solutions when there are three firms in each echelon, then study suppliers' and retailers' performance under different scenarios. We will

also compare the EOQ model with the previous price only model to evaluate the effects of operational synergies associated with the merger.

Observations - Price
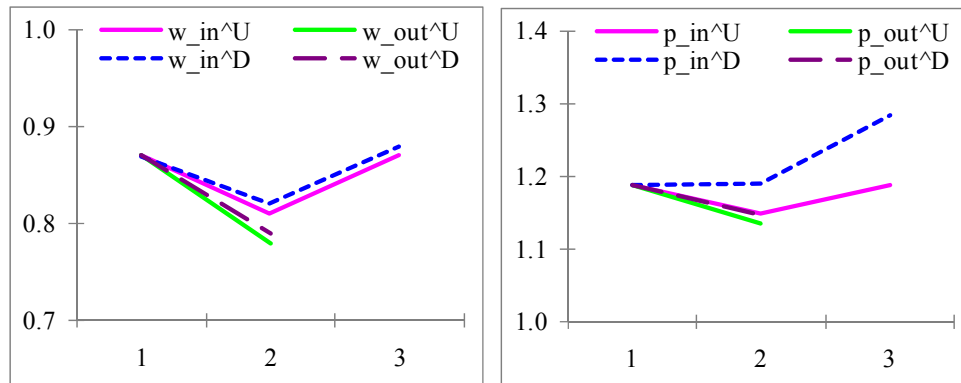
Figure 3.5: Wholesale price and retail price (EOQ)

Figure (3.5) shows the optimal wholesale price and retail price in the three firms case. When suppliers merge, merging suppliers benefit from the operational synergy and enjoy a lower operational cost, so they would charge a lower wholesale price than before the merger. On the other hand, since they gain greater market power, merging suppliers have the incentive to increase their wholesale prices. Since the effect of market power will be alleviated by downstream retailers, the effect of operational synergy dominates, and the wholesale price goes down for the merging suppliers. For the non-merging supplier, in order to compete with merging rivals and offset the disadvantage of having a higher operational cost, she has to set the wholesale price even lower than the merging firms to induce a higher demand. As a result, all the wholesale prices go down after merge, and merging suppliers charge a higher price than the non-merging supplier. The price changes in downstream are similar to those in upstream.

When retailers merge, benefit from the increasing market power, the merging retailers would charge a higher retail price. However, because of a lower operational cost, they also

have the incentive to lower the price. Different from the suppliers merger, because the inside suppliers do not have to reduce the wholesale price significantly to avoid a low demand, the effect of operational synergy will be weakened by inside suppliers. Therefore the retail prices for merging retailers slightly increase. For the outsider, in order to offset the disadvantage of having a higher operational cost, he has to set the retail price lower than the insiders to induce a higher demand. Therefore the retail price for non-merging retailer decreases. In the upstream, inside suppliers would lower the wholesale prices to prevent the merging retailers setting prices too high. Knowing that the outside retail has a higher operational cost after merge, outside supplier decreases the wholesale price further to induce her retailer to lower the price.

Observations - Demand and Order quantity
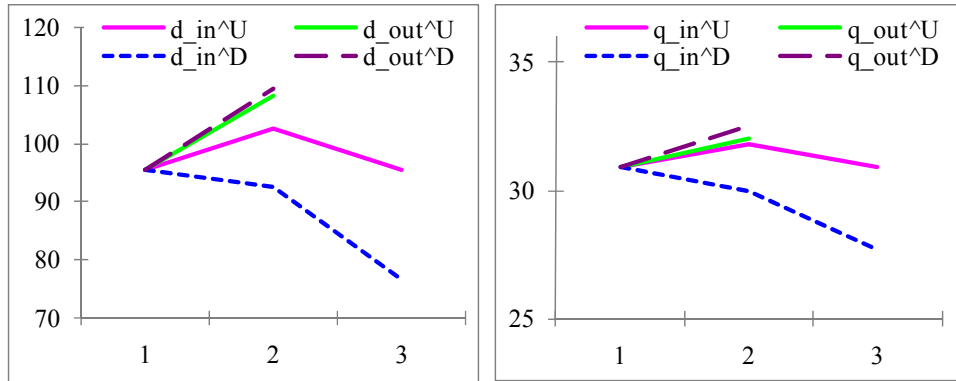
Figure 3.6: Demand and order quantity (EOQ)

From figure (3.6), we can see that when suppliers merge, since all the retail prices decrease and insiders' price is higher than outsider's price, demands for all retailers increase and insider's demand is lower than the outsider's. The behavior of retailers' order quantities follows the same pattern.

When retailers merge, because merging retailers slightly increase their price while non-merging retailer reduces the retail price, demand for the insiders decrease while increases for

the outsider. Again, the behavior of order quantities follow the same pattern as demand.

Observations - Profits
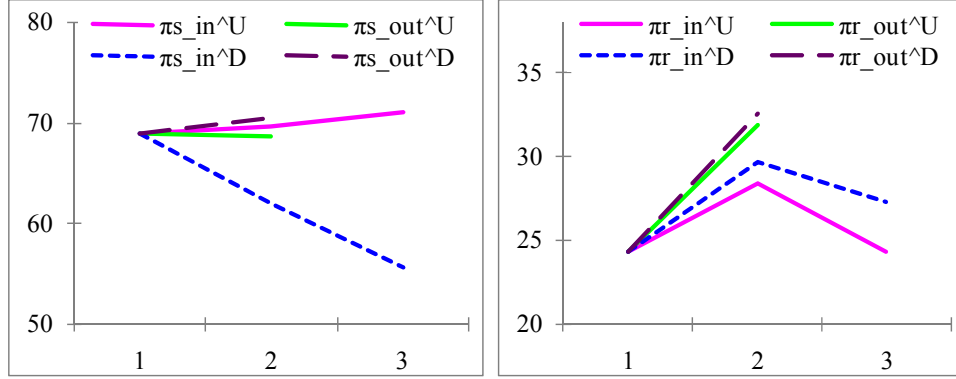
Figure 3.7: Suppliers' and Retailers' profit (EOQ)

Figure (3.7) provide the change of profit for suppliers and retailer under different scenarios. When suppliers merge in the upstream, benefit from the increased market power and the operational synergy, merging suppliers obtain a higher profit after merge. Due to the disadvantage in operations, the non-merging supplier has to reduce the wholesale price and suffers a little loss in profit. In the downstream, due to the reduced wholesale prices, every retailer faces a higher demand and hence profit. The outside retailer enjoys a lower wholesale price than the inside retailers, so his profit is higher than the insiders.

When retailers merge in the downstream, although their demand decreases, due to the operational synergy and the increase in profit margin, merging retailers still get a higher profit. For non-merging retailer, the benefit from a higher demand and an increased profit margin overcompensate the detrimental effect of a relatively higher operational cost. His profit increases even more than the merging retailers after merge. In the upstream, inside suppliers suffer from the demand and margin decrease, so their profits decrease. For the outside supplier, the gain from the increasing demand is more than the loss from the decreasing margin, so her profit increases.

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3.5.2 Comparison between EOQ model and price only model (P)

Next, we use the numerical results to compare the EOQ model with the previous price only model.

Wholesale price and retail price

Suppliers Merge	P - Insider	P - Outsider	EOQ - Insider	EOQ - Outsider
Wholesale price	⇑	↑	↓	⇓
Retail price	⇑	↑	↓	⇓

Retailers Merge	P - Insider	P - Outsider	EOQ - Insider	EOQ - Outsider
Wholesale price	⇓	↑	↓	⇓
Retail price	⇑	↑	↑	⇓

Table 3.4: Comparison: wholesale price and retail price

If suppliers merge, in the price only model, the merging suppliers gain a greater market power than the non-merging suppliers, so they will increase the wholesale price. On the other hand, due to the less competition, non-merging suppliers also increase the price, but not as much as the merging suppliers do. Downstream retailers follow the lead of their suppliers, so all retail prices go up and inside retailers' price is higher than the outside retailer's. In the EOQ model, although a suppliers merge leads to less competition in the upstream, merging suppliers tend to reduce the wholesale price due to the dominant effect of operational synergy. Outside supplier set the wholesale price even lower to induce a higher demand. So all the wholesale prices go down after merge. The price changes in downstream follow the same pattern.

If retailers merge, in the price only model, the merging retailers tend to increase the price,

and so as the non-merging retailers. Due to the less market power, the non-merging retailers will set the price lower than the merging retailers. In the upstream, to prevent merging retailers from raising their price too much, the inside suppliers reduce the wholesale prices. For the outside supplier, because demand increases, she would slightly increase the wholesale price to improve the profit. In the EOQ model, merging retailers tends to increase the price due to the higher market power, but the opposite effect of operational synergy weakens this tendency, so the price for merging retailers slightly increases. Outside retailer has to reduce his price to offset the operational disadvantage. In the upstream, inside suppliers still reduce the wholesale price to stimulate demand, but unlike the outside supplier in the price only model, in EOQ model, the outside supplier reduce the price dramatically to induce greater demand.

Demand

Demand	P - Insider	P - Outsider	EOQ - Insider	EOQ - Outsider
Suppliers Merge	$\Downarrow$	$\uparrow$	$\uparrow$	$\Uparrow$
Retailers Merge	$\Downarrow$	$\uparrow$	$\downarrow$	$\Uparrow$

Table 3.5: Comparison: Demand

In the price only model, no matter where the merger occurs, the inside retailers always raise the selling price. Although the outside retailer increase the price as well, he always undercuts insiders. Therefore, the demand for inside retailers decreases after merge, while increases for the outside retailer. In the EOQ model, outsider not only undercuts the insiders but also reduce the price, so his demand increase significantly after merge. The merging retailers lose demand due to a higher price, and non-merging retailers face a higher demand because they reduce the price.

Suppliers and retailers profit

Suppliers Merge	P - Insider	P - Outsider	EOQ - Insider	EOQ - Outsider
Supplier's profit	↑	⇑	⇑	↓
Retailer's profit	⇓	↑	↑	⇑

Retailers Merge	P - Insider	P - Outsider	EOQ - Insider	EOQ - Outsider
Supplier's profit	⇓	↑	⇓	↑
Retailer's profit	⇑	↑	↑	⇑

Table 3.6: Comparison: Supplier's and Retailer's profit

When suppliers merge, if there is no operational synergies associated with merger, then all the suppliers' profit increase due to the less competition. Non-merging supplier gets a higher profit than the merging suppliers because she has a higher demand. Inside retailers suffer from a loss of demand, so their profits shrink. Outside retailer benefits from the increasing demand, so his profit increases. If merger brings operational synergy, merging suppliers benefit from the lower operational cost and get a higher profit. For the non-merging supplier, the increase in demand does not fully compensate the big loss in profit margin, so her profit slightly decreases. In the downstream, the increasing demand caused by the lower prices helps all the retailers make more profit, and the outside retailer gains more than the insiders because of the higher demand.

When retailers merge, in the price only model, although merging retailers incur a decrease in demand, due to inside suppliers overcompensate them in wholesale price, so their profits still increase significantly; non-merging retailer only benefits from the increasing demand, so his profit also increases but not as much as merging retailers. In the upstream, inside suppliers incur a loss in both demand and profit margin, so their profits decrease; outsider

supplier raises the wholesale price and still has a higher demand, so her profit increases. In the EOQ model, the merging retails' benefit from the operation synergy is shared by inside suppliers, while outside supplier overcompensate the non-merging retailer for the relatively high operational cost. As a result, all the inside firms get a higher profit, outside supplier suffers a big loss, and the non-merging retailer gains more profit than the merging ones.

3.5.3 Effect of operational synergy

Generally speaking, the effect of operational synergy to merging suppliers is positive: if a merger only affects the pricing strategies, then when suppliers merge, the merging suppliers will increase the wholesale prices while the outside suppliers take a free ride and earn a higher profit improvement than the inside merging suppliers; while if a merger could provide operational synergies to the merging suppliers, it would reduce the price and increase the demand for all firms, and the merging suppliers will gain a higher profit than the non-merging suppliers.

While on the contrary, the effect of operational synergy to merging retailers is negative: if retailers merger without any operational synergies, the inside suppliers will reduce wholesale prices dramatically to prevent the merging retails to charge a too high price. Because outside retailers will have a lower price and higher demand comparing to the merging retailers, outside suppliers will slightly increase the wholesale price and enjoy a profit improvement. If a merger brings operational synergies to the merging retailers, the outside retailer will suffer from a higher operational cost and have a higher retail price and lower demand. In order to induce retailer to charge a lower price and get a higher demand, the outside supplier will have to set the wholesale price lower than the inside suppliers. Although the inside suppliers will still lower the price to prevent a low demand, merging retailers have to pay a higher wholesale price than the outside competitors. Therefore, the benefit of operational synergy

is mitigated, and the merging retailers gain less profit than the non-merging one.

3.6 Mergers under Uncertain Demand

So far, in our models, the market demand are deterministic, i.e. demand solely depend on price (Bertrand competition) or quantity (Cournot competition). To extend the model to a more realistic setting, now we assume the total market size is a random variable ϵ, and there are two possible states of demand: with probability r, the total market demand will be high (denote H); and with probability $1-r$, the total market demand will be low (denote L), where $L < H$ and $0 \le r \le 1$. So the individual demand for each retailers in a Bertrand competition are:

$$d_i = \begin{cases} \frac{1}{n}(H - p_i + \frac{e}{n-1}\sum_{j\neq i} p_j) & \text{with probability } r, \\ \frac{1}{n}(L - p_i + \frac{e}{n-1}\sum_{j\neq i} p_j) & \text{with probability } 1-r. \end{cases}$$

Each retailer R_i chooses its own price and quantity to maximize the expected profit:

$$\pi_{Ri} = \max_{p_i, Q_i} \{p_i \min(d_i, Q_i) - w_i Q_i\} \tag{3.35}$$

Since the low level of retailer's demand is $d_i(L, \boldsymbol{p})$ and the high level is $d_i(H, \boldsymbol{p})$, it is easy to verify that the optimal stock level Q_i should lie between $d_i(L, \boldsymbol{p})$ and $d_i(H, \boldsymbol{p})$, where $\boldsymbol{p} = (p_1, ..., p_n)$. Hence, problem (3.35) should subject to the constraint:

$$d_i(L, \boldsymbol{p}) \le Q_i \le d_i(H, \boldsymbol{p}).$$

From the second derivative of π_{Ri} with respect to p_i,

$$\frac{\partial^2 \pi_{Ri}}{\partial p_i^2} = -\frac{2}{n}(1 - r) < 0,$$

π_{Ri} is concave in p_i. So there exists an unique p_i^* that maximizes π_{Ri}. On the other hand,

$$\frac{\partial \pi_{Ri}}{\partial Q_i} = p_i r - w_i \triangleq \Delta_i, \text{ and } \frac{\partial^2 \pi_{Ri}}{\partial Q_i^2} = 0.$$

which implies that π_{Ri} is not concave in Q_i. Therefore, to solve this non-concave maximization problem, we decompose the problem into two disjoint subproblems:

$$\pi_{Ri}^1 = \max_{p_i, Q_i}\{p_i \min(d_i, Q_i) - w_i Q_i\} \tag{3.36}$$

$$s.t. \quad d_i(L, \boldsymbol{p}) \leq Q_i \leq d_i(H, \boldsymbol{p});$$

$$p_i \leq \frac{w_i}{r}.$$

and

$$\pi_{Ri}^2 = \max_{p_i, Q_i}\{p_i \min(d_i, Q_i) - w_i Q_i\} \tag{3.37}$$

$$s.t. \quad d_i(L, \boldsymbol{p}) \leq Q_i \leq d_i(H, \boldsymbol{p});$$

$$p_i > \frac{w_i}{r}.$$

Then $\pi_{Ri}^* = \max\{\pi_{Ri}^1, \pi_{Ri}^2\}$.

To be able to solve this linear program, we assume that there are three firms in each level, i.e., $n = 3$. For a given r and w_i, if $p_i \leq \frac{w_i}{r}$, then the derivative of retailer's profit (denoted by Δ_i) is negative, which means the expected revenue for a retailer to stock one unit of product will be less than or equal to his cost. Consequently, retailer R_i will have no interest to order more than the low level of demand. By substituting $Q_i^* = d_i(L, \boldsymbol{p})$ into the problem (3.36), we can solve the optimal retail price for product i as a function of the wholesale prices:

$$p_i^1(\boldsymbol{w}) = \frac{(4+e)L + (4-e)w_i + e\sum_{j\neq i} w_j}{(4+e)(2-e)}. \tag{3.38}$$

And the corresponding high profit is π_{Ri}^{1*}.

While if $p_i > \frac{w_i}{r}$, then Δ_i is positive which implies that the retailer's expected profit is increasing in Q_i. Therefore the optimal order quantity would be the high level of the demand, $Q_i^* = d_i(H, \boldsymbol{p})$. Solving the problem (3.37), we could obtain the high profit π_{Ri}^{2*}. Since π_{Ri}^{2*} depends on the value of r while π_{Ri}^{1*} does not, we have the following proposition to find the optimal solution for problem (3.35):

Proposition 6 *For a given set of (L, H, e, c):*

(i) if $r_L(L, e, c) = r_H(H, L, e, c)^1$, then every retailer will order the low level of demand $d_i(L)$ for $0 < r \leq r_L$, and order the high level of demand $d_i(H)$ for $r_L < r < 1$.

(ii) if $r_L(L, e, c) < r_H(H, L, e, c)$, then retailer should order $d_i(L)$ for $0 < r \leq r_H$, and $d_i(H)$ for $r_H < r < 1$.

(iii) if $r_L(L, e, c) > r_H(H, L, e, c)$, then retailer should order $d_i(L)$ for $0 < r \leq r_H$, and $d_i(H)$ for $r_L < r < 1$. For any $r_H < r < r_L$, $Q_i^* = \arg\max\{\pi_{Ri}(d_i(L, e, c)), \pi_{Ri}(d_i(H, L, e, c))\}$.

3.6.1   Upstream merger

If m out of n suppliers merge, then downstream retailers can be categorized into two groups: inside retailers and outside retailers. Since the wholesale prices for these two groups of retailers are different, there are four scenarios when retailers choose their order quantities, as shown in Table 3.7.

Table 3.7: Necessary conditions for ordering strategies

	$Q_{out} = d_i(L, \boldsymbol{p})$	$Q_{out} = d_i(H, \boldsymbol{p})$
$Q_{in} = d_i(L, \boldsymbol{p})$	$\Delta_{in}^{LL} \leq 0$	$\Delta_{in}^{LH} \leq 0$
	$\Delta_{out}^{LL} \leq 0$	$\Delta_{out}^{LH} > 0$
$Q_{in} = d_i(H, \boldsymbol{p})$	$\Delta_{in}^{HL} > 0$	$\Delta_{in}^{HH} > 0$
	$\Delta_{out}^{HL} \leq 0$	$\Delta_{out}^{HH} > 0$

Note: In the superscript of Δ, the first letter stands for the ordering policy for the inside retailers, and the second letter stands for the ordering policy for the outside retailer. H/L means the high/low level of demand.

For a given set of $\{H, L, r, e, c\}$, suppose all the retailers try to order the high level of

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[1]see the definition of r_L and r_H in the Appendix.

demand, i.e., $Q_{in}^{sm} = d_i(H, \boldsymbol{p})$ and $Q_{out}^{sm} = d_i(H, \boldsymbol{p})$. Solving the two level problem, we have p_{in}^{HH}, w_{in}^{HH}, p_{out}^{HH} and w_{out}^{HH}. To ensure the feasibility of such a ordering policy, we need to check whether the necessary conditions hold: $\Delta_{in}^{HH} > 0$ and $\Delta_{out}^{HH} > 0$.

Lemma 7 *If all the retailers choose to order the high level of demand, then expected profit margin for the quantities above $d_i(L, \mathbf{p})$ is larger for the outside retailer, i.e., $\Delta_{out}^{HH} - \Delta_{in}^{HH} > 0$.*

The above lemma leads to the following three cases for determining retailer's optimal order quantities:

(i) If $0 < \Delta_{in}^{HH} < \Delta_{out}^{HH}$, which means that all the retailers have a positive expected profit margin for the quantity they ordered over the low level of demand, then the optimal solutions are feasible and $d_i(H, \boldsymbol{p})$ is the optimal ordering strategy for all retailers.

(ii) If $\Delta_{in}^{HH} \leq 0 < \Delta_{out}^{HH}$, then the inside retailers will expect a non-positive expected return from the additional quantity they ordered over $d_i(L, \boldsymbol{p})$, so they will only order the low level of demand. For the outside retailer, due to the change in his rivals' strategy, his optimal order quantity depends on Δ_{out}^{LH}: if $\Delta_{out}^{LH} > 0$ then he could still order up to $d_i(H, \boldsymbol{p})$; while if $\Delta_{out}^{LH} \leq 0$, then he will also reduce the order quantity to $d_i(L, \boldsymbol{p})$.

(iii) If $\Delta_{in}^{HH} < \Delta_{out}^{HH} \leq 0$, then for the quantity over $d_i(L, \boldsymbol{p})$, the expected profit margin is non-positive for every retailer. Therefore, all the retailers only order the low level of demand $d_i(L, \boldsymbol{p})$.

Note that it is possible that all the retailers will order the low level of demand even if $\Delta_{in}^{LL} > 0$ or $\Delta_{out}^{LL} > 0$. The insight behind this is if one group of retailers finds that their expected margin for the addition items is positive, and tries to order more quantities, the upstream suppliers will adjust their wholesale price accordingly, which leads to a decrease in the retailer's expected margin. As a result, retailers may not be able to find a feasible solution in any of the four cases. Therefore, to avoid a potential loss from those additional

items, all the retailers will stay in the low-low situation.

We summarize the above analysis in the following proposition.

Proposition 8 *Facing uncertain demand, if two out of three suppliers merge, then*

(i) all the retailers will choose order up to the high level of demand if $\Delta_{in}^{HH} > 0$ and $\Delta_{out}^{HH} > 0$;

(ii) inside retailer will order the low level of demand as long as $\Delta_{in}^{HH} \leq 0$;

(iii) when inside retailers order the low level of demand, the outside retailer's ordering policy depends on Δ_{out}^{LH}: if $\Delta_{out}^{LH} > 0$ then $Q_{out} = d_i(H, \mathbf{p})$; otherwise, $Q_{out} = d_i(L, \mathbf{p})$.

3.6.2   Downstream merger

Similar to the upstream merger, if there is a downstream merger, retailers's ordering strategies should also satisfy the conditions in Table (3.7). Since the logic is very similar, we state without proof the following proposition.

Proposition 9 *Facing uncertain demand, when two out of three retailers merge,*

(i) if $\Delta_{in}^{HH} > 0$ and $\Delta_{out}^{HH} > 0$, then all the retailers will choose order up to the high level of demand;

(ii) otherwise, the merging retailers will order the high level of demand if $\Delta_{in}^{HL} > 0$, and non-merging retailer will order the high level of demand if $\Delta_{out}^{LH} > 0$;

(iii) all the retailers choose to order the low level of demand for the rest of situations.

3.7   Conclusions

In this chapter, we study the effect of an upstream and a downstream horizontal merger on merging firms, non-merging competitors, and their supply chain partners. We start with a basic model in which firms compete with each other in an Bertrand fashion. We find that in both upstream and downstream level, horizontal mergers benefit all the firms in the merging

industry while hurt the merging firms' supply chain partners. For an upstream merger, outsider non-merging suppliers are able to improve their profits more than the merging supplier, while for a downstream merger, merging retailers improve their profits more than outside non-merging retailers. In this basic model, we assume that a horizontal merger does not generate any operational synergy to the merging parties. As a result, both consumer surplus and social welfare reduce after a merger. However, comparing mergers of same size but at different levels, we find that a downstream merger is better than an upstream one from a consumer or a social planner's perspective. Then we analyze the impact of mergers under Cournot fashion and obtain similar results.

To investigate the impact of operational synergy created by mergers, we extend our analysis in two directions. First, if the synergy comes as a result of economies of scale and reduce the operational costs of merging firms, we find that a horizontal merger is no longer beneficial to outside non-merging competitors. The cost reductions benefit not only the merging firms but also the merging firms' supply chain partners. Therefore, the profit for the entire supply chain increases after mergers.

In the other scenario, we assume that the synergy comes as a result of economies of scope and construct an EOQ model to capture such effects. We show that in an upstream merger case, the merging suppliers benefit from the lower operational cost and get a higher profit. Non-merging supplier's profit slightly decreases. In the downstream industry, the inside retailers' profit increases due to the reduced retail price. Outside retailer gains even more than the inside retailers because of the lower wholesale price. In a downstream merger case, because the effect of increased market power dominates the effect of operational synergies, the merging retailers' profit slightly increase but upstream insiders' profit decreases. For the outsiders, upstream supplier reduces the wholesale price to compensate the non-merging retailer's higher operational cost. Therefore, the non-merging retailer benefits from the lower price and increased demand and also obtains a higher profit after merger.

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In addition, we relax the assumption of deterministic demand and consider mergers under uncertain demand. We show that even in the basic model without merger-induced synergies, the analysis becomes complicated and the closed-form expressions are not available. We are only able to characterize the optimal ordering policy for firms in the merging industry.

Chapter 4

Empirical Analysis of Horizontal Mergers and Acquisitions

4.1 Introduction

Mergers and acquisitions (M&As)[1] is one of the most popular expansion strategies within the corporate world. Like many other strategies, M&As have its fair share of successes and failures. A factor of particular importance in shaping the eventual success/failure of an M&A is the operational synergy (e.g., in terms of inventory management and/or distribution) that the merging firms can extract from it. For example, Banbury's acquisition of Adams in 2002 was quite successful in this respect with the merger exceeding original performance estimates by 14% (Herd et al. 2008). On the other hand, after Quaker Oats' acquired Snapple in 1994 it was not able to consolidate the two operational systems in an effective manner resulting in a significant loss for Quaker (Chopra and Meindl 2010).

The above examples are not isolated incidents. A number of surveys clearly attest to the

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[1]As is the norm in related literature (e.g., Fee and Thomas 2004), throughout this paper we use the terms mergers and acquisitions synonymously.

fact that M&As have a significant impact on operations, especially inventory management (refer to Saraan and Srai (2008)). For example, according to a survey by Accenture in 2007, among 154 managers (75 supply chain and 79 other business units), two-thirds experienced increased disruption in their business operations due to M&As and more than half of the managers reported problems in inventory management, e.g., filling out orders, out-of-stock issues and inventory buildup. The most frequently cited cause of these problems is corporate management not paying enough attention to operational issues and not taking into account difficulties in attaining synergistic benefits when deciding on M&A initiatives (Byrne 2007). It is not surprising that inventory management has a significant effect on the success of mergers given that a typical company has about 30 percent of its current assets and perhaps as much as 90 percent of its working capital invested in inventories (Stevenson and Hojati 2004). More importantly, according to practitioners, inventory-related supply chain functions account for 30-50% of the savings a successful M&A ultimately generates (Herd et al. 2008).[2]

Inventory management is clearly not the only issue that determine the eventual success or failure of a merger. There are a number of other factors - strategic, financial, cultural and political - that play important roles. Perhaps because of these many factors, failures seem to be more commonplace than successes. Recent academic studies suggest that more than half of M&As do not fulfill their intended objectives, with failure rates reaching as high as 80% in certain studies (Herd et al. 2008, Marks and Mirvis 2001, Saraan and Srai 2008 and references therein). In a similar vein, The Economist (1999) reports that two-thirds of all M&As have not worked and points out that "the only winners are the shareholders of the acquired firm, who sell their company for more than what it is really worth". Interestingly, despite such failures, M&As continue to be the lifeblood of many businesses. The aforementioned survey

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[2]Another rationale for mergers is to increase market power, which is frequently of concern to anti-trust authorities. Consequently, merging companies try to convince the regulators and the investors by mostly citing the expected improvement in operational synergies.

by Accenture notes that the negative outcomes have not curbed the trend; M&As continue to be a core strategy for companies, especially those striving to achieve global presence. In fact, the volume of M&A activity seems to be on the rise in 2011 following the financial crisis.[3]

Given the strategic importance of M&As in today's business environment and the anomaly between their expected and actual post-merger performance, it has been a rich source of research in a variety of fields including economics, finance and strategy (refer to DeYoung et al. 2009). However, in spite of the anecdotal evidence that inventory operations play a significant role in M&A context, rather surprisingly, they have received little attention in the academic operations management literature, especially from an empirical perspective.[4] The motivation for this paper stems from addressing this gap.

Specifically, in this paper, our primary objective is to answer the following questions in the context of horizontal M&As, i.e., mergers occurring in the same market or among firms offering similar products or services:

- How is the aggregate inventory performance of merging firms affected by M&As?

- How do M&As affect related operating performance of merging firms?

- What are the inventory and operating performance metrics that have the most significant impact on the "success" of a merger?

Note that, because of our interest on the *aggregate level* performance, we do not dwell on which specific *firm-level* inventory management tactics or strategies are used by successful

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[3]Recent examples include Express Scripts's purchase of Medco Health for $34 billion, and Johnson & Johnson's acquisition of Synthes for $21.3 Billion.

[4]As we discuss in §2, we could only find two other empirical papers on this topic. Even the amount of theoretical research on this issue in operations management literature is rather sparse.

M&As.[5] In order to address the above issues, we use quarterly financial accounting panel data from Compustat database, as well as 486 instances of horizontal M&As between 1997 and 2006 collected from the SDC Platinum database in manufacturing, wholesale and retail sectors (i.e., industries with significant inventory management activities). We focus on three commonly used efficiency, productivity and elasticity measures related to inventory management - *inventory turnover* (IT), *gross margin return on inventory* (GMROI) and *inventory responsiveness* (IR), respectively, to examine the changes during one year pre merger quarter to first year post merger results. For a comprehensive understanding of the impact of mergers, we also study the effects on the operating performance, which is measured via *gross profit margin*, *sales efficiency* and profitability (*return on assets* and *sales*).

We start by looking at the impact on the absolute performance of the above metrics. Subsequently, we study the effects on the (relative) industry-average-adjusted performance, to account for economic and industry wide factors. For inventory related metrics as well as profitability, we find that, in general, mergers *deteriorate* merging firms' absolute inventory performance and have a *mixed* impact on their industry-adjusted performance. Regarding operating performance, our empirical evidence shows that mergers *increase* merging firms' gross profit margins but *reduce* sales efficiency in both absolute and relative measures. Moreover, we demonstrate that if M&As are categorized based on their profitabilities, then indeed the "successful" M&As are associated with significantly better inventory management performance compared to the "failures".

Subsequently, we extend our analysis on two different levels. The first showing that when longer-term effects of mergers (two years post-merger) are considered, our main insights

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[5]As discussed in §7, such an analysis would require much more granular data. In that case we would need to focus on a small subset of firms, which would have implications in terms of the generality of the conclusions. Our approach is in line with most M&A related papers in the finance literature which also focus on the aggregate level performance.

remain valid. The second will compare the performance of merging firms with their "most comparable" non-merging competitors, and find that horizontal mergers only provide a *slight advantage* to merging firms, over similar non-merging rivals.

Lastly, with regards to the salient metrics, based on a multivariate regression analysis we are able to show that inventory efficiency, i.e., inventory turnover and gross profit margin are the two most important factors that influence the profitability of a merger, irrespective of the industry sector or size of the mergers.

The rest of the paper is organized as follows. §2 reviews related literature. §3 develops the relevant hypotheses. §4 describes the data sources and our methodology for analysis. §5 reports the detailed empirical results about pre- and post-merger performance comparison and §6 presents the regression analysis. §7 contains our concluding discussion and suggestions for future research.

4.2 Literature Review

The causes and effects of horizontal M&As have been researched extensively in a number of management disciplines. In finance literature, the approach of examining the abnormal stock price performance of merging firms and their competitors during pre- and post-merger periods is commonly used to measure the market power created by M&As. Eckbo (1983) and Stillman (1983) were the first to use such a technique, although they did not find any evidence to support the creation any market power. Subsequently, Fee and Thomas (2004) find that both merging firms and their rivals experience positive abnormal returns around the merger announcement date, and Shahrur (2005) suggests that some mergers "seem to" increase the buying power of the merging firms when facing their suppliers. However, from our perspective, the more relevant streams of literature are those that examine the impact of horizontal M&As on the operating performance and on the inventory performance. In what follows, we provide an overview of the research in these two areas.

M&A impact on operating performance. Besides the stock market reaction to horizontal M&As, the post-merger operating performance has also been investigated by different researchers within the financial community. Focusing on target firms' profitability (measured by returns on asset), Ravenscraft and Scherer (1989) find that acquired firms actually suffer a loss in profitability following mergers. An important paper in this stream is Healy et al. (1992), which examines the 50 largest mergers between 1979 and 1984 using industry-adjusted cash flow returns (IACR) as a measure of (relative) operating performance. They show that the merging firms' industry-adjusted operating performance improves after mergers, and also report that there is no evidence of correlation between post-merger operating performance and the level of business overlap.

Focusing on the mergers announced after Healy et al. (1992)'s investigation, Heron and Lie (2002) study M&As between 1985 and 1997. They find that the acquiring firms exhibit superior operating performance (in terms of return on sales) following acquisitions, and there is no evidence that the method of payment provides information regarding the firms' post-merger operating performance. Some other empirical studies, such as Andrade et al. (2001) and Fee and Thomas (2004), also confirm that merging firms' relative operating performance improves subsequent to the merger transactions.

M&A impact on inventory-related supply chain performance. As noted earlier, M&As have been relatively under-researched in the Operations Management (OM) field. To the best of our knowledge, there are only two empirical papers that investigate the impact of M&As on inventory-related supply chain performance. Langabeer (2003) suggests that there is a negative relationship between the volume and intensity of mergers with overall supply chain performance, and that such a negative relationship is substantially moderated by the size of the target. They also report that mergers have a negative correlation with inventory turns and operating margins. On the other hand, Langabeer and Seifert (2003) investigate an association between the success of a merger and the post-merger integration

of the supply chains of the merging firms. Based on their empirical findings, the faster and more effectively firms integrate their supply chains, the more profitable the mergers. Although these two papers are related to us because of their overall objectives, there are major differences both in terms of scope (data and measurement) and methodology. First, the analysis in the above two papers are based on only one industry segment, chemicals & allied products, whereas we cover a much larger range of industry sectors and with more recent data. Moreover, both aforementioned papers focus only on analyzing the effects on absolute inventory performance. In line with the recent empirical literature (e.g., Healy et al. 1992, Hendricks and Singhal 2005), we also discuss the effects on relative inventory performance (compared to industry-average and non-merging rivals). Lastly, our scope in terms of inventory and operating performance metrics is also broader. For example, we deal with metrics like GMROI, inventory responsiveness, gross profit margin and sales efficiency, which are not covered in the above two papers.

Interestingly, even the theoretical papers on quantifying the operational synergies due to M&As are not that common in the OM literature (Nagurney 2009). One of the first in this stream is Gupta and Gerchak (2002) who show how firm size, flexibility of capacity and variable demand patterns, interact to produce different levels of operational synergies in a merger. There are a few other papers which use a mathematical programming approach to quantify merger synergies. Examples include Alptekinoglu and Tang (2005) who focus on distribution networks, Soylu et al. (2006) who focus on energy systems, and Nagurney (2009) who uses a variational inequality approach for general supply chains.

We would like to point out that, although the questions addressed are very different, the metrics and methodology adopted in this paper follow empirical OM literature. For example, inventory turns, GMROI and inventory responsiveness have been used before to measure the effectiveness of a firm's inventory management practices (e.g., Rabinovich et al. 2003, Gaur et al. 2005, Chen et al. 2007, Rumyantsev and Netessine 2007, Gaur and Kesavan 2009). In

terms of methodology, we follow the event study analysis approach employed in Hendricks
and Singhal (2003) and Dehning et al. (2007).

Our main contribution is that we provide a comprehensive understanding of the effects
of horizontal M&As on the aggregate inventory management performance. In particular,
analyzing how such initiatives affect the absolute as well as the relative performances sets
our paper apart from the existing literature.

4.3   Hypothesis Development

In this section, we postulate our hypotheses regarding the impact of horizontal M&As on
operating and inventory performance, drawing on results from existent theoretical and em-
pirical literature. Following Barber and Lyon (1996)'s lead, we focus on the hypotheses
related to the performance of the merging entities compared to the industry average.[6] In
other words, all references to merging firms' performance in our hypotheses refers to the
performance compared to the industry average benchmark. In total, there are seven hy-
potheses - three of them dealing with operating performance and the other four dealing with
inventory-related supply chain performance measures. We start with the former set.

4.3.1   Operating performance

A great deal of attention has been devoted to the impact of horizontal mergers on a firm's
operating performance in both theoretical and empirical literature. In the classic model
of Bertrand competition with differentiated products, the seminal paper by Deneckere and
Davidson (1985) shows that due to less competition in the post-merger market, the merging
firms have the incentive to increase their prices, and higher prices lead to a reduction in the

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[6]Barber and Lyon (1996) find that in random samples or samples of large firms, test statistics using the
change in a firm's operating performance relative to an industry benchmark consistently yield well specified
and powerful test statistics.

merging firms' output. Subsequently, a number of other papers have theoretically extended the validity of this result to more general settings (e.g., Farrell and Shapiro 1990, Werden and Froeb 1994). It has also been confirmed empirically by Kim and Singal (1993), who found that the price increases in the airline industry are positively correlated with horizontal concentration. As for the change in output, using panel data from different countries, Gugler et al. (2003) demonstrate that, on average, mergers result in lower sales for merged firms. In terms of the merging firms' profitability, several empirical studies have tested and confirmed the improvement of merging firms' profitability performance (see, for example, Healy et al. 1992, Ghosh 2001, and Heron and Lie 2002). Although not our prime area of attention, we briefly assess the operating performance impact of horizontal M&As for completeness, utilizing the three mostly used metrics in the related literature, e.g., Dehning et al. (2007): gross profit margin, sales efficiency and profitability. Specifically based on the above discussion, we postulate that:

Hypothesis 4.1 *The gross profit margin for merging firms is positively correlated with horizontal mergers.*

Hypothesis 4.2 *The sales efficiency (Sales/Assets) for merging firms is negatively correlated with horizontal mergers.*

Hypothesis 4.3 *The profitability for merging firms is positively correlated with horizontal mergers.*

4.3.2 Inventory-related performance

We use four different metrics to measure the inventory performance of a firm: inventory (INV) which measures the total inventory of a firm; days-of-supply (DOS) which measures how quickly a firm turns over its inventory; inventory responsiveness (IR), which measures how rapidly a firm adjusts its level of inventory in response to changes in the sales environment; and gross margin returns on inventory (GMROI), which measures how much a

firm earns on every dollar spent on inventory. These measures capture different aspects of a firm's inventory performance, hence are complementary in nature. Broadly speaking, DOS is a measure of efficiency, GMROI is a measure of inventory profitability or productivity[7], while IR is more related to elasticity.

Inventory and Days-of-Supply(DOS). Days-of-supply refers to how many days worth of inventory, on average, is held by firms in anticipation of demand. This is measured by dividing the average value of finished goods inventory in stock by the average cost of goods sold (COGS). Note that days-of-supply is the inverse of inventory turns[8] - that is, a lower (respectively, higher) value of days-of-supply implies that a firm is turning its inventory faster (respectively, slower). There might be two contrasting effects of mergers on the days-of-supply for a merging firm.

The first effect arises from increased (gross) margins and reduced sales (i.e., Hypotheses 1 & 2). Higher margins usually lead to more aggressive stocking decisions and increased inventories. For example, from a newsvendor model perspective, increased margins make underage costs higher, prompting firms to stock more (see for example Cachon and Terwiesch 2005). We would also expect lower COGS as a result of reduced sales due to mergers. In combination, we then should expect days-of-supply to increase due to mergers.

The second effect arises from the ability of merging firms to consolidate or "pool" their inventory. Consolidation allows firms to exploit economies of scale while also taking advantage of risk pooling in face of uncertainty. There is considerable research in the OM discipline on the associated benefits, which include reduced holding cost, higher service level, higher profit, as well as increased turnover (e.g., Eppen 1979, Tagaras and Cohen 1992, Achabal et al. 2001). This effect would suggest that days-of-supply should decrease due to mergers.

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[7]In order to avoid confusion with the profitability measure considered as part of operating performance, henceforth we refer to GMROI as a measure of inventory "productivity".

[8]Hence days-of-supply can also be calculated from dividing 365 by the firm's inventory turnover ratio.

Since achieving scale economies is one of the prime motivations for undertaking M&As, we would expect the effects of inventory consolidation or pooling to dominate the increased margins or reduced sales effects, resulting in, an overall reduction of total inventory cost as well as days-of-supply for merging firms. Hence;

Hypothesis 4.4 *The total inventory for merging firms is negatively correlated with horizontal mergers.*

Hypothesis 4.5 *The days-of-supply for merging firms is negatively correlated with horizontal mergers.*

Inventory responsiveness (IR). Rumyantsev and Netessine (2007) define inventory responsiveness as the difference between the percentage change in inventory level and the percentage change in sales. Hence, if the inventory for a firm is growing at a faster rate than sales, then its inventory responsiveness would be positive, and if it is growing at a slower rate, their inventory responsiveness would be negative. Obviously, if they grow at the same rate, then the value would be exactly equal to zero. In essence, inventory responsiveness is a measure of how well the firm adapts its inventory practices in face of changes in demand (sales). Using financial panel data from Compustat, Rumyantsev and Netessine (2007) establish that a faster inventory growth and a faster inventory decline relative to sales are both negatively associated with firm's profitability.

As we discussed in the previous chapter, there are two major effects of horizontal mergers: increased market power and synergy effect. The increased market power leads to a higher price and lower sales while the synergy effect reduces merging firms' inventory level. If the market power effect is stronger than the synergy effect, then the change in sales should be faster than the reduction in inventory. Therefore, merging firms' should exhibit a positive inventory responsiveness. On the other hand, if the synergy effect dominates the increased market power, we shall observe more significant change in inventory than in sales, i.e., a

negative inventory responsiveness. However, based on the existing literature, it is difficult to identify which effect will dominate the other. To examine the relationship between these two effects, we propose the following hypothesis.

Hypothesis 4.6 *(a) Horizontal mergers result in a negative inventory responsiveness for merging firms. (b) Horizontal mergers result in a positive inventory responsiveness for merging firms.*

Gross margin returns on inventory (GMROI). GMROI can be used to analyze a firm's ability to turn inventory into cash above the cost of the inventory. This particular metric is calculated as the ratio of the gross margin earned by a firm to its average inventory cost. This is a useful measure as it helps managers to see whether a sufficient amount is being earned compared to the investments in inventory assets. A ratio higher than 1 indicates a positive return on inventory investment, while a ratio below 1 means the firm is selling the product for less than what it costs the firm to acquire it. This ratio can also be expressed as the gross profit margin multiplied by sales-to-inventory ratio. Note that sales-to-inventory ratio is itself related to both the days-of-supply and the gross profit margin.[9] Since we expect gross profit margin to increase (Hypothesis 1) and days-of-supply to decrease (Hypothesis 5), we should observe GMROI for merging firms to increase after mergers. That is:

Hypothesis 4.7 *The gross margin return on inventory for merging firms is positively correlated with horizontal mergers.*

In what follows, we test the above hypotheses based on data collected from multiple sources.

4.4 Data and Methodology Description

In this section, we discuss the data and methodology used to establish the effects of horizontal M&As. Our sample is drawn from the population of M&As that took place between January

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[9]Inventory-to-sales ratio is the multiplication of days-of-supply with COGS-to-sales ratio (i.e., one minus gross profit margin). Sales-to-inventory ratio is the reciprocal of inventory-to-sales ratio.

1, 1997 and December 31, 2006 found in the Securities Data Corporation (SDC) Mergers & Acquisitions database. Since we are interested in companies with more inventory related activities, we look for mergers with primary SIC codes in the following ranges: 2000-3999 (manufacturing), 5000-5199 (wholesale trade) and 5200-5999 (retail trade).[10] Moreover, we require all deals in our sample to meet the following criteria: (i) both target and acquirer are U.S. domestic and publicly traded firms, (ii) the announced merger was eventually completed, (iii) the target and acquirer share the same primary four-digit SIC code, and (iv) the acquirer did not previously own a majority share in the target firm and obtained more than fifty percent of the target's stock through the transaction. The first criteria is to ensure that we have access to their financial data in the Compustat database; the second one is to filter out those merger announcements that did not get approval from authorities; the third one is to focus our attention on horizontal M&As; and the last requirement is to ensure that transactions have a significant impact on the relationship between the two merging firms. Note that throughout this paper we assume the merger date to be the date when the merger was completed (i.e., when there was a change of control of the acquirer to the target) and not when it was announced.

For the financial data, we use quarterly financial data for all publicly held U.S. companies with primary SIC codes in the three ranges indicated before (i.e., manufacturing, wholesale and retail sectors) and for the 13-year period 1996 - 2008. We obtain this data from Standard & Poor's Compustat database accessed through Wharton Research Data Services (WRDS). We collect them for three years longer than the merger period to ensure that we have at least one (resp., two) more year data available for the pre- (resp., post-) merger analysis.

Within the 318 SIC codes covered in our sample, there are 10138 companies whose financial data is available from Compustat, and 486 acquirer and target pairs which can be

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[10]Standard Industry Classification (SIC) is an extensive hierarchical structure of codes developed by the U.S. Department of Commerce to categorize companies based on their industries.

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identified from the SDC database.[11] For each of the 10138 companies, we collect the quarterly data on the following financial items which are required to calculate the performance metrics of interest to us: asset (data item: ATQ), cost of goods sold (data item: COGSQ), inventories (data item: INVTQ), operating income before depreciation (data item: OIBDPQ), and net sales (data item: SALEQ).
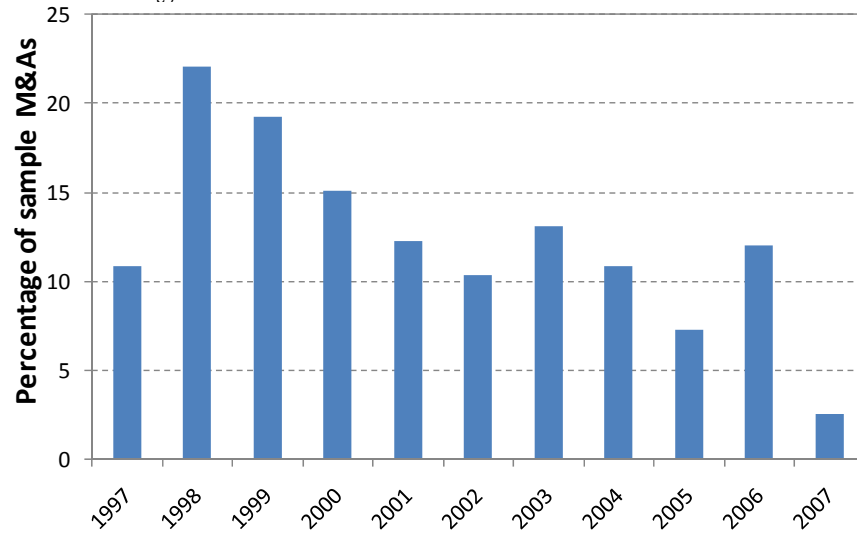
Figure 4.1: Distribution of the 486 mergers by year

Figure 4.1 presents the annual number of mergers in our data collection period. The merger activities in our sample are widely distributed, from 9 per year to 79 per year. Because in some cases there is a time lag between the date of the merger announcement and the effective date of the merger. Nine transactions took place beyond our sample period, but are included in our sample. Note that due to reporting requirements and how Compustat collects data, some of our sample firms have missing values for the above quarterly data items. Moreover, in order to calculate the percentage change in each metric due to a merger, we require at least eight data points for each sample firm. Therefore, the actual number of observations used in our analysis is smaller than the theoretically possible number (refer to the analysis tables later on for the actual number of observations used).

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[11] We use the identifier GVKEY to keep track of each company in Compustat because other firm identifiers such as the company name, CUSIP, or ticker may change over time.

Table 4.1 provides the basic summary statistics for firms in our sample, based on the last fiscal quarter prior to the effective date of mergers. Several issues are important in this context. First of all, in contrast to prior research in this area, we include the financial data not only for the merging firms (targets and acquirers) but also for the non-merging ones, because later on we compare the effects of M&As on the performance of the two sets. Second, this table shows that the size of the firms in our sample varies significantly (large standard deviation and range). Moreover, the high kurtosis implies that most of the variance is due to infrequent extreme deviations, and positive skewness means that the mass of the distribution is concentrated on the left and there are relatively few high values.

Based on the above facts and results from Barber and Lyon (1996), we focus our attention on the change in a firm's performance relative to a benchmark instead of the level of a firm's performance relative to a benchmark. Moreover, we mainly use Wilcoxon signed-rank test for our analysis[12]. However, we also utilize the t-test and the binomial test to provide robustness checks for the results.

In order to test our hypothesis, we use basic quarterly financial data (e.g., total assets, cost of goods sold, operating income, net sales, and inventory total (INVT)) to compute the performance metrics for each firm i in quarter t as shown in Table 4.2. We focus our analysis on the four quarters before the merger (quarters -4 to -1) and four quarters following the merger (quarters 1 to 4). We exclude quarter 0 (the quarter of the merger) from the analysis because in this quarter the two firms are consolidated for financial reporting purposes only from the merger completion date. Consistent with previous studies, we combine the

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[12]Concerning the choice of an expectation model, Barber and Lyon (1996) find that test statistics using the change in a firm's performance relative to an appropriate benchmark consistently yield more powerful test statistics than do those based on the level of a firm's performance relative to the same benchmark. In the choice of statistical test, they find that nonparametric Wilcoxon test statistics are uniformly more powerful than parametric t-statistics, regardless of the operating performance measure employed.

Table 4.1: Descriptive Statistics for Firms in Our Sample (in million US$)

	Average	Median	St.Dev.	Max	Min	Kurtosis	Skewness
Panel A: Descriptive statistics for 486 target firms before mergers							
Total Assets	3723.31	334.88	9914.00	111550	1.395	49.96	5.84
Cost of Goods Sold	629.36	53.57	1821.53	22234	0.075	67.42	6.85
Inventory Total	473.63	54.29	1147.91	7791	0.086	17.55	3.95
Operating Income	158.79	6.84	505.21	5212	-255.5	43.45	5.76
Net Sales	997.82	90.67	2421.56	23315	0.038	26.44	4.30
Panel B: Descriptive statistics for 486 acquiring firms before mergers							
Total Assets	4339.41	913.31	10616.18	120058	0.008	44.27	5.57
Cost of Goods Sold	560.98	124.46	1131.25	10982.7	0.132	26.11	4.30
Inventory Total	435.42	119.64	840.55	6701	0.101	15.73	3.62
Operating Income	216.01	24.18	608.86	4036	-146.2	18.47	4.24
Net Sales	1072.15	211.40	2138.01	13982	0.011	10.95	3.17
Panel C: Descriptive statistics for all 10138 firms in sample							
Total Assets	2584.22	160.04	12105.20	479921	0.001	299.03	14.24
Cost of Goods Sold	422.36	28.11	2372.20	189081	0.001	658.82	20.03
Inventory Total	229.48	22.33	1015.30	40416	0.001	321.10	14.41
Operating Income	95.64	3.57	533.70	25324	-5810.1	383.16	16.02
Net Sales	595.73	45.43	2983.40	195805	0.001	455.62	16.95

target and acquiring firms' financial data before the merger to obtain the pro forma pre-merger performance of the combined firms. Then, for each sample firm, comparison of the relative change between the pre-merger and post-merger quarterly average performance provides a measure of the percentage change in absolute performance of the merging firms due to the merger. An exception is the inventory responsiveness (IR) metric, which, by definition, involves a rate of change (i.e., the difference between percentage changes in sales and percentage changes in inventory). For this reason, we compute the merger induced changes in IR by subtracting the *average* quarterly change in sales (pre- and post-merger) from the *average* quarterly change in inventory (pre- and post-merger).

We recognize that some of the changes in performance between pre- and post-merger could be due to macroeconomic and/or industry-specific factors. Hence, to rule out the

Operating Performance	Metrics
Gross profit margin	$GPM_{it} = \dfrac{SALEQ_{it} - COGSQ_{it}}{SALEQ_{it}}$
Sales efficiency: Sales on assets	$SOA_{it} = \dfrac{SALEQ_{it}}{ATQ_{it}}$
Profitability: Return on assets	$ROA_{it} = \dfrac{OIBDPQ_{it}}{ATQ_{it}}$
Profitability: Return on sales	$ROS_{it} = \dfrac{OIBDPQ_{it}}{SALEQ_{it}}$

Inventory Performance	Metrics
Total inventory	$INV_{it} = INVTQ_{it}$
Days-of-supply	$DOS_{it} = \dfrac{INVTQ_{it}}{COGSQ_{it}}$
Inventory responsiveness	$IR_{it} = \dfrac{INVTQ_{it} - INVTQ_{i,t-1}}{INVTQ_{i,t-1}}$ $- \dfrac{SALEQ_{it} - SALEQ_{i,t-1}}{SALEQ_{i,t-1}}$
Gross margin return on inventory	$GMROI_{it} = \dfrac{SALEQ_{it} - COGSQ_{it}}{INVTQ_{it}}$

Note: ATQ stands for total asset, $COGSQ$ stands for cost of goods sold, $INVTQ$ stands for total inventory, $OIBDPQ$ stands for operating income before depreciation, and $SALEQ$ stands for net sales.

potential industry or economy related effects, in line with previous studies (e.g., Healy et al. 1992 and Barber and Lyon 1996), we use the industry-average performance as a benchmark to evaluate the merging firms' *industry-adjusted* post-merger performance.[13]

[13]To check the robustness of our results, we also used the industry median performance as a benchmark to adjust the merging firm's performance. In that case, the signs of all the changes in the performance metrics of our interest are the same as the results we report, but the level of significance is weaker. We choose to focus on the industry-average adjusted performance because sometimes the industry-median performance happens to be the same as the sample firm's performance, which reduces the significance of the results.

To assess whether a merging firm is performing unusually well or poorly, we specify the performance we expect in the absence of a merger, thus providing a benchmark against which sample firms can be compared (Barber and Lyon 1996). By comparing the performance, we can control various factors, unrelated to the merger event, that may affect the operating performance of merging firms. As in pervious studies, such as Hendricks et al. (2007), we denote P_{it} as the average quarterly performance for firm i in year t. On the other hand, suppose the firm i's industry (based on SIC code) average quarterly performance in year t is PI_{it}. Then ΔAP_{it}, the *industry-adjusted* percentage change in performance for merging firm i in year t, is given by

$$\Delta AP_{it} = \frac{P_{it} - P_{i,t-1}}{P_{i,t-1}} - \frac{PI_{it} - PI_{i,t-1}}{PI_{i,t-1}}.$$

Obviously, $\frac{P_{it} - P_{i,t-1}}{P_{i,t-1}}$ itself represents the *absolute change* in performance due to the merger event. To illustrate how the adjusted performance is computed, consider the following example. Suppose that during one year prior to the merger quarter, the average quarterly return-to-assets (ROA) ratio for the pro-forma combined firms is 0.048, and during one year subsequent to the merger quarter, the average quarterly ROA for the merged firm increases to 0.052. Therefore, there is 8.3% increase in ROA during the first year following the merger. For the same time period, we calculate the percentage change in ROA for all firms in the same SIC code (industry) and find that the industry average ROA ratio increases by 4%. In this case, the industry-adjusted percentage change in ROA is +4.3% for the merging firm.[14]

4.5   Empirical Results

In this section, we report the results of our empirical study. We start by studying the effects of M&As on the absolute performance of the merging firms. Next, we investigate how

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[14]Note that, following Barber and Lyon (1996) and Hendricks and Singhal (2003), throughout this document, we discard extreme values by symmetrically winsorizing the data at the 1% level in each tail while calculating the ratio measures.

those effects compare to the effects on the industry average performance. Subsequently, we discuss whether (and if so, how) our results change if we take into account long-term effects of mergers (two-year post-merger rather than one). We end this section by comparing the effects on the merging firms to those on the performance of their closest rivals.

4.5.1 Effects on the absolute performance

The effects of M&As on the absolute performance of the merging firms is shown under the "+1 Year Absolute" columns in Table 4.4. From the table we observe that the basic financial measures (e.g., Assets, COGS, Income and Sales) increase significantly after mergers.[15] As regards to operating performance, in general, the gross profit margin of the merging firms increases significantly by about 1% with 67% of the firms showing benefits. However, the sales efficiency decreases significantly by about 5% for most of the merging firms. In terms of profitability, it seems that mergers actually result in lower absolute profits for the merging firms, especially from a return on assets (ROA) perspective - indeed, 57% of the mergers result in losses of ROA.

More interestingly, there is *no significant positive impact* on the absolute inventory performance due to mergers. In fact, almost 78% of the merging firms experience an increase in total inventory, while the median increase is 12%. Likewise, mergers result in about 55% of the merging firms turning their inventories slower resulting in a significant 2% increase in the days-of-supply. This lower turn does not manifest itself in higher productivity returns from inventory investments or more responsive inventory management. Both GMROI and inventory responsiveness do not change significantly after mergers.

Absolute performance based on profitability of mergers. While the aggregate

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[15]Throughout this section, we focus on the median change in performance for discussing the effects of M&As (as in Healy et al. (1992)). We also calculated the mean change in performance. The results, which are available from the authors, do not change significantly.

median performance of all M&As shows that mergers do not significantly improve absolute inventory performance (they might actually deteriorate performance), this is not true if we categorize them based on profitability performance. To illustrate this, we rank all M&As in our sample by their percentage changes in ROA into three groups: top 25% change in ROA, median performance in ROA, and bottom 25% change in ROA. Table 4.3 displays the median merger-induced changes for firms in each group.

Table 4.3: Median performance for merging firms in different groups

Measures	Bottom 25%	Median	Top 25%
Δ**ROA**	**-0.5603**	**-0.0456**	**0.5492**
ΔASSET	0.1800	0.1556	0.1554
ΔCOGS	0.0088	0.0778	0.1357
ΔSALES	-0.0366	0.0948	0.2460
ΔOIBD	-0.4168	0.1109	0.6414
ΔGPM	-0.0568	0.0139	0.0799
ΔROS	-0.3752	0.0101	0.4093
ΔSOA	-0.2471	-0.0470	0.0883
ΔINVT	0.1189	0.1157	0.1197
ΔDOS	0.0740	0.0209	-0.0456
ΔGMROI	-0.2220	0.0021	0.2209
IR	0.1067	0.0105	-0.1312

The first row shows that the median ROA for "top-performing", i.e., most profitable, mergers increased by 54.92%, the median ROA of median-performing mergers decreased by 4.56%, and the median ROA for "bottom performing", i.e., least profitable, mergers decreased by 56.03%. Based on the level of merging firms' ROA performance, we present the median change of other performance measures in rows 2-12. Comparison of the data shows that the changes in performance metrics are quite different between the top and bottom groups. In general, we find that: i) the least profitable mergers experienced a decline or a slower growth in COGS, sales and operating income; however, they have a greater growth in

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assets (increased by 18%); ii) the most profitable mergers exhibited significant improvements in profit margin, return on sales, and sales efficiency, while the least profitable group suffered from a decline in these three metrics; iii) most importantly, from the point of view of this paper, more successful mergers experienced a reduction in days-of-supply and an increase in GMROI also their growth in inventory is slower than their growth in sales. In contrast, less successful mergers suffered an increase in days-of-supply and a decline in GMROI, while their growth in sales was slower than the growth in inventory. In summary, *successful mergers are characterized by more efficient, more profitable and more flexible inventory management compared to the failed mergers.* This suggests that indeed inventory management could play an important role in defining the profitability of mergers.

4.5.2 Effects on the relative performance compared to the industry average

The effects on the absolute performance discussed above do not tell the whole story since the macroeconomic factors that might affect the industry sector are not taken into account. To deal with this issue, this section will investigate the effects on the industry-adjusted performance of merging firms, and will use the effects of M&As on the industry average performance as the benchmark. Readers may refer to §4 for more details about how we calculate the adjusted performance. We proceed with the testing of the seven hypotheses about operating and inventory performances developed in §3 based on the adjusted performance. As mentioned before, because of the large disparity among observations, we are using the Wilcoxon signed-rank statistics to test our hypotheses and report the t-test statistics and the binomial test statistics to provide robustness checks for the results. Generally speaking, we find that the results of Wilcoxon signed-rank test and binomial test are always coherent, while the results of paired t-tests are not always consistent with the other tests because of the presence of extreme values. Before discussing the effects on inventory performances, we

will briefly discuss the effects of M&As on the operating performance metrics.

Table 4.4: Effects of horizontal mergers on merging firms' performance

Merging firms' Performance	Exp. Changes	Obs	+1 Year Absolute % Change		+1 Year Ind-Adjusted % Change	
			median	% neg.	median	% neg.
Panel A: Basic Financial Performance						
Assets		460	0.16	25.43%	-0.16	69.57%
statistic			(11.53)***	(-10.54)***	(-8.91)***	(8.39)***
Cost of Goods Sold		460	0.08	35.00%	-0.15	70.87%
statistic			(6.58)***	(-6.43)***	(-9.48)***	(8.95)***
Operating Income		402	0.11	38.31%	0.03	46.77%
statistic			(4.26)***	(-4.69)***	(0.67)	(-1.30)
Sales		460	0.09	28.26%	-0.25	75.00%
statistic			(8.95)***	(-9.33)***	(-12.01)***	(10.72)***
Panel B: Operating Performance						
GPM	+	460	0.01	43.04%	0.09	39.57%
statistic			(2.60)***	(-2.98)***	(7.06)***	(-4.48)***
SOA	-	458	-0.05	62.66%	-0.18	76.42%
statistic			(-4.92)***	(5.42)***	(-12.24)***	(11.31)***
ROA	+	399	-0.05	57.14%	0.01	47.87%
statistic			(-2.34)**	(2.85)***	(0.67)	(-0.85)
ROS	+	401	0.01	47.63%	0.22	36.66%
statistic			(0.33)	(-0.95)	(8.02)***	(-5.34)***
Panel C: Inventory Performance						
Inventory	-	445	0.12	28.31%	-0.15	70.34%
statistic			(9.72)***	(-9.15)***	(-9.10)***	(8.58)***
DOS	-	444	0.02	45.50%	-0.19	72.52%
statistic			(3.97)***	(-1.90)*	(-9.70)***	(9.49)***
GMROI	+	444	0.00	49.55%	-0.17	67.79%
statistic			(1.06)	(-0.19)	(-7.67)***	(7.50)***
Inventory Respon.	-	444	0.01	47.75%	0.07	39.41%
statistic			(1.47)	(-0.95)	(5.68)***	(-4.46)***

This table presents the merging firms' absolute and industry-adjusted performance during the period from one year before mergers to one year after mergers. Panel A reports the percentage changes in basic financial performance, Panel B reports the percentage changes in operating performance, and the percentage changes in inventory performance are reported in Panel C. We use Wilcoxon sign rank test for the median, and the binomial sign test for the percentage of negativity. The statistics are given in the row denoted "statistic" and the superscripts *, **, and *** indicate that the result is significantly different from zero at 0.10, 0.05 and 0.01 level for two-tailed tests, respectively.

Operating performance. The percentage changes in operating performance metrics

are shown in Panel B of Table 4.4. Looking at the percentage changes in industry-adjusted profit margin, the statistics show that the merging firms are able to *significantly increase* their margins. In fact, 60% of the merging firms increase their margins compared to the industry average, and the median increase is 9%. This evidence confirms hypothesis 1 that merging firms do benefit from less competition in the industry. However, unfortunately, there are strong indications that the sales efficiency of the merging firms *actually decreases*. Specifically, the industry-adjusted median value of percentage change in Sales on Assets (SOA) metric for merging firms reduces by 18% (significantly different from zero at 1% level). The binomial z-statistics also generate similar results with over 76% of merging firms experiencing a decrease of industry-adjusted SOA within four quarters after the transactions. So, there is strong support for hypothesis 2 that the sales efficiency for the merging firms is negatively correlated with M&As.

Lastly, we come to the most important operating performance measure - profitability. In the literature, profitability is usually measured by return on assets, i.e., ROA and/or by return on sales, i.e., ROS (Dehning et al. 2007; Rumyantsev and Netessine 2007). It turns out that the effect of M&As is sensitive to the measurement criterion used. If the profitability is measured in terms of ROA, then there is no significant evidence of worsening or improvement in performance. Indeed, around half of the merging firms improve their industry-adjusted ROAs, while the other half decline. However, ROS metric suggests that mergers significantly improve the profitability of firms. The median of industry-adjusted percentage change due to M&As in ROS is 22%, with around 65% of the merging firms showing improvement. Overall, although the change in ROA is not significant, the improvement in ROS partially supports hypothesis 3 that the merging firms' profitability is *positively correlated* with M&As. These results, in general, are consistent with the findings in Healy et al. (1992), Vafeas (1999) and Fee and Thomas (2004).

In summary, like extant literature, we find empirical evidence to support our first three

hypotheses. Specifically, mergers result in higher profit margins, lower sales efficiency and higher profitability (from ROS perspective) for merging firms compared to the industry average.

Inventory performance. The merger effects on industry-adjusted inventory performance is illustrated under the "+1 Year Industry-Adjusted" columns in Panel C of Table 4.4. In this context, first note that there is a significant slowdown in the growth of inventory held by merging firms, compared to the industry benchmark. The median of post-merger inventory for merging firms decreased almost 15% more than the change in the industry average level, and for 70% of the merging firms, inventory growth is slower than the industry average level. This suggests that the merging firms' inventory growth is *significantly lower* than their industry average level, which supports Hypothesis 4. However, total inventory is an aggregate measure, which does not take into account the size of the firm. A better measure of inventory efficiency is days-of-supply (= average inventory / COGS) with a lower value of days-of-supply representing more efficient firms and vice versa. From inventory efficiency perspective, merging firms are *better* than the industry average. Although the merging firms' absolute days-of-supply do not change much, due to the significant increase in industry level days-of-supply, 72% of the merging firms' post-merger days-of-supply perform better than the industry benchmark, and the median decrease of industry-adjusted days-of-supply is 19%.

While our above analysis suggests that mergers help in improving inventory efficiency, we also need to understand how they affect two other relevant inventory management measures: inventory responsiveness (IR) and gross margin return on inventory (GMROI). We find that there is a *significant positive impact* on the former, inventory elasticity metric in M&As. This is due to the fact that the industry-average inventory growth is slower than the industry-average sales growth, which leads to a negative inventory responsiveness benchmark. Although the merging firms' absolute performance does not change significantly, compared

to a negative benchmark, their industry-adjusted performance is significantly positive after mergers. This result supports the Hypothesis 6(b), which suggests that the effect of increased market power is stronger than the synergy effect.

Moreover, interestingly, we find that inventory investments might not be providing much returns to the merging firms, compared to the industry average. Rather, the median change in GMROI decreases by 17% for merging firms, with more than 67% of them experiencing a significant decline. The underlying reason for this result is that the industry average profit margin increases faster than inventory, which leads to a positive industry level GMROI benchmark. Since the absolute GMROI for merging firms does not change significantly, the difference between absolute GMROI and industry benchmark results in a negative industry-adjusted GMROI. Therefore, we conclude that there is a *significant deterioration* in inventory productivity of merging firms.

In summary, the efficiency of inventory-related operations for merging firms improves after mergers since their days-of-supply decrease (i.e., their turnovers increase). However, the gross margin return on inventory is significantly lower than in the pre-merger scenario, suggesting a decrease in inventory productivity. In other words, for each dollar spent on inventory, fewer profit dollars are generated from inventory investments in the first year after mergers than in the year prior to the merger quarter.

4.5.3   Longer-term effects of mergers

Although there is some anecdotal evidence that suggests that success or failure of an M&A is mostly evident within one year from the time of merger (Herd et al. 2008), there are two main reasons to extend our analysis beyond the first year post merger: i) to assess the robustness of the short-term effects of mergers; and ii) to measure the potential bias due to accounting treatment. In mergers where the purchase accounting method is used to account for the business transaction, all the assets of the target firm have to be marked to

market before being combined with the acquirer's book assets, and the difference between the purchase price and the revised book value of target firm's equity is recorded as goodwill in the acquirer's book. This accounting treatment might result in an (artificial) increase in the value of the target's total assets (Healy et al. 1992). To mitigate the effects of such accounting adjustment, it is worthwhile to investigate how our results of the previous section are affected if we consider the longer term effects of M&As. Specifically, rather than one year post-merger, in this section we calculate the percentage changes in performance metrics from one year before the transaction to two years after the transaction. These results are exhibited in Table 4.5 for the merging firms performance for two levels of analysis - unadjusted and industry-average-adjusted.

If we compare the results in this table to those in Table 4.4, we can conclude that, qualitatively speaking, most of our results in §5.1 - §5.2 still hold true. That is, there is *not much difference* between short-term and longer-term effects of mergers. Specifically, most of the directionality of changes in the performance metrics remain the same, although the levels of significance might change. For example, as in §5.1, when we look at the changes in the absolute performance of the merging firms: gross profit margin increases, sales efficiency and profitability (from ROA perspective) decrease, total inventory and days-of-supply increases, while there is no significant impact on GMROI. The only difference is that the inventory responsiveness becomes significantly positive during the second year after mergers. Likewise, the effects on the industry-average adjusted performance are also very similar to what we discussed in §5.2, but the degree of changes becomes more significant, and the most noticeable difference is that the industry-adjusted ROA is now significantly improved. So, as previously noted, the longer-term effects of mergers also suggest that merging firms' inventory efficiency, profit margins, and profitability are improved while sales efficiency and inventory productivity are down from where they were prior to mergers.

Table 4.5: Effects of horizontal mergers

Merging firms' Performance	Exp. Changes	+2 Year Absolute % Change		+2 Year Ind-Adjusted % Change	
		Obs	median	% neg.	median	% neg.

Merging firms' Performance	Exp. Changes	Obs	median	% neg.	median	% neg.
Panel A: Basic Financial Performance						
Assets		447	0.22	34.23%	-0.92	78.97%
statistic			(11.55)***	(-6.67)***	(-14.07)***	(12.25)***
Cost of Goods Sold		446	0.13	33.63%	-0.75	79.82%
statistic			(7.83)***	(-6.91)***	(-14.18)***	(12.60)***
Operating Income		384	0.12	39.06%	-0.25	60.68%
statistic			(4.53)***	(-4.29)***	(-4.88)***	(4.18)***
Sales		446	0.17	27.58%	-1.12	80.94%
statistic			(9.52)***	(-9.47)***	(-15.03)***	(13.07)***
Panel B: Operating Performance						
GPM	+	446	0.01	47.76%	0.16	38.12%
statistic			(1.65)*	(-0.95)	(8.44)***	(-5.02)***
SOA	-	445	-0.06	61.57%	-0.30	78.65%
statistic			(-3.86)***	(4.88)***	(-13.25)***	(12.09)***
ROA	+	381	-0.09	61.15%	0.11	43.31%
statistic			(-2.78)***	(4.35)***	(4.35)***	(-2.61)**
ROS	+	383	-0.02	54.31%	0.87	28.98%
statistic			(-1.12)	(1.69)	(10.85)***	(-8.23)***
Panel C: Inventory Performance						
Inventory	-	431	0.20	26.45%	-0.69	77.49%
statistic			(10.26)***	(-9.78)***	(-13.41)***	(11.42)***
DOS	-	430	0.04	42.33%	-0.33	78.60%
statistic			(4.34)***	(-3.18)***	(-11.76)***	(11.86)***
GMROI	+	430	-0.02	52.56%	-0.36	75.81%
statistic			(0.53)	(1.06)	(-10.66)***	(10.71)***
Inventory Respon.	-	430	0.02	46.05%	0.20	37.44%
statistic			(2.44)**	(-1.64)	(7.20)***	(-5.21)***

This table presents the merging firms' absolute and industry-adjusted performance during the period from one year before mergers to two year after mergers. Panel A reports the percentage changes in basic financial performance, Panel B reports the percentage changes in operating performance, and the percentage changes in inventory performance are reported in Panel C. We use Wilcoxon sign rank test for the median, and the binomial sign test for the percentage of negativity. The statistics are given in the row denoted "statistic" and the superscripts *, **, and *** indicate that the result is significantly different from zero at 0.10, 0.05 and 0.01 level for two-tailed tests, respectively.

4.5.4 Effects on the relative performance compared to non-merging rivals

The previous sections accounted for the macroeconomic factors affecting a particular industry sector by comparing the performance of merging firms to the industry average. However, comparing the merging firms' performance with industry benchmark may not give the complete picture because of the potential disparity in sizes between the industry average and the merging firms. So, an alternative basis for comparison to understand the impact of M&As can be *rival-adjusted* post-merger performance, i.e., comparing the effects of M&As on the merging firms and their "matching" non-merging rivals. For this we need to identify matching non-merging rivals for each merging firm. The process we adopt for choosing matching rivals is similar to that used in literature (e.g., Ghosh 2001 , Fee and Thomas 2004 and Hendricks and Singhal 2005).

Our selection criteria are as follows: (1) the matching rival must be in the same industry segment as the acquiring firm, i.e., share at least three digits in the SIC code with the acquirer, (2) the matching rival must not have experienced any M&A activity during a three year window surrounding the merger event (from one year before to two years after), (3) the size of rival (total assets) should be between 25% and 200% of the combined firm. By applying the above criteria, we were able to find 459 (94%) matching rivals. If there are no matching rivals in the same industry meeting the above asset-size requirement, we relax the last constraint and a matching firm is then chosen without regard to size. Next, we compare the effects of M&As on the merging firms' performance to the corresponding performance of their matched non-merging rivals. The results are provided in Table 4.6 for both short and long terms.

In terms of the operating performance, during the first year after mergers, there is not much difference between merging and rival firms as far as SOA and ROA are concerned,

Table 4.6: Merging firms' rival-adjusted performance

Merging firms Vs. Rivals	+1 Year % Change			+2 Year % Change		
	Obs	median	% neg.	Obs	median	% neg.
Panel A: Basic Financial Performance						
Assets	460	0.03	46.52%	445	0.02	47.42%
statistic		(2.07)**	(-1.49)		(0.71)	(-1.09)
Cost of Goods Sold	460	0.00	49.35%	444	0.04	46.62%
statistic		(0.02)	(-0.28)		(1.51)	(-1.42)
Operating Income	390	0.04	47.18%	373	0.03	47.45%
statistic		(0.58)	(-1.11)		(1.31)	(-0.98)
Sales	460	0.04	43.91%	444	0.07	43.24%
statistic		(2.29)**	(-2.61)**		(3.36)***	(-2.85)***
Panel B: Operating Performance						
GPM	460	0.02	45.43%	444	0.01	47.97%
statistic		(1.72)*	(-1.96)*		(0.78)	(-0.85)
SOA	458	0.00	50.00%	443	0.04	44.70%
statistic		(-0.68)	(0.00)		(2.28)**	(-2.23)**
ROA	387	0.06	46.51%	370	0.04	46.49%
statistic		(1.51)	(-1.37)		(1.44)	(-1.35)
ROS	389	0.06	44.22%	389	0.02	48.12%
statistic		(1.71)*	(-2.28)**		(1.46)	(-0.74)
Panel C: Inventory Performance						
Inventory	445	0.03	46.74%	429	0.07	45.92%
statistic		(1.80)*	(-1.37)		(1.60)	(-1.69)
DOS	444	0.03	46.17%	428	-0.03	53.97%
statistic		(1.85)*	(-1.61)		(-0.48)	(1.64)
GMROI	444	0.02	47.30%	428	0.06	43.46%
statistic		(0.98)	(-1.14)		(1.86)*	(-2.71)***
Inventory Respon.	444	-0.02	53.15%	428	-0.05	57.01%
statistic		(-0.81)	(1.33)		(-2.63)***	(2.90)***

This table presents the comparison between merging firms and their non-merging rivals' performance, during two years after mergers. Panel A reports the percentage changes in basic financial performance, Panel B reports the percentage changes in operating performance, and the percentage changes in inventory performance are reported in Panel C. We use Wilcoxon sign rank test for the median, and the binomial sign test for the percentage of negativity. The statistics are given in the row denoted "statistic" and the superscripts *, **, and *** indicate that the result is significantly different from zero at 0.10, 0.05 and 0.01 level for two-tailed tests, respectively.

but the gross profit margin and ROS of the merging firms increase more than the non-merging rivals (significant at the 0.10 level). In the second year after mergers, however,

merging firms' advantages in GPM and ROS are not statistically significant, while their sales efficiency becomes higher than their main rivals. So, M&As provide some market power to the merging firms, which enable them to either increase their prices or sales. As a consequence, they may also earn higher profits, although the benefits are not that significant.

When we compare the inventory performance, the merging firms are *worse off* than their rival firms in the first year after mergers, but *better off* during the second year (significant at the 0.10 level). For example, the increase in days-of-supply is higher for merging firms than their matching rivals during the first year, while the merging firms are significantly more responsive and productive in the second year. This suggests that some of the expected inventory management benefits due to M&As are accruing to the rival firms during the short term shock.[16] However, over the long term, merging firms may indeed benefit in terms of inventory management performance. However, note that, except for inventory responsiveness, none of the effects are that significant. This suggests that the merging firms may not be accruing that much advantage, in terms of inventory performance, compared to their matching rivals.

In summary, there is evidence that merging firms gain slight improvement in terms of market power compared to their matched non-merging rivals. In terms of inventory management, in general, mergers neither provide significant advantage nor create significant damage to the merging firms over their rivals.

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[16]This might be a manifestation of Murphy's Law as has been observed in a number of industrial settings (refer to Chew et al. 1991).

4.6 Effects of Performance Metrics on Merger Profitability

Our analysis so far has concentrated on establishing the effects of mergers on operating and inventory performance through an event study. A complementary question is whether operating and inventory related variables can indeed affect the profitability of mergers. We address this question in this section. Specifically, we conduct a multivariate regression analysis to examine the relationship between merger-induced changes in profitability and the changes in other performance metrics discussed before. Following Dehning et al. (2007) and Eroglu and Hofer (2011), we use ROA and ROS as the primary dependant variables in measuring profitability which shows the rate of return for both creditors and investors of the company.[17]

Table 4.7: Pearson's correlation matrix of performance variables

	ΔROA	ΔROS	ΔGPM	ΔSOA	ΔDOS	ΔGMROI	IR	ΔINV	ΔAST	ΔCOGS	ΔOIBD	ΔSALES
ΔROA	1.000											
ΔROS	0.568***	1.000										
ΔGPM	0.190***	0.425***	1.000									
ΔSOA	0.187***	0.128***	0.078*	1.000								
ΔDOS	-0.067	-0.180***	0.248***	-0.064	1.000							
ΔGMROI	0.076	0.113**	0.794***	0.218***	0.038	1.000						
IR	-0.026	-0.042	-0.061	-0.057	0.108**	-0.080	1.000					
ΔINV	0.147***	0.114**	-0.078*	0.113**	0.305***	-0.137***	0.161***	1.000				
ΔAST	0.073	0.034	-0.092*	-0.223***	-0.046	-0.067	0.010	0.603***	1.000			
ΔCOGS	0.229***	0.127**	-0.198***	0.220***	-0.311***	-0.154***	0.000	0.586***	0.579***	1.000		
ΔOIBD	0.804***	0.530***	0.193***	0.107**	-0.069	0.134***	-0.023	0.136***	0.002	0.140***	1.000	
ΔSALES	0.300***	0.191***	0.015	0.438***	-0.102**	0.050	-0.020	0.608***	0.616***	0.752***	0.224***	1.000

All the variables are the percentage changes in performance measures from 1 year before mergers to 2 years after. They are also industry average adjusted performance. The superscripts *, **, and *** indicate that the result is significantly different from zero at 0.10, 0.05 and 0.01 level, respectively.

Table 4.7 represents the correlation matrix for the variables we are interested in, where Δ stands for the merger-induced percentage change of performance during three years surrounding the merger event (i.e., one year pre-merger and two years post-merger). To control the industry-specific and year-specific fixed effect, we add two control variables, namely *Ind*

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[17]See Barber and Lyon (1996) for a comparison of ROA, ROS and other profitability performance measures.

and $Year$, where variable Ind is a categorical variable which stands for the industry sector of merging firms based on their four-digit primary SIC code, and variable $Year$ is the calendar year when the merger is completed. We use the Herfindahl index ($Herf$), calculated as the sum of squared market shares of the firms in an industry as a measure of competition within an industry (see Bhattacharyya and Nain 2010). In addition, we use the natural logarithm of average quarterly assets one year following the merger as control for the effect of firm size, denoted as $Size$. The resulting regression model can be stated as follows:

$$\Delta ROA_{it} \text{ or } \Delta ROS_{it} = F_i + b_1 \Delta GPM_{it} + b_2 \Delta SOA_{it} + b_3 \Delta DOS_{it} + b_4 IR_{it} + b_5 \Delta GMROI_{it}$$
$$+ b_6 Ind_i + b_7 Year + b_8 Herf_i + b_9 Size_i + \epsilon_{it}.$$

In this model, F_i represents the time-invariant fixed effects for firm i, b_1 to b_5 are the coefficients for the independent variables, b_6 to b_9 are the coefficients for four control variables, and ϵ_{it} is the error term for each merging firm i at year t.

According to the definition of IR, the significant effects of ΔInv_{it} and $\Delta Sales_{it}$ could be canceled out, and render an insignificant coefficient of IR. To further investigate the individual effect of these two variables, we replace the variable IR_{it} with ΔINV_{it} and $\Delta SALES_{it}$, which results in the following alternative models:

$$\Delta ROA_{it} \text{ or } \Delta ROS_{it} = F_i + b_1 \Delta GPM_{it} + b_2 \Delta SOA_{it} + b_3 \Delta DOS_{it} + b_{41} \Delta INV_{it} + b_{42} \Delta SALES_{it}$$
$$+ b_5 \Delta GMROI_{it} + + b_6 Ind_i + b_7 Year + b_8 Herf_i + b_9 Size_i + \epsilon_{it}.$$

Since we focus our attention on the merging firms' relative performance, industry adjusted performance measures are used to determine the effects of performance metrics on the industry adjusted change in ROA and ROS.

In Table 4.8, we present the results of regression analysis for the above four models. The difference among these models are: (i) in models (1) and (3), the dependent variable is the industry adjusted percentage change in ROA, while in models (2) and (4), we use the industry

Table 4.8: Merging firms' profitability: Multivariate Analysis

Model	(1)	(2)	(3)	(4)
Dep.Var	ΔROA	ΔROS	ΔROA	ΔROS
ΔGPM	0.210	1.059	0.214	1.063
	(3.70)***	(10.55)***	(3.76)***	(10.53)***
ΔSOA	0.383	0.327	0.372	0.318
	(2.66)***	(1.29)	(2.50)**	(1.21)
ΔDOS	-0.360	-0.880	-0.395	-0.909
	(-2.98)***	(-4.12)***	(-3.12)***	(-4.07)***
IR	0.023	0.076	-	-
	(0.38)	(0.70)	-	-
ΔINV	-	-	0.074	0.121
	-	-	(0.96)	(0.88)
ΔSALES	-	-	-0.028	-0.079
	-	-	(-0.44)	(-0.71)
ΔGMROI	0.063	-0.328	0.064	-0.325
	(0.90)	(-2.66)***	(0.91)	(-2.63)***
Ind(Manuf.)	-	-	-	-
Wholesale	0.008	0.301	0.028	0.318
	(0.02)	(0.46)	(0.07)	(0.49)
Retail	-0.087	-0.214	-0.092	-0.220
	(-0.39)	(-0.55)	(-0.41)	(-0.56)
Year	-0.001	-0.029	-0.003	-0.030
	(-0.04)	(-0.57)	(-0.10)	(-0.59)
Herf	0.440	1.173	0.423	1.150
	(0.75)	(1.14)	(0.73)	(1.12)
Size	-0.022	0.004	-0.023	0.003
	(-0.50)	-0.05	(-0.51)	-0.03
Constant	2.54	58.21	6.15	61.17
	(0.04)	(0.57)	(0.11)	(0.60)
Adj R-square	0.056	0.261	0.056	0.260
Obs	368	371	368	371

Δ stands for industry adjusted percentage changes in performance measures from 1 year before mergers to 2 years after. The t-statistics are shown in parentheses. The superscripts *, **, and *** indicate that the result is significantly different from zero at 0.10, 0.05 and 0.01 level, respectively.

adjusted percentage change in ROS as the dependent variable; (ii) In models (1) and (2), we use IR as one of the explanatory variables, while in model (3) and (4), we decompose this variable and look at the individual effects of Δinv and $\Delta sales$ on merging firms' profitability.

The variance inflation factors (VIF) for all the models are 2.0, well below the commonly used cut-off of 10, indicating that multi-collinearity is not a problem in our analysis. To ensure that the models are not misspecified, we also conduct Ramsey RESET test, and find that the null hypothesis cannot be rejected at the 5 percent level in all specifications. In general, all the models are significant at an 0.0001 level of significance. Models (2) and (4) have a higher adjusted R-square than models (1) and (3), suggesting that our model can better explain the variation of changes in ROS than in ROA. The insignificant coefficients of control variables imply that the industry-adjusted changes in merging firms' profitability do not change much across different industry sectors and years, and are independent of the degree of competition in the market and the size of the combined firms.

In terms of operating metrics, in all the models, the significant, positive coefficient of GPM implies that if a merging firm's profit margin grows faster than the industry benchmark, its profitability will increase significantly faster than the industry average level. The sales efficiency (SOA) is significantly positive in models (1) and (3), but not significant in models (2) and (4).

Regarding the inventory related performance, we show evidence of a negative correlation between merging firms' change in days-of-supply and change in profitability, suggesting that the reduced days-of-supply does explain in part the improvement in merging firms' profitability. We have not found a significant relationship between inventory responsiveness and profitability. Even when we look at the individual effect of inventory and sales, the industry-adjusted percentage change in these two metrics are not significantly associated with the merging firms' profitability. This result suggests that the increase in merging firms' inventory level alone does not account for the negative change in profitability. In terms of the GMROI, evidence shows that GMROI is not correlated with ROA but negatively correlated with ROS, which implies that the relatively reduced inventory productivity can actually improve the merging firms return on sales performance. So, we can conclude that (higher)

GPM and (higher) DOS are perhaps the most significant metrics that are associated with successful M&As.

4.7 Concluding Summary and Directions for Future Research

Mergers and acquisitions is a critical element of corporate strategy in today's business world. It is a strategic tool often employed for accessing new markets, increasing market power and share, accelerating sales, as well as achieving economies of scale and supply chain efficiencies. Although a significant percentage of M&As fail to achieve these intended outcomes, their popularity remains. In fact, there has been extensive research on the relationship between M&As and stock market reaction, shareholder value, and firm profitability. Interestingly, despite the strong real-life evidence that M&As have a significant impact on operational elements, especially inventory management, as well as the fact that they contribute significantly to the motivational ground for mergers and their eventual success/failure, the relationship has been widely unexplored in OM literature. Our paper makes the first step towards bridging this gap.

We have conducted a comprehensive, cross-industry empirical study of horizontal mergers and acquisitions that took place between 1997 and 2006 in the manufacturing, wholesale and retail sectors, and search for high-level, aggregate evidence on the effect of M&As on firm's performance. Our primary focus is on inventory-related performance metrics, while we also report on the effects on operating performance. The multi-layered analysis approach we utilize generates detailed evidence on the impact of M&As on the performance of merging firms in absolute terms, as well as in comparison to the industries they operate in and the main rivals in those industries. The general consistency with respect to different test measures and short-term versus long-term effects (one year versus two year post-merger)

attest to the robustness of our results.

Regarding inventory related performance, we find that merging firms are not able to garner desirable operational benefits in an absolute sense. On the contrary, most experience a slower inventory turn after the merger. Furthermore, there is no significant change in their ability to generate more margin from inventory, nor in their ability to adapt inventory to the changes in sales. In other words, merging firms are less efficient in managing their inventories post-merger, while their inventory productivity and agility are not significantly changed. Comparisons to the average industry performance put a slightly different spin to these results. Despite the drop in absolute turns, merging firms are indeed more efficient in managing inventory compared to industry average. However, they are not able to generate profit from this efficiency; the margin earned by merging firms on inventory is less than the inventory average. Interestingly, rival firms perform just as well, if not better than merging firms (at least in the short term). In fact, our empirical evidence suggests that merging firms are not able to garner significant competitive advantage over their main competitors through M&As-generated inventory management efficiencies. In a longer-term perspective, the effects of M&As on merging firms' industry-adjusted performance are reinforced, but still do not provide much advantage over their main rivals.

We find that the impact of mergers on profitability is very similar to that of inventory related measures. Mergers deteriorate absolute performance, only marginally improve performance compared to the industry average, but do not provide much advantage over similar non-merging competitors. In contrast, consistent with earlier works in the finance and economics literature (e.g., Fee and Thomas 2004, Bhattacharyya and Nain 2010), we find strong evidence that merging firms gain stronger market power, which enables them to command higher profit margins. However, higher margins come at the expense of sales. Our empirical evidence shows that M&As reduce the sales efficiency of merging firms.

In addition to identifying those merger-induced changes in merging firms' performance,

we also try to establish the connection between these performance metrics through a regression analysis. In spite of the evidence that M&As have mixed effects on inventory related metrics, it does not imply that the inventory management is not playing an important role in the eventual success of mergers. Quite the contrary, our regression analysis shows that inventory efficiency, measured via days-of-supply/turns, is crucial to merger profitability, irrespective of the industry sector, time or the size of mergers. Moveover, we find inventory productivity, as well as profit margins and sales efficiency, are also major determinants in the success of mergers.

Chapter 5

Vertical Mergers and Inventory Related Performance

5.1 Introduction

Vertical merger (or acquisition) occurs when an upstream supplier and a downstream distributor merge (or one acquires the other). There are two types of vertical acquisitions: forward and backward. A forward vertical acquisition occurs when a company combines with one of its downstream distributors or retailers where its products are sold. A well-known example is Disney's acquisition of American Broadcasting Company (ABC) in 1996; Disney is a leading provider of family entertainment while ABC is a broadcasting company with news, cable, and entertainment networks. A backward vertical acquisition is where a company acquires an upstream supplier that produces some of the inputs used in the production of its products. American Technology's acquisition of HST Inc is an example. American Technology is a high-tech producer of branded components while HST is a designer and manufacturer of technologically advanced components for branded consumer products. Recent vertical transactions include Google's purchase of Motorola Mobility, and HP's acquisition of Autonomy,

Britain's largest software company.

According to the existing literature, there are two major effects of vertical mergers and acquisitions. One is the cost efficiency and the other is anticompetitive market foreclosure. As on example of cost efficiency that can be gained from vertical mergers, consider the well-known double marginalization in a decentralized supply chain. Double marginalization occurs when both the upstream and downstream firms have monopoly power. The upstream producer of the input will price above marginal cost when it sells the input to the downstream firm, who will then price above marginal cost again when they sell the final product that uses the input. This means the product being market up above the marginal cost twice, which creates two deadweight losses. Vertical mergers eliminates such inefficiency by enabling the upstream firm to directly observe the joint profits. The merged firm can then induce the downstream subsidiary to reveal the correct price by rewarding the downstream subsidiary only when the optimal quantity for the reported price is consistent with the observed joint profits (Perry 1989).

Market foreclosure refers to the effect of vertical mergers on non-merged firms (Salinger 1988). A backward vertical merger can cause market foreclosure, which is the exclusion that results when non-merging downstream firms are foreclosed from the upstream input supply controlled by a vertically integrated firm. The foreclosure of rivals means that remaining suppliers will face less competition. As a result, they may be able to increase their profits by raising their input prices to the non-merging downstream firms, which benefits the vertically integrated firm. Analogous effects occur in a forward vertical merger, where upstream competitors are foreclosed from selling to the downstream division of the integrated firm.

Although many empirical studies have been conducted to examine the existence of these two effects, no research has been done on how vertical mergers affect merged firms' operating as well as inventory related performance. Does the acquiring firm's operating performance improve after a vertical acquisition? How does a vertical acquisition affect the acquiring

firm's inventory related performance? These questions are unaddressed in the literature. In this paper, we empirically investigate the impact of vertical mergers on merged firms performance. Our empirical work employs an unbalanced panel of 1175 acquiring firms taken from the Compustat database for the period 1995-2008. By comparing the merging firms absolute performance with their industry benchmarks, we find that i) vertical mergers are generally associated with significant deterioration in operating and inventory related performance during the first year following mergers; ii) merged firms generally take at least two years to recover from the negative effects; iii) within the five years following the vertical merger, merged firms do no exhibit significant competitive advantage over the industry average performance.

The rest of the paper is organized as follows. We review related literature in §2, then propose our hypotheses in §3. The data sources and adopted methodology are discussed in §4. §5 report the detailed results and findings. We provide the concluding discussion and future research directions in §6.

5.2 Literature Review

In literature, there are many expected benefits from vertical integration, such as cost savings, market foreclosure, information sharing, etc. Although a number of researchers in economics and operations management areas have investigated analytically these effects of vertical integration, less attention has been paid to providing empirical evidence of these benefits. In this section, we shall review the literature on the related areas, including both theoretical and empirical studies.

How vertical mergers affect competition is an important issue in economics. Riordan (2008) reviews the effects of vertical integration around five major theories: single monopoly profit, eliminating markups, restoring monopoly power, raising rivals' costs, and facilitating

collusion. Other commonly argued benefits of vertical integration include the reduction of risk (Buzzell 1983, Porter 1985), the integrated firms' ability to innovate and to differentiate (Porter 1985, Perry 1989) increased efficiency in the exchange of information and organizational structures (Porter 1985), and improved market positions of the integrated firm (Perry 1989). Since our interest in this paper does not concern monopoly profit, monopoly power and horizontal collusion, we will focus on the theories and evidence regarding the elimination of markups and the increase in rivals' cost.

Elimination of markups and increase in rivals' cost

Salinger (1988) summarizes three major effects of vertical mergers: i) the merging firm increases its final good output; ii) the unintegrated downstream firms lowers their demand for the intermediate good; iii) the merged firm withdraws from the intermediate good market and the increased concentration causes the intermediate good go up. He shows that which effect dominates depends on market structure and under certain conditions, a vertical merger increase the price for the final products.

More recently, the post-Chicago approach (proposed by Ordover et al. (1990) and Riordan and Salop (1995)) has emerged that has shed new light on the issue of the competitive effects of vertical mergers. This new analysis shows that vertical mergers create vertical integration efficiencies between upstream suppliers and downstream distributors. Potential efficiency benefits include improved coordination in pricing, production, and design that can reduce costs and improve product quality. They also involve more efficient input usage and promotion. Hart et al. (1990) develop a theoretical model showing how vertical integration changes the nature of competition in upstream and downstream markets and identifying conditions under which market foreclosure will be a consequence or a purpose, or both, of such integration. Chen (2001) also shows that vertical mergers will lead to both an

efficiency gain and collusive behavior in horizontal competition. Whether the efficiency or the collusive effect dominates depends on the cost of switching suppliers and the degree of product differentiation. A vertical merger can raise downstream rivals' cost if and only if its own cost is reduced through the integration.

Although there are many expected benefits of vertical merger, the existing empirical literature seems to have focused mostly on issues related to transaction costs, foreclosures, and the determinants of vertical integration. The empirical literature on an important aspect of vertical merger, i.e., its effect on operating performance and inventory related supply chain performance, is surprisingly limited. Among the existing studies, McBride (1983) found that vertical integration negatively impacted post-integration prices. Gaudet and Long (1996) utilize a large panel of data to analyzes the effects of three different types of mergers. They show that mergers on average do result in significant increases in profits, but reduce the sales of the merging firms. Bhuyan (2002) finds that vertical mergers negatively impact profits, which may be due to the failure of vertical mergers to create differential advantages, such as cost savings, for the integrated firm. Azzam and Pagoulatos (1999) conclude that there are serious gaps in the vertical integration literature and the limited empirical work that has been done in this area makes generalization difficult to achieve. Therefore, the main purpose of this study is to empirically examine the effect of vertical mergers on the merged firm's performance.

Information sharing

In the supply chain management literature, however, a lot of emphasis has been put on designing an appropriate contract between upstream supplier and downstream retailer to achieve a channel coordination (see Cachon (2003) for a detailed review). Although the coordinated firms still operate independently, the effects of such contracts and vertical inte-

gration can be similar[1].

Double marginalization and information asymmetry are two of the major causes of supply chain inefficiency (Tsay et al. 1999, and Ozer and Wei 2006). Without vertical integration or cooperation, these factors can distort firms' incentives such that supply chain members are primarily concerned with optimizing their own objectives, instead of achieving the optimal supply chain performance (Cachon 2003). The classic supply chain management theory suggests that the vertical integration of successive monopolies eliminates double marginalization and results in a lower price of the final good. By this argument, vertical integration both raises profits and benefits consumers (Spengler 1950).

Lee et al. (2000) show that the order information transferred within a vertical supply chain tends to be distorted and can misguide upstream suppliers in their inventory and production decisions. Their analysis suggests that information sharing between supply chain members could provide significant inventory reduction and cost savings to the upstream manufacturer. Yu et al. (2000) also illustrate the benefit of supply chain partnership with vertical partnership. They show that the negative impact of bullwhip effect on a supply chain can be reduced or eliminated because the vertical partnership can help the supply chain members share more information to reduce uncertainties.

Although there are extensive literature in supply chain management area dealing with the supply chain coordination schemes (see Cachon (2003) for a detailed review) and the benefit or information sharing (e.g., Lee et al. (2000), Chen et al. (2000), Lee and Whang (2000), Yao et al. (2007)), to the best of our knowledge, there are few empirical studies on the vertical integration and firm's inventory performance. As the only one related to this issue, Carr and Kaynak (2007) empirically investigate the relationships among communication

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[1]Tan (2001) states that since most of the benefits of forward and backward vertical integration can be obtained by coordinating the logistics operations of independent firms in the supply chain. In this respect, supply chain management is synonymous with integrated logistics systems.

methods, information sharing within a firm, information sharing between firms, and supplier development support. They find that information sharing between firms have significant impact on improving buyers product quality and financial performance. However, they did not measure inventory performance such as inventory turnover for supply chain members.

5.3   Hypothesis Development

In this section, we postulate our hypotheses regarding the impact of vertical acquisitions on operating and inventory performance, drawing on results from extant theoretical and empirical literature. In the interest of space, we focus on the hypotheses related to the performance of the acquiring firms compared to their rivals that have similar size in this context. In total, there are seven hypotheses - three of them dealing with operating performance and the other four dealing with inventory-related supply chain performance measures. We start with the former set.

5.3.1   Operating performance

A well-developed body of classical economic literature describes the motivations for vertical integrations. One of such motivations is the cost savings (see Spengler (1950), Salinger (1988), and Williamson (1971)). For example, Williamson (1971) suggests that vertical integration may reduce the cost of negotiation between the upstream and downstream firms. Such an effect could also improve the coordination between supply chain players and reduce the effect of double marginalization, so as to improve the profit margin for the vertically integrated firm. On the other hand, according to the vertical foreclosure theory,[2] the foreclosure of rivals from the merged suppliers means that remaining suppliers will face less

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[2]See Krattenmaker and Salop (1986) for a general discussion of potential anticompetitive consequences of vertical mergers.

competition. As a result, they may be able to increase their profits by raising their input prices to the unintegrated downstream firms. Using a Cournot model, Salinger (1988) shows that a vertical merger will reduce the competition in the unintegrated segment of the input market, causing the price of the input to unintegrated firms in the downstream market to rise. He also shows that when no market foreclosure occurs, a vertical mergers causes the price of the final good to decrease.

Since the vertically integrated firms benefit from the cost savings and market foreclosure, their market power increases. Under a typical downward sloping demand curve, the merging firms take advantage of their increase in market power by raising price, and both their output and sales will fall. Gugler et al. (2003) show that a vertical merger can increase the degree of vertical contact between the merging firms and their rivals. High vertical contact raises the costs of cutting price in any given market and thus can facilitate more cooperative behavior thereby effectively increasing the merging firm's market power. A vertical merger can also increase market power by raising entry barriers and thus effectively lowering the merging firm's elasticity of demand. Krattenmaker and Salop (1986) point out that by embedding a collusive agreement in a vertical contract that raises input prices, the merged firms can restrain sales to rivals. Salinger (1988) also states that a vertical merger may give an intermediate good producer an incentive to restrict its sales of the intermediate good.

In terms of one of the major motivations of all kinds of M&As - profitability. The market foreclosure theory suggests that the vertical integrated firms may be able to increase their profits by raising their input prices to the unintegrated downstream firms. For example, Ordover et al. (1990) show that these higher prices benefit the vertically integrated firm. If rivals' costs of inputs are increased, they will be forced to reduce their production and raise the prices they charge in the downstream market. This reduction in competition allows the downstream division of the integrated firm to increase its market share and its price. Thus the profits of the vertically integrated firm can rise, even if there are no production efficiency

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benefits flowing from the vertical integration. D'Aveni and Ravenscraft (1994) also show that vertical integration can increase profits through higher prices by creating barriers to entry, and the integrated firms exhibit higher profitability than non-integrated competitors in the same industry.

Based on the aforementioned theories, we postulate the following hypotheses to examine the effect of vertical mergers on merging firms' operating performance.

Hypothesis 5.1 *The gross profit margins for merging firms will be positively correlated with vertical mergers.*

Hypothesis 5.2 *The sales efficiency for merging firms is negatively correlated with vertical mergers.*

Hypothesis 5.3 *The profitability for merging firms is positively correlated with vertical mergers.*

5.3.2   Inventory-related performance

As the focus in this paper, we use four different metrics to measure the inventory performance of firms: inventory (INV) which measures the total inventory level of a firms; days-of-supply (DOS) which measures how quickly a firm turns over its inventory; inventory responsiveness (IR), which measures how rapidly a firm adjusts its level of inventory in response to changes in the sales environment; and, gross margin returns on inventory (GMROI), which measures how much a firm earns on every dollar spent on inventory. The last three measures capture different aspects of firm's inventory performance, and hence are complementary in nature. Broadly speaking, DOS is a measure of efficiency, GMROI is a productivity/profitability measure, while IR is more related to elasticity.

Inventory and days-of-supply

In terms of the supply chain inventory management, the major benefits of vertical merger include the information sharing within the integrated firms and the reduction of transaction cost. Lee et al. (2000) point out that sharing sales information can be viewed as a major strategy to counter the bullwhip effect. The bullwhip effect is essentially due to the phenomenon of demand distortion, which creates problems for suppliers, such as grossly inaccurate demand forecasts, low capacity utilization, excessive inventory, and poor customer service. With the integrated supply chain, the merged firms can improve their inventory performance by sharing information and reducing the bullwhip effect, which can lower the total inventory level. Therefore, it is natural to expect the inventory level for the combined firms reduce after vertical mergers.

Hypothesis 5.4 *The total inventory for merged firms is negatively correlated with vertical mergers.*

On the other hand, D'Aveni and Ravenscraft (1994) shows that vertical integration also results in lower transaction-related costs, but higher production costs. While Lin et al. (2002) find that the more detailed information shared between firms, the lower the total cost, the higher the order fulfillment rate, and the shorter the order cycle time. Combining the effect of vertical mergers on costs and inventory, we postulate the following regarding the merging firms' days-of-supply.

Hypothesis 5.5 *The days-of-supply for merged firms is negatively correlated with vertical mergers.*

Inventory responsiveness

Rumyantsev and Netessine (2007) propose inventory responsiveness metric to link a firm's inventory performance and operating performance. Specifically, they define inventory re-

sponsiveness as the difference between the percentage change in inventory level and the percentage change in sales. Hence, if the inventory for a firm is growing at a faster rate than sales, then its inventory responsiveness would be positive, and if it is growing at a slower rate, the value of inventory responsiveness would be negative. Obviously, if they grow at the same rate, then the value would be exactly equal to zero. In essence, inventory responsiveness is a measure of how well the firm adapts its inventory practices in face of changes in demand (sales). Using financial panel data from Compustat, Rumyantsev and Netessine (2007) establish that a faster inventory growth and a faster inventory decline relative to sales are both negatively associated with firm's profitability.

In our context, for vertically merged firms, we expect days-of-supply to decrease (Hypothesis 5) while gross profit margin to increase (Hypothesis 1). From the definition of these two metrics and coupling with the fact that we expect sales to reduce due to mergers (see Hypothesis 2), inventory should reduce at a faster rate than sales for merging firms, leading to a negative inventory responsiveness. On the basis of above, we postulate:

Hypothesis 5.6 *Vertical acquisitions result in a negative inventory responsiveness for merged firms.*

Gross margin returns on inventory

Gross margin return on inventory (GMROI) can be used to analyze a firm's ability to turn inventory into cash above the cost of the inventory. This particular metric is calculated as the ratio of the gross margin earned by a firm to its average inventory cost. This is a useful measure as it helps managers to see whether a sufficient amount is being earned compared to the investments in inventory assets. A ratio higher than 1 indicates a positive return on inventory investment, while a ratio below 1 means the firm is selling the product for less than what it costs the firm to acquire it. This ratio can also be expressed as the gross profit margin multiplied by sales-to-inventory ratio. Note that sales-to-inventory ratio

is itself related to both the days-of-supply and gross profit margin.[3] Since we expect gross profit margin to increase (Hypothesis 1) and days-of-supply to decrease (Hypothesis 5), we should observe GMROI for merging firms to increase after mergers. That is:

Hypothesis 5.7 *The gross margin return on inventory for merged firms is positively correlated with vertical mergers.*

5.4   Data and Methodology Description

In this section, we discuss the data and methodology we use for establishing the effects of vertical M&As. Our sample is drawn from the population of M&As that took place between January 1, 1997 and December 31, 2006 and is included in the Securities Data Corporation (SDC) Mergers & Acquisitions database. Since we are interested in companies with more inventory related activities, we look for mergers with primary SIC codes in the following ranges: 2000-3999 (manufacturing), 5000-5199 (wholesale trade) and 5200-5999 (retail trade).[4] Moreover, we require all deals in our sample to meet the following criteria: (i) both target and acquirer are U.S. domestic, publicly traded firms, (ii) the announced merger was eventually completed, (iii) the target and acquirer have different primary four-digit SIC code, and (iv) the acquirer did not previously own a majority share of target firm and obtained more than fifty percent of the target's stock through the transaction. The first criteria is to ensure that we have access to their financial data in the Compustat database; the second one is to filter out those merger announcements that did not get approval from authorities; the third one is to exclude other horizontal M&As; and the last requirement is to ensure that transactions have a significant impact on the relationship between two merged

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[3]Inventory-to-sales ratio is the multiplication of days-of-supply with COGS-to-sales ratio (i.e., one minus gross profit margin). Sales-to-inventory ratio is the reciprocal of inventory-to-sales ratio.

[4]Standard Industry Classification (SIC) is an extensive hierarchical structure of codes developed by the U.S. Department of Commerce to categorize companies based on their industries.

firms. Note that throughout this paper we assume the merger date to be the date when the merger was completed (i.e., when there was a change of control of the acquirer to the target) and not when it was announced.[5]

The requirement of target and acquirer having different primary four-digit SIC code does not guarantee the vertical relationship between these two firms. To identify those vertical link between two merged firms, we use the benchmark Make and Use tables obtained from the Bureau of Economic Analysis (BEA) at the U.S. Department of Commerce to create the Input-Output table. The benchmark IO accounts are compiled once every five years and primarily based on the census data collected by the Bureau of Census. In this paper, we use the 2002 benchmark accounts to define the upstream and downstream industries that experienced horizontal mergers between 1997 and 2006. The Make table is a matrix showing that the commodities (columns) that are produced by each industry (rows) at producers' prices, and the Use table shows the inputs to industry (columns) production and the commodities (rows) that are consumed by industries, consumers and government. The detailed procedure is referred to the appendix of Allayannis and Ihrig (2001). Based on the input-output matrix, we follow the approach by McGuckin et al. (1991) and define a forward (backward) vertical merger that satisfies the input percentage to the target (acquirer) from the acquirer's (target's) industry is more than 5 percent of the total input of the target (acquirer) industry. [6]

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[5]In contrast, most papers in finance (e.g., Shahrur 2005), where the objective is mainly to understand the reaction of the stock market, assume the merger date to be the date when it was announced.

[6]McGuckin et al. (1991) shows that the categorization between a vertical and conglomerate merger are sensitive to this cutoff. And on average, a four-digit SIC code had ten material inputs involving more than 1 percent of total input costs. We use 5 percent cutoff in this paper to filter out the cases where two merged firms are not closely related from a supply chain perspective. D'Aveni and Ravenscraft (1994) define a line of business as vertically integrated when some combination of its forward or backward transfers exceeds 10 percent of its sales or cost of sales.

For the financial data, we use quarterly financial data for all publicly held U.S. companies with primary SIC codes in the three ranges indicated before (i.e., manufacturing, wholesale and retail sectors) for the 13-year period 1996 - 2008. We obtain this data from Standard & Poor's Compustat database accessed through Wharton Research Data Services (WRDS). We collect them for three years longer than the merger period to ensure that we have at least one (and two) more year data available for the pre- (and post-) merger analysis.

Within the 318 SIC codes covered in our sample, there are 10138 companies whose financial data is available from Compustat, and 1175 acquirers which can be identified from the SDC database.[7] The distribution of vertical M&As covered in our sample is provided in Figure 5.1. Due to the way Compustat collects data, some of our sample firms have missing value in their accounting data. Therefore, the actual number of usable observations is less than the sample size. For each of the 10138 companies, we collect the quarterly data on the following financial items which are required to calculate the performance metrics of interest to us: asset (data item: ATQ), cost of goods sold (data item: COGSQ), inventories (data item: INVTQ), operating income before depreciation (data item: OIBDPQ), and net sales (data item: SALEQ).

Table 5.1 provides the basic summary statistics for firms in our sample, based on the last fiscal quarter prior to the effective date of mergers. Several issues need to be discussed in this context. First of all, in contrast to prior research in this area, we include the financial data not only for the merging firms (targets and acquirers) but also for the non-merging ones, because later on we compare the effects of M&As on the performance of the two sets. Second, this table shows that the size of the firms in our sample varies significantly (large standard deviation and range). Moreover, the high kurtosis implies that most of the variance is due to infrequent extreme deviations, and positive skewness means that the mass of the

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[7]We use the identifier GVKEY to keep track of each company in Compustat because other firm identifiers such as the company name, CUSIP, or ticker may change over time.
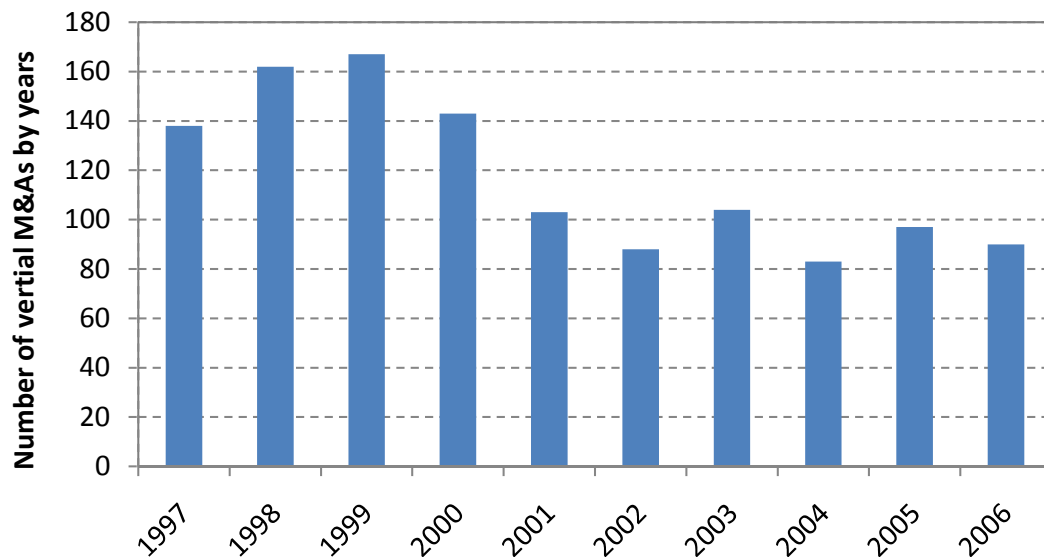
Figure 5.1: Distribution of 1175 vertical M&As by year

distribution is concentrated on the left and there are relatively few high values.

Based on the above facts, we focus our attention on the change in a firm's performance instead of the level of a firm's performance, and we will mainly use Wilcoxon signed-rank test in our analysis[8]. We will also conduct the t-test and the binomial test to provide robustness checks for the results.

In order to test our hypothesis, we use basic quarterly financial data (e.g., total assets, cost of goods sold, operating income, net sales, and inventory total (INVT)) and compute the performance metrics for each firm i in quarter t as shown in Table 4.2. We focus our analysis on the four quarters before the merger (quarters -4 to -1) and four years following the merger (quarters 1 to 4). We exclude quarter 0, the quarter of the merger, from the analysis because in this quarter the two firms are consolidated for financial reporting purposes only from the merger completion date. Consistent with previous studies, we combine the target

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[8]Concerning the choice of an expectation model, Barber and Lyon (1996) find that test statistics using the change in a firm's performance relative to an appropriate benchmark consistently yield more powerful test statistics than do those based on the level of a firm's performance relative to the same benchmark. In the choice of statistical test, they find that nonparametric Wilcoxon test statistics are uniformly more powerful than parametric t-statistics, regardless of the operating performance measure employed.

Table 5.1: Descriptive Statistics for Firms in Our Sample (in million US$)

	Average	Median	St.Dev.	Max	Min	Kurtosis	Skewness
Panel A: Descriptive statistics for 1175 acquiring firms before mergers							
Total Assets	3723.31	334.88	9914.00	111550	1.395	49.96	5.84
Cost of Goods Sold	629.36	53.57	1821.53	22234	0.075	67.42	6.85
Inventory Total	473.63	54.29	1147.91	7791	0.086	17.55	3.95
Operating Income	158.79	6.84	505.21	5212	-255.5	43.45	5.76
Net Sales	997.82	90.67	2421.56	23315	0.038	26.44	4.30
Panel B: Descriptive statistics for 1175 rivals before mergers							
Total Assets	4339.41	913.31	10616.18	120058	0.008	44.27	5.57
Cost of Goods Sold	560.98	124.46	1131.25	10982.7	0.132	26.11	4.30
Inventory Total	435.42	119.64	840.55	6701	0.101	15.73	3.62
Operating Income	216.01	24.18	608.86	4036	-146.2	18.47	4.24
Net Sales	1072.15	211.40	2138.01	13982	0.011	10.95	3.17
Panel C: Descriptive statistics for all 10138 firms in sample							
Total Assets	2584.22	160.04	12105.20	479921	0.001	299.03	14.24
Cost of Goods Sold	422.36	28.11	2372.20	189081	0.001	658.82	20.03
Inventory Total	229.48	22.33	1015.30	40416	0.001	321.10	14.41
Operating Income	95.64	3.57	533.70	25324	-5810.1	383.16	16.02
Net Sales	595.73	45.43	2983.40	195805	0.001	455.62	16.95

and acquiring firms' financial data before the merger to obtain the pro forma pre-merger performance of the combined firms. Then, for each sample firm, comparison of the relative change between the pre-merger and post-merger quarterly average performance provides a measure of the percentage change in absolute performance of the merging firms due to the merger. An exception is the inventory responsiveness (IR) metric, which is by definition involves a rate of change (difference between percentage changes in sales and percentage changes in inventory). For this reason, we compute the merger induced changes in IR by subtracting the *average* quarterly change in sales (pre- and post-merger) from the *average* quarterly change in inventory (pre- and post-merger).

We recognize that some of the changes in performance between pre- and post-merger

could be due to macroeconomic and/or industry-specific factors. Hence, to rule out the potential industry or economy related effects, in line with previous studies (e.g., Healy et al. 1992 and Barber and Lyon 1996), we use the industry-average performance as a benchmark to evaluate the merging firms' *industry-adjusted* post-merger performance.[9]

Similarly to pervious studies, such as Hendricks et al. (2007), we denote P_{it} as the average quarterly performance for firm i in year t. The firm i's industry average quarterly performance in year t is PI_{it}. Then ΔAP_{it}, the industry-adjusted percentage change in performance for merging firms i in year t is

$$\Delta AP_{it} = \frac{P_{it} - P_{i,t-1}}{P_{i,t-1}} - \frac{PI_{it} - PI_{i,t-1}}{PI_{i,t-1}}.$$

To illustrate how to compute the adjusted performance, consider the following example: Suppose during one year prior to the merger quarter, the average quarterly return-to-assets (ROA) ratio for the pro-forma combined firms is 0.048; and during one year subsequent to the merger quarter, the average quarterly ROA for the merged firm increases to 0.052. Therefore, there is 8.3% increase in ROA during the first year following the merger. For the same time period, we calculate the percentage change in ROA for every non-merging firms in the industry and find that the industry average ROA ratio increases by 4%. In this case, the industry-adjusted percentage change in ROA is 4.3% for the merging firm. [10]

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[9]To check the robustness of our results, we also used the industry median performance as a benchmark to adjust the merging firm's performance. In that case, the signs of all the changes in the performance metrics of our interest are the same as the results we report, but the level of significance is weaker. We choose to focus on the industry-average adjusted performance because sometimes the industry-median performance happens to be the same as the sample firm's performance, which reduces the significance of the results.

[10]Note that, similar to Barber and Lyon (1996) and Hendricks and Singhal (2003), throughout this document, we discard extreme values by symmetrically winsorizing the data at the 1% level in each tail while calculating the ratio measures.

5.5   Empirical Results

In this section, we report our empirical results. We start by studying the effects of M&As on the absolute performance of the merging firms. Next, we investigate how those effects compare to the effects on the industry average performance. Subsequently, we directly compare the effects on the merging firms to the effects on the performance of the matching rivals. We end this section by discussing whether (and if so, how) our results change if we take into account long-term effects of mergers (two-year post-merger rather than one).

5.5.1   Effects on the absolute performance

The effects of M&As on the absolute performance of the merging firms is shown under the "+1 Year Absolute" columns in Table 5.2. From the table we observe that the basic financial measures (e.g., Assets, COGS, Income and Sales) increase significantly after mergers.[11] As regards to operating performance, in general, the gross profit margin of the merging firms decreases significantly (by about 1%) with 54% of the firms showing deterioration. The sales efficiency also decreases significantly (by about 4%) for most of the merging firms. In terms of profitability, it seems that vertical mergers result in lower absolute profitability for the merging firms - both return on assets and return on sales measures decrease significantly (by 10% and 4% respectively).

More importantly, there is *no significant positive impact* on the absolute inventory performance due to vertical mergers. For example, mergers result in about 54% of the merging firms turning their inventories slower resulting in a significant 2% increase in the days-of-supply. This lower turn does not manifest itself in higher productivity returns from inventory investments or more responsive inventory management. Due to the significant increase in

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[11]Throughout this section, we focus on the median change in performance (as in Healy et al. (1992)) for analyzing the effects of M&As, although we also report the mean change in performance in the summary tables. The reason for this is the fact that the mean is affected by extreme values.

Merging firms' Performance	Exp. Changes	+1 Year Absolute % Change			+1 Year Ind-Adjusted % Change	
		Obs	median	% neg.	median	% neg.
Panel A: Basic Financial Performance						
Assets		1069	0.20	17.59%	0.11	35.38%
statistic			(22.87)***	(-21.20)***	(11.30)***	(-9.43)***
Cost of Goods Sold		1070	0.17	22.24%	0.10	37.56%
statistic			(19.09)***	(-18.16)***	(9.76)***	(-8.03)***
Operating Income		988	0.11	39.88%	0.05	46.73%
statistic			(4.75)***	(-6.36)***	(0.47)	(-2.03)**
Sales		1070	0.16	20.56%	0.10	37.56%
statistic			(19.34)***	(-19.26)***	(9.05)***	(-8.03)***
Panel B: Operating Performance						
GPM	+	1069	-0.01	53.88%	0.00	50.10%
statistic			(-0.28)***	(2.54)**	(-1.54)	(0.06)
SOA	-	1062	-0.04	61.58%	-0.03	57.12%
statistic			(-7.87)***	(7.55)***	(-5.16)***	(4.57)***
ROA	+	984	-0.10	63.62%	-0.04	52.35%
statistic			(-8.15)***	(8.54)***	(-3.62)***	(1.45)
ROS	+	984	-0.04	56.91%	-0.02	50.99%
statistic			(-5.40)***	(4.34)***	(-2.91)***	(0.61)
Panel C: Inventory Performance						
Inventory	-	1057	0.21	23.08%	0.14	36.73%
statistic			(19.80)***	(-17.50)***	(11.72)***	(-8.51)***
DOS	-	1055	0.02	45.78%	0.03	45.28%
statistic			(5.60)***	(-2.74)***	(3.53)***	(-3.03)***
GMROI	+	1055	-0.04	56.21%	-0.05	53.94%
statistic			(-4.20)***	(4.03)***	(-3.56)***	(2.53)**
Inventory Respon.	-	1055	0.03	44.17%	0.04	44.99%
statistic			(6.13)***	(-3.79)***	(5.41)***	(-3.21)***

This table presents the merging firms' absolute and industry-adjusted performance during the period from one year before mergers to one year after mergers. Panel A reports the percentage changes in basic financial performance, Panel B reports the percentage changes in operating performance, and the percentage changes in inventory performance are reported in Panel C. We use Wilcoxon sign rank test for the median, and the binomial sign test for the percentage of negativity. The statistics are given in the row denoted "statistic" and the superscripts *, **, and *** indicate that the result is significantly different from zero at 0.10, 0.05 and 0.01 level for two-tailed tests, respectively.

inventory (21%) and decrease in GPM, GMROI also reduces significantly. Comparing the growth in merging firms' sales and inventory, the significantly positive IR shows that the

increase in inventory outweighs the increase in sales (by 3%). In summary, during the first year after vertical mergers, the merged firms experienced significant deterioration in their absolute operating and inventory related performance. This finding is consistent with the results of an Accenture survey of business executives involved in their companies' mergers or acquisitions that more than 40% of them observed problems in inventory management. (Byrne 2007).

5.5.2 Effects on the relative performance compared to industry average

The effects on the absolute performance discussed above do not tell the whole story since the macroeconomic factors that might affect the whole industry sector are not taken into account. To deal with this issue, in this section, we investigate the effects on the industry-adjusted performance of merging firms, where we use the effects of M&As on the industry average performance as the benchmark. We refer the readers to §4 for more details about how we calculate the adjusted performance. We proceed with the testing of the seven hypotheses about operating and inventory performances developed in §3 based on adjusted performance. As mentioned before, because of the large disparity among observations, we use the Wilcoxon signed-rank statistics to test our hypotheses and report the t-test statistics and the binomial test statistics to provide robustness checks for the results. Generally speaking, we find that the results of Wilcoxon signed-rank test and binomial test are always in good agreement, while the results of paired t-tests are not always consistent with the other tests because of the presence of extreme values. Before discussing about the effects on operating and inventory performances, we briefly discuss the effects of M&As on the basic financial performance metrics.

Basic financial performance. Under the "+1 Year Industry-adjusted" columns in Table 5.2, Panel A shows the percentage changes in financial data items - assets, COGS,

operating income and sales - for the merging firms. The positive values of Wilcoxon sign rank z-statistic for assets, COGS, and sales indicate that compared to the average level of merging industry, merging firms experience *significantly faster growth in financial performance* after the vertical integration, all significantly different from zero at 1% level. More than 60% of the merged firm experience a significant increase in sales. The only financial performance metric that does not experience a significant change after mergers is the percentage change in operating income before depreciation.

Operating performance. The percentage changes in operating performance metrics are shown in Panel B of Table 5.2. Looking at the percentage changes in industry-adjusted profit margin, the statistics show that the merging firms' adjusted profit margin is not significantly different from the industry benchmark. This result does not support our first hypothesis that vertical mergers generate market power to the merged firms. However, there are strong indications that *the sales efficiency of the merging firms actually decreases.* Specifically, the industry-adjusted median value of percentage change in Sales on Assets (SOA) metric for merging firms reduces by 13% (significantly different from zero at 1% level). The binomial z-statistics also generate similar results with over 73% of merging firms experiencing a decrease of industry-adjusted SOA within four quarters after the transactions. So, there is strong support for our second hypothesis that the sales efficiency for the merging firms is negatively correlated with M&As. This is because the acquiring firms' post-merger growth in sales does not occur as fast as the growth in total assets (including inventories).

Lastly, we come to the most important operating performance measure - profitability. In the literature, profitability is usually measured by return on assets, i.e., ROA and/or by return on sales, i.e., ROS (Griffin and Mahon 1997; Dehning et al. 2007). Although the industry-adjusted performance looks better than the merging firms' absolute performance, unfortunately, the evidence shows that for both measures, vertical M&As deteriorate the profitability of the merging firms. Specifically, we note that there are negative changes in

industry-adjusted ROA and ROS of merging firms (-4% and -2% respectively), which are significant at 1% level. This result is mainly driven by the fact that merged firms failed to achieve a significant improvement in operating income compared to the industry benchmark, although they are still able to increase the absolute operating income.

In summary, our empirical evidence shows that during the first year after vertical mergers, there is no any improvement in merging firms' operating performance, which is characterized by lower sales efficiency and lower profitability.

Inventory performance. The merger effects on industry-adjusted inventory performance is illustrated under the "+1 Year Industry-Adjusted" columns in Panel C of Table 5.2. In this context, first note that there is a significant increase in the growth of inventory held by merging firms, comparing to the industry benchmark. The median of post-merger inventory for merging firms increased 14% more than the change in the industry average level and around 37% of the merging firms' inventory growth is faster than the industry average level. This suggests that *the merging firms' inventory growth is significantly faster than their industry average level*; however, total inventory is an aggregate measure, which does not take into account the size of the firm. A better measure of inventory efficiency is days-of-supply (= average inventory / COGS) with a lower value of days-of-supply representing more efficient firms and vice versa. *From inventory efficiency perspective, merging firms are also worse than the industry average.* Due to the significant increase in industry level, merging firms' days-of-supply also become longer after mergers. 55% of the merging firms' post-merger days-of-supply performance is worse than the industry benchmark, and the median increase of industry-adjusted days-of-supply is 3%.

While the above evidence suggests that vertical mergers do not improve inventory efficiency (compared to the industry average), we also need to understand how they affect two other relevant inventory management measures: inventory responsiveness (IR) and gross margin return on inventory (GMROI). In terms of inventory responsiveness, we find that

there is significantly positive impact on the inventory elasticity metric due to M&As, which means the industry adjusted inventory growth is faster than the industry adjusted sales growth. This fact partly explains the reduction in merging firms' sales efficiency. Moreover, we find that inventory investments are not be providing much returns to the merging firms, compared to the industry average. Rather, the median change in GMROI decreases by 5% for merging firms, with around 54% of them experiencing a significant decline. The underlying reason for this results is that the industry adjusted inventory increases faster than profit margin.

In summary, inventory-related operations for merging firms deteriorate after vertical mergers since their inventory efficiency and inventory productivity reduce. In other words, after vertical mergers, merging firms hold inventory for a longer period, and for each dollar spent on inventory, fewer profit dollars is generated in the first year after mergers than in the year prior to the merger quarter. All of these evidence suggests that vertical mergers do not benefit firms in inventory management at least in a short term.

5.5.3   Long-term effects of mergers

There are two main reasons to extend our analysis beyond the first year post merger: i) to assess the robustness of the short-term effects of mergers; and ii) to measure the potential bias due to the accounting treatment. In mergers where the purchase accounting method is used to account for the business combination, all the assets of the target firm have to be marked to market before being combined with the acquirer's book assets, and the difference between the purchase price and the revised book value of target firm's equity is recorded as goodwill in the acquirer's book. This accounting treatment might result in increases in the values of target total assets. Thus, results for this year are therefore not comparable across firms or for industry comparisons Healy et al. (1992). To mitigate the effects of such accounting adjustment, it is worthwhile to investigate how our results of the previous section

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are affected if we consider the long term effects of M&As. Specifically, rather than one year post-merger, in this section we calculate the percentage changes in performance metrics from one year to five years after the transaction. These results are exhibited in Figure 5.2 for the merging firms for two levels of analysis - unadjusted and industry-average-adjusted.

Based on comparison of the results in this table to those in Figure 5.2, we can see that, broadly speaking, most of previous performance metrics improves over time, in both absolute and relative measures. In terms of operating performance, merging firms' profit margins gradually improve and catch up with the industry average level. The adjusted changes in sales efficiency and profitability also became insignificant since the second year after mergers. As for the absolute performance, we observe an evident increase in merging firms' sale efficiency since the third year after mergers.

Regarding the inventory related performance measures, the first thing we noticed is that merging firms' inventory growth is significantly slower than the industry average benchmark since the second year after mergers, which implies a potential improvement in the inventory management of vertically integrated firms. The evidence from other performance measure verified such an improvement. The adjusted days-of-supply (DOS) is reduced from the second year and maintains the same level as the industry average level. The adjusted inventory responsiveness (IR) and inventory productivity (GMROI) are also insignificantly different from the industry level since the second year after mergers. The absolute measures even showed some improvement in these measures.

Overall, looking at the long-term changes in merged firms' performance, we find that although mergers deteriorate firms' operating and inventory related performance immediately after the vertical integration, the negative effects diminish over time. Generally speaking, it takes about at least two years for the merged firms to recover from the merger and match the industry average performance. Interestingly, even after five years following vertical mergers, there is still no significant evidence showing that vertical mergers create a competitive

Figure 5.2: Long-term effects of vertical mergers
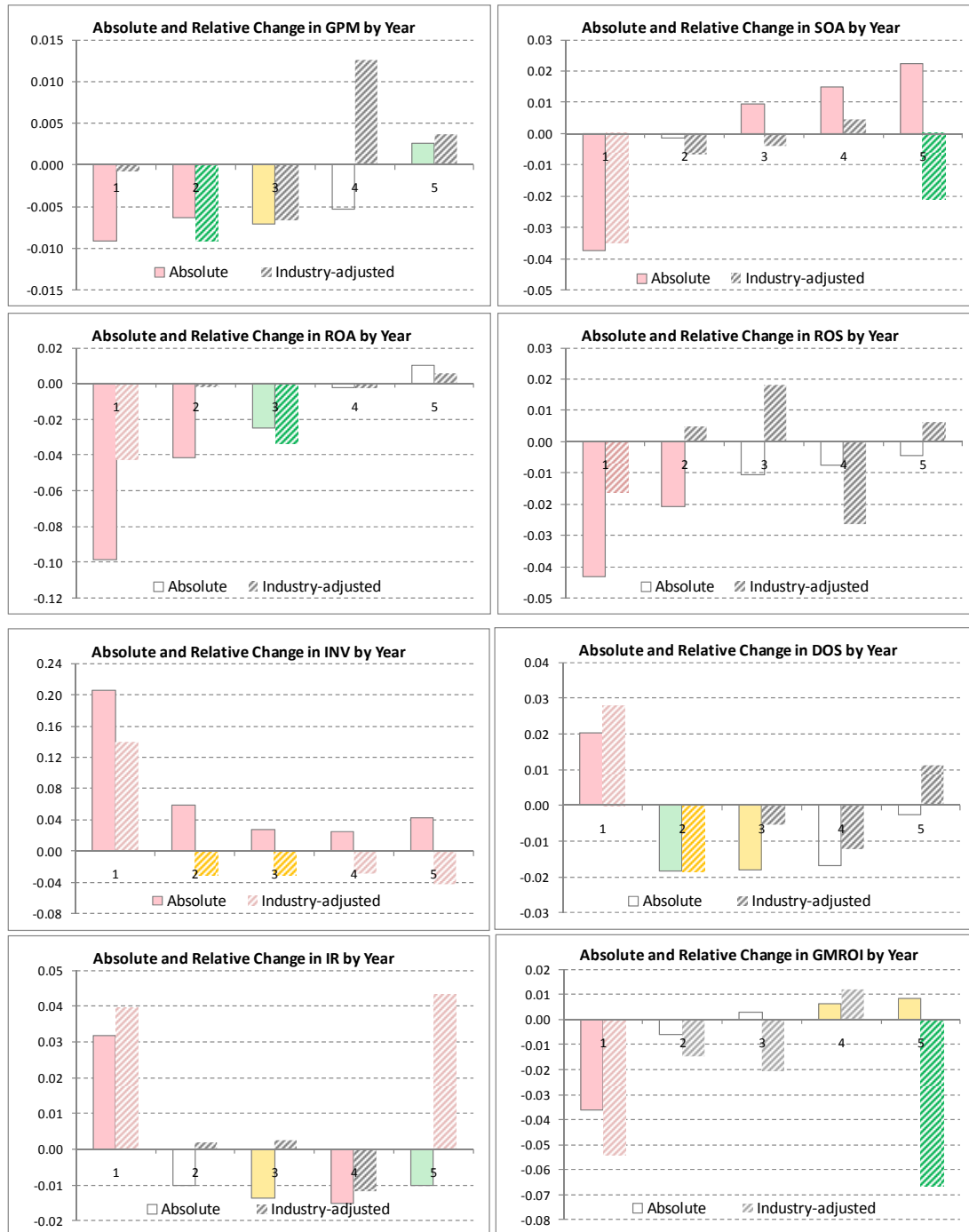
This figure presents the merging firms' absolute and industry-adjusted performance during the period from one year to five years after mergers. Solid bars represent the absolute performance, while striped ones represent the industry-adjusted performance. The pink, yellow, and green color indicate that the result is significantly different from zero at 0.01, 0.05 and 0.10 level for two-tailed tests, respectively.

advantage over industry average benchmarks.

5.6   Summary and managerial implications

In this paper, we conduct a cross-industry empirical study of vertical mergers and acquisitions that took place between 1997 and 2006 in manufacturing, wholesale and retail sectors. Our primary focus is on inventory-related supply chain metrics, while we also report to the effects on operating performance and financial performance. The comparison between merging firms' absolute performance and industry average benchmark provides a detailed evidence on the impact of vertical M&As. To investigate the consistency of the effects over time, we extend our analysis up to five years following the transactions.

In general, we find that immediately following the vertical mergers, merging firms' operating and inventory performance deteriorate significantly. Merging firms suffer from a significant reduction in their gross profit margin and sales efficiency. The profitability is also lower than the pre-merger level. Regarding the performance in inventory related measures, the significant buildup in merging firms' inventory levels increases their days-of-supply while reduces the inventory productivity. The growth in inventory is much faster than the growth in sales. All these evidences suggest that merged firms experience significantly negative effect subsequent to the vertical M&As.

Looking at the long term performance of merging firms, we find that over the five years following the vertical transaction, merging firms continued to recover from the negative consequences of mergers. Generally speaking, it takes at least two years for merged firm to catch up with the industry average performance. However, there is no significant evidence showing that merged firms exhibit superior performance over the industry benchmark, even after considerable time, which suggests that vertical mergers do not provide significant competitive advantages to the merging firms.

Chapter 6

Conclusions

This thesis draws elements from operations management and other related streams (e.g., marketing, finance and economics) to study the impact of mergers and acquisition on inventory-related supply chain performance. Specifically, the primary objective is to answer the following questions in the context of M&As, using both analytical and empirical techniques:

- What are the differences in effects between an upstream and a downstream horizontal merger?

- What are the effects of merger-induced synergies on inventory-related supply chain performance?

- How is the aggregate inventory performance of merging firms affected by horizontal M&As?

- How do horizontal M&As affect related operating performance of merging firms?

- What are the inventory and operating performance metrics that have the most significant impact on the "success" of a merger?

- How is the merging firms' performance affected by vertical M&As?

- What are the long-term effects of vertical M&As?

In the first essay, we develop several models to compare the effects of an upstream and a downstream horizontal merger on supply chain performance, and explore the theoretical underpinnings of merger-induced operational synergies. Table 6.1 provides a comparison of firms' expected profit under different scenarios, in which ↑ and ⇑ stand for an increase and a bigger increase in the expected profit, and ↓ stands for a decrease in the expected profit. For those horizontal mergers without any operational synergies, we find that under both Bertrand and Cournot competitions, mergers always benefit all firms in the merging industry. Which firm benefits more depends on the position of merging industries in the supply chain. If the horizontal merger takes place in a downstream industry, then the merging firms experience a higher improvement in profit than their non-merging rivals. On the other hand, if the merger occurs in an upstream industry, the non-merging firms get a free ride and gain more profit than the merging ones.

Types of synergy	Level of merger	Merging firms	Non-merging rivals
No Synergies	Upstream	↑	⇑
	Downstream	⇑	↑
Economies of Scale	Upstream	↑	↓
	Downstream	↑	↓
Economies of Scope	Upstream	⇑	↓
	Downstream	↑	⇑

Table 6.1: Comparison of Expected Profits under Different Models

Then we present two frameworks to analyze the effects of operational synergies. In the first framework, we assume that merging firms achieve cost efficiency through economies of scale. In the presence of economies of scale, mergers create the advantage of cost efficiency for the merging firms. At both upstream and downstream industries, we find that merging firms

succeed in improving their expected sales and profit through mergers, while non-merging rivals suffer from loss in both sales and profits due to the cost disadvantages. In the second framework, we model economies of scope, which arise from the ability to eliminate costs by operating two businesses under the same corporate umbrella, in an economic order quantity model. Under this setting, the merger-induced synergy also improves merging firms' profit at both levels; however, the effects on non-merging rivals are quite different. If a merger occurs in an upstream industry, the non-merging firm suffer from a loss in profit; while if a merger occurs in a downstream industry, the non-merging retailers are also able to improve their profits. Moreover, from a consumer's perspective, an upstream merger is worse than a downstream merger.

To investigate how exactly mergers and acquisition affect the merging firms and their non-merging rivals' growth, in the second essay, we conduct an empirical study on horizontal mergers and acquisitions from 1997 to 2006. Our primary focus is on inventory-related supply chain metrics like days-of-supply, inventory productivity and inventory responsiveness. By using data from various databases, we study how the (one year) post-merger inventory performance compares to that of the (one-year) pre-merger level. We also investigate how mergers impact other operating performance measures such as gross profit margin, sales efficiency and profitability. We conduct our investigation at three different levels of analysis: merging firms' absolute performance, their performance compared to industry average benchmark, and their performance compared to matching rivals.

For inventory related metrics as well as operating performance we find in general that mergers deteriorate absolute performance, might improve or deteriorate performance compared to the industry average, but do not provide much advantage over similar non-merging competitors. Moreover, mergers increase gross margins but reduce sales efficiency. These insights remain valid even if we consider longer term effect of mergers (two-year post-merger). We also perform a multivariate regression analysis which demonstrates that inventory re-

lated metrics like days-of-supply, as well as profit margins and sales efficiency are major determinants in the success of mergers.

As stated in the Chapter 1, there are three types of merger activities: horizontal mergers, vertical mergers, and conglomerate mergers. To further investigate the effects of different types of mergers, we have also conducted an empirical study regarding the second type - vertical mergers. Through an event study, we show that vertical mergers have significant negative impact on merging firms' short-term performance. During the first year after transactions, the merged firms suffered from significant reduction in gross profit margin, sales efficiency, profitability, and inventory productivity. Their days-of-supply also significantly increases compared to the industry average level. Since the second year after vertical mergers, merged firms generally recovered from the negative impact of vertical mergers and caught up with the industry average. However even after five years subsequent to vertical mergers and acquisitions, merged firms do not exhibit significant competitive advantage over their industry average performance.

6.1   Future Research

This thesis represents a first attempt in understanding inventory implications of M&As. We believe that the area bears significant potential for further relevant research. Some immediate extensions of our empirical work would be to consider different operational metrics (e.g., cash-to-cash cycle, sales surprise, inventory backlog). Another direction would be to draw parallels and contrasts among different types of mergers, their impact on inventory and operating performance, and relative success.

We believe that the evidence documented in this paper regarding the impact of M&As on aggregate inventory performance provides a compelling motivational ground for a more detailed analysis at the firm or industry level. Such an analysis could shed light on what type

of pre- and post-merger inventory policy or strategy would influence the success of an M&A, and vice versa. For example, are there restructuring efforts after the merger to consolidate inventory? Is centralized purchasing able to take advantage of economies of scale? If so, is there sufficient evidence to conclude that such policies contribute to the success of mergers? Obviously, this type of detailed empirical analysis would necessitate collecting inventory information at a more granular level; i.e., knowledge about the exact policies being used by merging firms, focusing on a small subset of firms, which can be an interesting direction for future research.

Bibliography

Achabal, Dale D., Shelby H. McIntyre, Stephen A. Smith, Kirthi Kalyanam. 2001. A decision support system for vendor managed inventory. *Journal of Retailing* **76**(4) 430–454.

Allayannis, G., J. Ihrig. 2001. Exposure and markups. *Review of Financial Studies* **14** 805–835.

Alptekinoglu, Aydin, Christopher S. Tang. 2005. A model for analyzing multi-channel distribution systems. *European Journal of Operational Research* **163**(3) 802–824.

Amir, R., E. Diamantoudi, L. Xue. 2009. Merger performance under uncertain efficiency gains. *International Journal of Industrial Organization* **27**(2) 264–273.

Andrade, Gregor, Mark Mitchell, Erik Stafford. 2001. New evidence and perspectives on mergers. *Journal of Economic Perspectives* **15**(2) 103–120.

Azzam, A., E. Pagoulatos. 1999. *Vertical Relationships: Economic Theory and Empirical Evidence*. Heidelberg: Physica-Verlag, 7–20.

Barber, Brad M., John D. Lyon. 1996. Detecting abnormal operating performance: The empirical power and specification of test statistics. *Journal of Financial Economics* **41** 359–399.

Barney, J.B., W.S. Hesterly. 2008. *Strategic management and competitive advantage: concepts*. Pearson Prentice Hall.

Bhattacharyya, S., A. Nain. 2010. Horizontal acquisitions and buying power: A product market analysis. *Journal of Financial Economics* **99**(1) 97–115.

Bhuyan, Sanjib. 2002. Impact of vertical mergers on industry profitability: An empirical evaluation. *Review of Industrial Organization* **20**(1) 61–79.

Buzzell, R. D. 1983. Is vertical integration profitable? *Harvard Business Review* **62** 92.

Byrne, Pat. 2007. Supply chain management: The secret key to post-merger integration? Accenture Blog.

Cachon, Gérard P. 2003. *Supply chain coordination with contracts*. North-Holland.

Cachon, Gérard P., Serguei Netessine. 2004. Game theory in supply chain analysis. D. Simchi-Levi, S. D. Wu, M. Shen, eds., *Supply Chain Analysis in the eBusiness Era*. Kluwer Academic Publishers, Boston, MA.

Cachon, Gérard P., Christian Terwiesch. 2005. *Matching Supply with Demand: An Introduction to Operations Management*. McGraw-Hill/Irwin, New York.

Carr, Amelia S., Hale Kaynak. 2007. Communication methods, information sharing, supplier development and performance: An empirical study of their relationships. *International Journal of Operations & Production Management* **27**(4) 346–370.

Carr, Scott M., Uday S. Karmarkar. 2005. Competition in multiechoelon assembly supply chains. *Management Science* **51**(1) 45–49.

Chen, Frank, Zvi Drezner, Jennifer K. Ryan, David Simchi-Levi. 2000. Quantifying the bullwhip effect in a simple supply chain: The impact of forecasting, lead times, and information. *RAND Journal of Economics* **46**(3) 436–443.

Chen, Hong, Murray Z. Frank, Owen Q. Wu. 2007. U.s. retail and wholesale inventory performance from 1981 to 2004. *Manufacturing Service Oper. Management* **9**(4) 430–456.

Chen, Yongmin. 2001. On vertical mergers and their competitive effects. *RAND Journal of Economics* **32**(4) 667–685.

Cheung, Francis K. 1992. Two remarks on the equilibrium analysis of horizontal merger. *Economics Letters* **40** 119–123.

Chew, W.B., D. Leonard-Barton, R.E. Bohn. 1991. Beating murphy's law. *Sloan Management Review* **32**(3) 5–16.

Chopra, Sunil, Peter Meindl. 2010. *Supply Chain Management: Strategy, Planning and Operations*. 4th ed. Prentice Hall.

Chwe, M. S.-Y. 1994. Farsighted coalitional stability. *Journal of Economic Theory* **63** 299–325.

Corbett, Charles J., Uday S. Karmarkar. 2001. Competition and structure in serial supply chains with deterministic demand. *Management Science* **47**(7) 966–978.

Daughety, Andrew F. 1990. Beneficial concentration. *American Economic Association* **80**(5) 1231–1237.

D'Aveni, Richard A., David J. Ravenscraft. 1994. Economies of integration versus bureaucracy costs: Does vertical integration improve performance? *Academy of Management Journal* **37**(5) 1167–1206.

Dehning, Bruce, Vernon J. Richardson, Robert W. Zmud. 2007. The financial performance effects of it-based supply chain management systems in manufacturing firms. *Journal of Operations Management* **25** 806–824.

Deneckere, Raymond, Carl Davidson. 1985. Incentives to form coalitions with bertrand competition. *Rand Journal of Economics* **16**(4) 473–486.

DeYoung, Robert, Douglas D. Evanoff, Philip Molyneux. 2009. Mergers and acquisitions of financial institutions: A review of the post-2000 literature. *Journal of Financial Services Research* **36** 87–110.

Eckbo, B. Espen. 1983. Horizontal mergers, collusion, and stockholder wealth. *Journal of Financial Economics* **11** 241–273.

Eppen, Gary D. 1979. Effects of centralization on expected costs in a multi-location newsboy problem. *Management Sci.* **25**(5) 498–501.

Eroglu, Cuneyt, Christian Hofer. 2011. Lean, leaner, too lean? the inventory-performance link revisited. *Journal of Operations Management* **29**(4) 356–369.

Farrell, Joseph, Carl Shapiro. 1990. Horizontal mergers: An equilibrium analysis. *The American Economic Review* **80**(1) 107–126.

Faulí-Oller, Ramon. 1997. On merger profitability in a cournot setting. *Economics Letters* **54** 75–79.

Faulí-Oller, Ramon, Lluis Bru. 2008. Horizontal mergers for buyer power. *Economics Bulletin* **12**(3) 1–7.

Fee, C. Edward, Shawn Thomas. 2004. Sources of gains in horizontal mergers: evidence from customer, supplier, and rival firms. *Journal of Financial Economics* **74** 423–460.

Finbarr Flynn. 2010. Greencore will merge with northern foods to cut costs in convenience foods.

Froeb, Luke M., Steven Tschantz. 2006. Vertical restraints and the effects of upstream horizontal mergers. Vanderbilt Law and Economics Research Paper No. 06-13.

Froeb, Luke M., Steven Tschantz, Gregory J. Werden. 2005. Pass-through rates and the price effecets of mergers. *International Journal of Industrial Organization* **23** 703–715.

Froeb, Luke M., Gregory J. Werden. 1998. A robust test for consumer welfare enhancing mergers among sellers of a homogeneous product. *Economics Letters* **58** 367–369.

Fumagalli, Chiara, Massimo Motta. 2001. Upstream merger, downstream mergers, and secret vertical contracts. *Research in Economics* **55** 275–289.

Gal-Or, Esther. 1988. The informational advantages or disadvantages of horizontal mergers. *International Economic Review* **29**(4) 639–661.

Gale Encyclopedia of E-Commerce. 2002. Mergers and acquisitions - joining forces to compete with industry giants, seeking refuge with a larger partner.

Gaudet, Gearard, Ngo Van Long. 1996. Vertical integration, foreclosure, and profits in the presence of double marginalization. *Journal of Economics & Management Strategy* **5**(3) 409–432.

Gaughan, Patrick A. 2007. *Mergers, Acuisitions, and Corporate Restructurings*. John Wiley & Sons, Inc.

Gaur, Vishal, Marshall Fisher, Ananth Raman. 2005. An econometric analysis of inventory turnover performance in retail services. *Management Science* **51**(2) 181–194.

Gaur, Vishal, Saravanan Kesavan. 2009. The effects of firm size and sales growth rate on inventory turnover performance in the us retail sector. *Retail Supply Chain Management* 1–28.

Ghosh, Aloke. 2001. Does operating performance really improve following corporate acquisitions? *Journal of Corporate Finance* **7** 151–178.

Granot, Daniel, Greys Sošić. 2005. Formation of alliances in internet-based supply exchanges. *Management Sci.* **54**(4) 92–105.

Granot, Daniel, Shuya Yin. 2008. Competition and cooperation in decentralized push and pull assembly systems. *Management Sci.* **54**(4) 733–747.

Griffin, J.J., J.F. Mahon. 1997. The corporate social performance and corporate financial performance debate. *Business & Society* **36**(1) 5.

Gugler, Klaus, Dennis C. Mueller, B. Burcin Yurtoglu, Christine Zulehner. 2003. The effects of mergers: an international comparison. *International Journal of Industrial Organization* **21**(5) 625–653.

Gupta, Diwakar, Yigal Gerchak. 2002. Quantifying operational synergies in a merger/acquisition. *Management Sci.* **48**(4) 517–533.

Hart, Oliver, Jean Tirole, Dennis W. Carlton, Oliver E. Williamson. 1990. Vertical integration and market foreclosure. *Brookings Papers on Economic Activity. Microeconomics* **1990** 205–286.

Healy, Paul M., Krishna G. Palepu, Richard S. Ruback. 1992. Does corporate performance improve after mergers. *Journal of Financial Economics* **31** 135–175.

Hendricks, Kevin B., Vinod R. Singhal. 2003. The effect of supply chain glitches on shareholder wealth. *Journal of Operations Management* **21**(5) 501–522.

Hendricks, Kevin B., Vinod R. Singhal. 2005. Association between supply chain glitches and operating performance. *Management Sci.* **51**(5) 695–711.

Hendricks, Kevin B., Vinod R. Singhal, Jeff K. Stratman. 2007. The impact of enterprise systems on corporate performance: A study of ERP, SCM, and CRM system implementations. *Journal of Operations Management* **25**(1) 65–82.

Hennessy, David A. 2000. Cournot oligopoly conditions under which any horizontal merger is profitable. *Review of Industrial Organization* **17** 277–284.

Herd, Tom, Terry W. Steger, Arun K. Saksena. 2008. Improving the odds of M&A success. *Harvard Business Review Newsletter* **13**(9).

Heron, Randall, Erik Lie. 2002. Operating performance and the method of payment in takeovers. *Journal of Financial and Quantitative Analysis* **37**(1) 137–155.

Horn, Henrick, Asher Wolinsky. 1988. Bilateral monopolies and incentives for merger. *RAND Jounral of Economics* **19**(3) 408–419.

Huck, Steffen, Kai A. Konrad, Wieland Müller. 2001. Big fish eat small fish: on merger in stackelberg markets. *Economic Letters* **73** 213–217.

Inderst, Roman, Greg Shaffer. 2007. Retail mergers, buyer power and product variety. *The Economic Journal* **117**(516) 45–67.

Kim, E. Han, Vijay Singal. 1993. Mergers and market power: Evidence from the airline industry. *The American Economic Review* **83**(3) 549–569.

Krattenmaker, Thomas G., Steven C. Salop. 1986. Anticompetitive exclusion: Raising rivals' costs to achieve power over price. *Yale Law Journal* **96**(2) 209–293.

Langabeer, Jim. 2003. An investigation of post-merger supply chain performance. *Journal of Academy of Business and Economics* **2** 14–25.

Langabeer, Jim, D. Seifert. 2003. Supply chain integration: the key to merger success (synergy). *Supply Chain Management Review* **7** 58–64.

Lee, Hau L., Kut C. So, Christopher S. Tang. 2000. The value of information sharing in a two-level supply chain. *Management Science* **46**(5) 626–643.

Lee, Hau L., Seungjin Whang. 2000. Information sharing in a supply chain. *International Journal of Manufacturing Technology and Management* **1**(1) 79–93.

Lin, Fu-ren, Sheng-hsiu Huang, Sheng-cheng Lin. 2002. Effects of information sharing on supply chain performance in electronic commerce. *IEEE Transaction on Engineering Management* **49**(3) 258–267.

Lommerud, K.E., O.R. Straume, L. Sørgard. 2005. Downstream merger with upstream market power. *European Economic Review* **49**(3) 717–743.

Marks, M.L., P.H. Mirvis. 2001. Making mergers and acquisitions work: strategic and psychological preparation. *Academy of Management Executive* **15** 80–92.

McAfee, R. Preston, Michael A. Williams. 1992. Horizontal mergers and antitrust policy. *Journal of Industrial Economics* **40**(2) 181–187.

McBride, M. E. 1983. Spatial competition and vertical integration: Cement and concrete revisited. *American Economic Review* **73** 1011–1022.

McElroy, F. W. 1993. The effects of mergers in markets for differentiated products. *Review of Industrial Organization* **8** 69–81.

McGuckin, Robert H., Sang V. Nguyen, Stephen H. Andrews. 1991. The relationships among acquiring and acquired firms' product lines. *Journal of Law and Economics* **34**(2) 477–502.

M'Chirgui, Zouhaïer, Walid Hichri. 2006. Horizontal merger in bilaterally duopolistic industries with differentiated products. *Applied Economics Letters* **13** 93–95.

Milliou, Chrysovalantou, Emmanuel Petrakis. 2007. Upstream horizontal mergers, vertical contracts, and bargaining. *International Journal of Industrial Organization* **25** 963–987.

Nagarajan, Mahesh, Yehuda Bassok. 2004. A bargaining framework in supply chains (the assembly problem). Working Paper, University of Southern California, LA, CA.

Nagarajan, Mahesh, Greys Sošić. 2007. Stable farsighted coalitions in competitive markets. *Management Sci.* **53**(1) 29–45.

Nagurney, Anna. 2009. Formulation and analysis of horizontal mergers among oligopolistic firms with insights into the merger paradox: a supply chain network perspective. *Computational Management Science* **7**(4) 377–406.

Ordover, Janusz A., Garth Saloner, Steven C. Salop. 1990. Equilibrium vertical foreclosure. *The American Economic Review* **80**(1) 127–142.

Ozer, O., W. Wei. 2006. Strategic commitments for an optimal capacity decision under asymmetric forecast information. *Management Science* **52**(8) 1238.

Panzar, John C., Robert D. Willig. 1981. Economies of scope. *The American Economic Review* **71**(2) 268–272.

Perry, Martin K. 1989. *Handbook of Industrial Organization*, chap. Vertical Integration: Determinants and Effects. Amsterdam: North-Holland.

Perry, Martin K., Robert H. Porter. 1985. Oligopoly and the incentive for horizontal merger. *The American Economic Review* **75**(1) 219–227.

Porter, M. 1985. Competitive advantage. New York: Free Press.

Rabinovich, Elliot, Martin E. Dresner, Philip T. Evers. 2003. Assessing the effects of operational processes and information systems on inventory performance. *Journal of Operations Management* **21**(1) 63–80.

Ravenscraft, David J., F. M. Scherer. 1989. The profitability of mergers. *International Journal of Industrial Organization* **7**(1) 101–116.

Riordan, Michael H. 2008. *Competitive Effects of Vertical Integration*. 145–82.

Riordan, Michael H., Steven C. Salop. 1995. Evaluating vertical mergers: A post-chicago approach. *Antitrust Law Journal* **63** 513–568.

Rumyantsev, Sergey, Serguei Netessine. 2007. What can be learned from classical inventory models? a cross-industry exploratory investigation. *Manufacturing Service Oper. Management* **9**(4) 409–429.

Salant, Stephen W., Sheldon Switzer, Robert J. Reynolds. 1983. Losses from horizontal merger: The effects of an exogenous change in industry structure on cournot-nash equilibrium. *Quarterly Journal of Economics* **98**(2) 185–199.

Salinger, Michael A. 1988. Vertical mergers and market foreclosure. *Quarterly Journal of Economics* **103**(2) 345–56.

Saraan, John, Jagjit Singh Srai. 2008. Understanding supply chain operational drivers in mergers and acquisitions. *13th Cambridge International Manufacturing Symposium*.

Shahrur, Husayn. 2005. Industry structure of horizontal takeovers: Analysis of wealth effects on rivals, suppliers, and corporate customers. *Journal of Financial Economics* **76** 61–98.

Singh, Nirvikar, Xavier Vives. 1984. Price and quantity competition in a differentiated duopoly. *Rand Journal of Economics* **15**(4) 546–554.

Sošić, Greys. 2006. Transshipment of inventories among retailers: Myopic cs. farsighted stability. *Management Sci.* **52**(10) 1493–1508.

Soylu, Ahu, Cihan Oruc, Metin Turkay, Kaoru Fujita, Tatsuyuki Asakura. 2006. Synergy analysis of collaborative supply chain management in energy systems using multi-period MILP. *European Journal of Operational Research* **174**(1) 387–403.

Spengler, Joseph J. 1950. Vertical integration and antitrust policy. *Journal of Political Economy* **58**(4) 347–352.

Stennek, Johan. 2003. Horizontal mergers without synergies may increase consumer welfare. *Topics in Economic Analysis & Policy* **3**(1) Article 2.

Stevenson, William J., Mehran Hojati. 2004. *Operations Management*. McGraw–Hill Ryrson.

Stillman, Robert. 1983. Examining antitrust policy towards horizontal mergers. *Journal of Financial Economics* **11** 225–240.

Tagaras, George, Morris A. Cohen. 1992. Pooling in two-location inventory systems with non-negligible replenishment lead times. *Management Sci.* **38**(8) 1067–1083.

Tan, Keah Choon. 2001. A framework of supply chain management literature. *European Journal of Purchasing & Supply Management* **7**(1) 39–48.

The Economist. 1999. After the deal.

Tsay, A.A., S. Nahmias, N. Agrawal. 1999. Modeling supply chain contracts: A review. *International Series in Operations Research and Management Science* 299–336.

Vafeas, N. 1999. Board meeting frequency and firm performance. *Journal of Financial Economics* **53**(1) 113–142.

Vives, Xavier. 1984. Duopoly information equilibrium: Cournot and bertrand. *Journal of Economic Theory* **34** 71–94.

Vives, Xavier. 1985. On the efficiency of bertrand and cournot equilibria with product differentation. *Journal of Economic Theory* **36** 166–175.

Werden, Gregory J. 1996. A robust test for consumer welfare enhancing mergers among sellers of differentiated products. *The Journal of Industrial Economics* **44**(4) 409–413.

Werden, Gregory J., Luke M. Froeb. 1994. The effects of mergers in differentiated products industries: Logit demand and merger policy. *Journal of Law, Economics and Organization* **10**(2) 407–426.

Weston, J. Fred, Samuel C. Weaver. 2004. *Mergers and Acquisitions*. McGraw-Hill.

Williamson, Oliver E. 1971. The vertical integration of production: Market failure considerations. *The American Economic Review* **61**(2) 112–123.

Yao, Yuliang, Philip T. Evers, Martin E. Dresner. 2007. Supply chain integration in vendor-managed inventory. *Decision Support Systems* **43**(2) 663–674.

Yu, Zhenxin, Hong Yan, T.C. Edwin Cheng. 2000. Benefits of information sharing with supply chain partnerships. *Industrial Management & Data Systems* **101**(3) 114 – 121.

Appendix A

Appendix for Chapter 3

Proof of Proposition 1. Given the n retailers' problems (3.2), we first solve the first order conditions(FOC) $\frac{\partial \pi_{Ri}(\boldsymbol{p})}{\partial p_i} = 0$, for $i = 1, ..., n$, and find $p_i(\boldsymbol{w}) = \frac{2(n-1)+e+(2(n-1)-(n-2)e)w_i+e\sum_{j\neq i} w_j}{4(n-1)-2(n-2)e-e^2}$.

Then substitute $p_i(\boldsymbol{w})$ into $d_i(\boldsymbol{w})$, and write suppliers profit as a function of $\boldsymbol{w}$,

$$\pi_{Si}(\boldsymbol{w}) = (w_i - c)\frac{2(n-1) + e - (2(n-1) - (n-2)e - e^2)w_i + e\sum_{j\neq i} w_j}{n(4(n-1) - 2(n-2)e - e^2)}.$$

Solving the FOC for the suppliers' problem gives the optimal wholesale price w_i^*. Substituting the optimal wholesale price into the retail price and demand functions respectively, we can derive the optimal retail price and demand for each product. Then the expected profit for each supplier and retailer is easy to obtain. □

Proof of Proposition 2. Follow from similar argument as in Proposition 1.

Proof of Proposition 3. Follow from similar argument as in Proposition 1.

Proof of Proposition 4. To be able to compare the optimal strategies and profits in different scenarios, we first need the detailed expressions of these parameters. Since the general results under pre-merger, monopoly supplier and monopoly retailers cases have been shown in Proposition 1-3, we only present here the results under other two cases: merger between two suppliers (with superscript $s12$) and merger between two retailers (with super-

script $r12$). Recall that the feasible range for e is between zero and 1, and from the inverse demand function (3.1), the production cost c must strictly less than $1/(1-e)$. Then we can conclude that for any feasible pair of e and c, the relationships in Proposition 4 hold. $\square$

Optimal parameters under an upstream merger between two suppliers:

$$w_{in}^{s12} = \frac{32 + 4e - 9e^3 - 2e^3 + (32 - 20e - 13e^2 + 5e^3 + 2e^4)c}{2(32 - 24e - 13e^2 + 6e^3 + 2e^4)}, \tag{A.1}$$

$$w_{out}^{s12} = \frac{16 - 5e^2 - e^3 + (16 - 8e - 8e^2 + 2e^3 + e^4)c}{32 - 24e - 13e^2 + 6e^3 + 2e^4}, \tag{A.2}$$

$$p_{in}^{s12} = \frac{48 - 22e - 18e^2 + 5e^3 + 2e^4 + (16 - 10e - 6e^2 + 2e^3 + e^4)c}{(2 - e)(32 - 24e - 13e^2 + 6e^3 + 2e^4)}, \tag{A.3}$$

$$p_{out}^{s12} = \frac{48 - 24e - 17e^2 + 5e^3 + 2e^4 + (16 - 8e - 9e^2 + 3e^3 + e^4)c}{(2 - e)(32 - 24e - 13e^2 + 6e^3 + 2e^4)}, \tag{A.4}$$

$$d_{in}^{s12} = \frac{32 - 20e - 14e^2 + 5e^3 + 2e^4 - (32 - 52e + 6e^2 + 19e^3 - 3e^4 - 2e^5)c}{6(2 - e)(32 - 24e - 13e^2 + 6e^3 + 2e^4)}, \tag{A.5}$$

$$d_{out}^{s12} = \frac{16 - 8e - 7e^2 + 2e^3 + e^4 - (16 - 24e + e^2 + 9e^3 - e^4 - e^5)c}{3(2 - e)(32 - 24e - 13e^2 + 6e^3 + 2e^4)}, \tag{A.6}$$

$$\pi_{Sin}^{s12} = \frac{32 + 4e - 9e^2 - 2e^3 - (32 - 28e - 13e^2 + 7e^3 + 2e^4)c}{12(2 - e)(32 - 24e - 13e^2 + 6e^3 + 2e^4)^2} \tag{A.7}$$
$$\cdot (32 - 20e - 14e^2 + 5e^3 + 2e^4 - (32 - 52e + 6e^2 + 19e^3 - 3e^4 - 2e^5)c),$$

$$\pi_{Sout}^{s12} = \frac{16 - 5e^2 - e^3 - (16 - 16e - 5e^2 + 4e^3 + e^4)c}{3(2 - e)(32 - 24e - 13e^2 + 6e^3 + 2e^4)^2} \tag{A.8}$$
$$\cdot (16 - 8e - 7e^2 + 2e^3 + e^4 - (16 - 24e + e^2 + 9e^3 - e^4 - e^5)c),$$

$$\pi_{Rin}^{s12} = \frac{(32 - 20e - 14e^2 + 5e^3 + 2e^4 - (32 - 52e + 6e^2 + 19e^3 - 3e^4 - 2e^5)c)^2}{12(2 - e)^2(32 - 24e - 13e^2 + 6e^3 + 2e^4)^2}, \tag{A.9}$$

$$\pi_{Rout}^{s12} = \frac{(16 - 8e - 7e^2 + 2e^3 + e^4 - (16 - 24e + e^2 + 9e^3 - e^4 - e^5)c)^2}{3(2 - e)^2(32 - 24e - 13e^2 + 6e^3 + 2e^4)^2}. \tag{A.10}$$

Optimal parameters under a downstream merger between two retailers:

$$w_{in}^{r12} = \frac{128 - 80e - 40e^2 + 16e^3 + 4e^4 + (128 - 112e - 40e^2 + 32e^3 + 6e^4 - e^5)c}{256 - 320e + 88e^3 - 6e^4 - 5e^5}, \tag{A.11}$$

$$w_{out}^{r12} = \frac{128 - 64e - 36e^2 + 10e^3 + 2e^4 + (128 - 128e - 28e^2 + 42e^3 + 2e^4 - 3e^5)c}{256 - 320e + 88e^3 - 6e^4 - 5e^5}, \tag{A.12}$$

$$p_{in}^{r12} = \frac{1536 - 1472e - 384e^2 + 460e^3 + 58e^4 - 32e^4 - 5e^6 + (512 - 576e - 64e^2 + 180e^3 + 2e^4 - 14e^5 - e^6)c}{(8 - 4e^4 - e^2)(256 - 320e + 88e^3 - 6e^4 - 5e^5)}, \tag{A.13}$$

$$p_{out}^{r12} = \frac{1536 - 1536e - 304e^2 + 464e^3 + 36e^4 - 32e^4 - 4e^6 + (512 - 512e - 208e^2 + 256e^3 + 28e^4 - 36e^5 - 2e^6 + e^7)c}{(8 - 4e^4 - e^2)(256 - 320e + 88e^3 - 6e^4 - 5e^5)}, \tag{A.14}$$

$$d_{in}^{r12} = \frac{1024 - 1152e - 192e^2 + 440e^3 + 8e^4 - 50e^5 - 2e^6 + e^7 - (1024 - 2176e + 960e^2 + 632e^3 - 432e^4 - 58e^5 + 48e^6 + 3e^7 - e^8)c}{6(8 - 4e^4 - e^2)(256 - 320e + 88e^3 - 6e^4 - 5e^5)}, \tag{A.15}$$

$$d_{out}^{r12} = \frac{2(256 - 256e - 72e^2 + 88e^3 + 12e^4 - 7e^5 - e^6 - (256 - 512e + 184e^2 + 160e^3 - 76e^4 - 19e^5 + 6e^6 + e^7)c)}{3(8 - 4e^4 - e^2)(256 - 320e + 88e^3 - 6e^4 - 5e^5)}, \tag{A.16}$$

$$\pi_{Sin}^{r12} = \frac{2(32 - 20e - 10e^2 + 4e^3 + e^4 - (32 - 52e + 10e^2 + 14e^3 - 3e^4 - e^5)c)}{3(8 - 4e^4 - e^2)(256 - 320e + 88e^3 - 6e^4 - 5e^5)^2} \tag{A.17}$$

$$\cdot (1024 - 1152e - 192e^2 + 440e^3 + 8e^4 - 50e^5 - 2e^6 + e^7 - (1024 - 2176e + 960e^2 + 632e^3 - 432e^4 - 58e^5 + 48e^6 + 3e^7 - e^8)c),$$

$$\pi_{Sout}^{r12} = \frac{4(64 - 32e - 18e^2 + 5e^3 + e^4 - (64 - 96e + 14e^2 + 23e^3 - 4e^4 - e^5)c)}{3(8 - 4e^4 - e^2)(256 - 320e + 88e^3 - 6e^4 - 5e^5)^2}. \tag{A.18}$$

$$\cdot (256 - 256e - 72e^2 + 88e^3 + 12e^4 - 7e^5 - e^6 - (256 - 512e + 184e^2 + 160e^3 - 76e^4 - 19e^5 + 6e^6 + e^7)c),$$

$$\pi_{Rin}^{r12} = \frac{(512 - 320e - 256e^2 + 92e^3 + 50e^4 - e^6 - (512 - 832e + 64e^2 + 348e^3 - 42e^4 - 50e^5 - e^6 + e^7)c)}{6(8 - 4e^4 - e^2)^2(256 - 320e + 88e^3 - 6e^4 - 5e^5)^2} \tag{A.19}$$

$$\cdot (1024 - 1152e - 192e^2 + 440e^3 + 8e^4 - 50e^5 - 2e^6 + e^7 - (1024 - 2176e + 960e^2 + 632e^3 - 432e^4 - 58e^5 + 48e^6 + 3e^7 - e^8)c),$$

$$\pi_{Rout}^{r12} = \frac{4(256 - 256e - 72e^2 + 88e^3 + 12e^4 - 7e^5 - e^6 - (256 - 512e + 184e^2 + 160e^3 - 76e^4 - 19e^5 + 6e^6 + e^7)c)^2}{3(8 - 4e^4 - e^2)^2(256 - 320e + 88e^3 - 6e^4 - 5e^5)^2}. \tag{A.20}$$

Proof of Proposition 5. Follow from similar argument as in Proposition 4.

Proof of Proposition 6. The problem facing each retailer is

$$\pi_{Ri}^1 = \max_{p_i, Q_i} \ p_i d_i(L, \boldsymbol{p})(1-r) + (p_i r - w_i)Q_i$$

$$s.t. \quad d_i(L, \boldsymbol{p}) \le Q_i \le d_i(H, \boldsymbol{p}).$$

If for some r, $\frac{\partial \pi_{Ri}}{\partial Q_i} = (p_i r - w_i) \triangleq \Delta_i$ is negative, then the retailer's profit is decreasing in his order quantity, so to maximize the profit, he will only order the low quantity which is $d_i(L, \boldsymbol{p})$. On the other hand, if Δ_i is positive, then the retailer will order up to the high level of demand, $d_i(H, \boldsymbol{p})$. While if $\Delta_i = 0$, then retailer's profit does not change in his stocking level for any given price. For the sake of analysis convenience, suppose all the retailers are risk-averse and stock only the low level of demand in this case. To summarize, the optimal order quantity should satisfy:

$$Q_i^* = \begin{cases} d_i(L, \boldsymbol{p}) & \text{if } \Delta_i \le 0, \\ d_i(H, \boldsymbol{p}) & \text{if } \Delta_i > 0. \end{cases}$$

Next, we will study the optimal pricing strategy for retailers. Let us start with the case where $\Delta_i \le 0$. Retailer R_i's order quantity is $Q_i^* = d_i(L, \boldsymbol{p})$, and no matter the realized market demand is high or low, his profit is:

$$\pi_{Ri} = (p_i - w_i)d_i(L, \boldsymbol{p}),$$

which is independent of r. Using the same approach in the proof of Proposition 1, we first solve this problem for $p_i(\boldsymbol{w})$, then solve the upstream supplier's problem and find the optimal wholesale price $w_i^*(L)$.

$$w_i^*(L) = \frac{(4+e)L + (4-e-e^2)c}{2(4-2e-e^2)}. \tag{A.21}$$

Substitute w_i^* into p_i and Q_i, we have the optimal values for the retail price and order quantity:

$$p_i^*(L) = \frac{(12 - 3e - 2e^2)L + (4 - e - e^2)c}{2(2 - e)(4 - 2e - e^2)}, \qquad \text{(A.22)}$$

$$Q_i^*(L) = \frac{(4 - e - e^2)L - (4 - 5e + e^3)c}{6(2 - e)(4 - 2e - e^2)}. \qquad \text{(A.23)}$$

Note that all the above results are derived based on the assumption $\Delta_i \leq 0$, therefore the feasible range for r is $0 < r \leq r_L$, where $r_L \triangleq w_i^*(L)/p_i^*(L) = \frac{(2-e)((4+e)L+(4-e-e^2)c)}{(12-3e-2e^2)L+(4-e-e^2)c}$.

Now, consider the other case where $\Delta_i > 0$ and retailer's order quantity is $Q_i^* = d_i(H, \boldsymbol{p})$. Since retailer's profit depends on the value r, so does his decision $p_i(H, r)$. Again, solve this problem gives

$$w_i^*(H, r) = \frac{(4 + e)(2 - e)H - (4 + e)(1 - e)L + (4 - e - e^2)c - (4 + e)(1 - e)(H - L)r}{2(4 - 2e - e^2)}, \qquad \text{(A.24)}$$

$$p_i^*(H, r) = \frac{(4 + e)(2 - e)H + (4 - e - e^2)L + (4 - e - e^2)c + (4 - e - e^2)(H - L)r}{2(2 - e)(4 - 2e - e^2)}, \qquad \text{(A.25)}$$

$$Q_i^*(H, r) = \frac{(8 - 6e - e^2 + e^3)H - (4 - 5e + e^3)L - (4 - 5e + e^3)c - (4 - 5e + e^3)(H - L)r}{6(2 - e)(4 - 2e - e^2)}. \qquad \text{(A.26)}$$

Since both $w_i^*(H, r)$ and $p_i^*(H, r)$ are a linear function of r, $\Delta_i(r)$ has a quadratic form with respect to r, and the coefficient of the squared term r^2 is positive. To find the feasible range of r which satisfies $\Delta_i(r) > 0$, we check two extreme cases of r: if $r = 0$, then $\Delta_i(0) = -w_i^*(H, 0) < 0$; if $r = 1$, then $\Delta_i(0) = \frac{(4-e-e^2)H-(4-5e+e^3)c}{2(2-e)(4-2e-e^2)} > 0$ (since $H \geq 1$ and $c < \frac{1}{1-e}$). Therefore, there is a unique point $r_H \in (0, 1)$ such that $\Delta_i(r_H) = 0$, and to have $\Delta_i > 0$, r should satisfy $r_H < r < 1$.

Next we need to discuss the relationship between r_L and r_H, which depends on the value of L, H, e and c. Since r_L does not depend on H, we fix r_L for any give set of L, e and c, then determine the value of r_H. There are three cases: (i)$r_H = r_L$, then it is straightforward to see that retailers should order $Q_i^* = d_i(L, e, c)$ when $0 < r \leq r_0$; and order $Q_i^* = d_i(H, L, e, c)$ when $r_0 < r < 1$, where $r_0 = r_L = r_H$. (ii)$r_H > r_L$, retailers still

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should order $Q_i^* = d_i(L, e, c)$ for $0 < r \leq r_L$; and order $Q_i^* = d_i(H, L, e, c)$ for $r_H < r < 1$.
For any $r_L < r \leq r_H$, if retailer orders $Q_i^* = d_i(H, L, e, c)$, then supplier will increase the
wholesale price accordingly which leads to $\Delta_i < 0$, which means the retailer's profit margin
for the additional quantity $Q_i^* - d_i(L, e, c)$ will be negative. Therefore even a risk-neutral
retailer has no incentive to order more than $d_i(L, e, c)$, the quantity that can be sold. As
a result, he will still order $Q_i^* = d_i(L, e, c)$, for $r_L < r \leq r_H$. (iii)$r_H < r_L$, in this case,
retailers should order $Q_i^* = d_i(L, e, c)$ for $0 < r \leq r_H$; and order $Q_i^* = d_i(H, L, e, c)$ for
$r_L < r < 1$. For $r_H < r \leq r_L$, both order quantities are feasible options for the retailer,
so his decision solely depends on the expected profit, if $\pi_{Ri}(d_i(H, L, e, c)) > \pi_{Ri}(d_i(L, e, c))$,
then $Q_i^* = d_i(H, L, e, c)$; while if $\pi_{Ri}(d_i(H, L, e, c)) \leq \pi_{Ri}(d_i(L, e, c))$, then $Q_i^* = d_i(L, e, c)$.
□

Proof of Lemma 7. Assuming $Q_{in} = d_i(H, \boldsymbol{p})$ and $Q_{out} = d_i(H, \boldsymbol{p})$, we can solve the
problem for a given set of $\{L, H, r, e, c\}$ and find the optimal pricing strategies are:

$$w_{in}^{HH} = \frac{A_1 H + A_2 L + A_3 c}{2(32 - 24e - 13e^2 + 6e^3 + 2e^4)},$$

$$w_{out}^{HH} = \frac{B_1 H + B_2 L + B_3 c}{32 - 24e - 13e^2 + 6e^3 + 2e^4},$$

$$p_{in}^{HH} = \frac{C_1 H + C_2 L + C_3 c}{(2 - e)(32 - 24e - 13e^2 + 6e^3 + 2e^4)},$$

$$p_{out}^{HH} = \frac{D_1 H + D_2 L + D_3 c}{(2 - e)(32 - 24e - 13e^2 + 6e^3 + 2e^4)},$$

$$\text{where} \quad A_1 = (4 + e)(8 - e - 2e^2)(1 + (1 - r)(1 - e)),$$

$$A_2 = -(4 + e)(8 - e - 2e^2)(1 - r)(1 - e),$$

$$A_3 = (4 - e - e^2)(8 - e - 2e^2),$$

$$B_1 = (4 + e)(4 - e - e^2)(1 + (1 - r)(1 - e)),$$

$$B_2 = -(4 + e)(-e - e^2)(1 - r)(1 - e),$$

$$B_3 = (2 + e)(2 - e)(4 - 2e - e^2),$$

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$$C_1 = (2+e)(2-e)(8-3e-e^2) + (16-10e-6e^2+2e^3+e^4)r,$$

$$C_2 = (1-r)(16-10e-6e^2+2e^3+e^4),$$

$$C_3 = (16-10e-6e^2+2e^3+e^4),$$

$$D_1 = (2-e)(16-4e^2-e^3) + (16-8e-9e^2+3e^3+e^4)r,$$

$$D_2 = (1-r)(16-8e-9e^2+3e^3+e^4),$$

$$D_3 = (16-8e-9e^2+3e^3+e^4).$$

Then it can be shown that the following inequality holds:

$$\Delta_{out}^{HH} - \Delta_{in}^{HH} = \frac{e(4+e-2r)[(1-e)(1-r)(H-L)+(H-c(1-e))]}{2(32-24e-13e^2+6e^3+2e^4)} > 0.$$