Do Merged Firms Benefit from Inventory Pooling?

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Firms' interest for engaging in merger and acquisition activities globally in various sectors and scales despite many failed examples triggers researchers' curiosity for investigating the reasons and results of these activities. According to researchers' findings, the consolidated and enlarged power obtained by merged firms seems to be an important motivation. This study empirically investigates whether merged firms facilitate this consolidation also to derive inventory pooling benefits. The seminal work in operations management literature, Eppen (1979), shows that when the inventories for several demand sources are aggregated and a joint inventory decision is made, (i) total inventory related costs can be decreased by the decreased safety stock and (ii) savings in inventory costs are negatively correlated with the correlation among demand sources. By using firm-level data covering a sample of ??? same-industry mergers over a ???-years period, we show that merged firms do realize significant improvements in overall inventory performance compared to their industries, which is measured by inventory turnover rate (IT), the ratio of a firm's cost of goods sold to its average inventory level. We also show that as the theory suggests, the improvement in inventory is inversely related with the pre-merger demand correlation between the merged firms. Variation??? Capacity pooling??? IT of target firm???
Key words: merger; acquisitions; inventory pooling; inventory turnover.

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1 Introduction

Mergers and acquisitions have important impacts on both overall economies and individuals in relation with these firms. In 2000, worldwide merger and acquisition activities had a value of $3.2 trillion for over 40,000 deals (Bruner 2004). After some decrease between 2000 and 2002, total worldwide value of these activities reached around $4.2 trillion in 2007 (Financial Times 2010) despite some decrease after 2007 following the recession. Significant financial value of mergers and acquisitions impact all stakeholders including shareholders as well as employees. When Hewlett-Packard(HP) and Compaq agreed to merge in 2001, HP had 88,000 employees in more than 120 countries, while Compaq had 66,000 employees in over 200 countries, who were prone to the changes by the merger. Given the intensity of merger activities and potential impact of a merger on stakeholders, researchers focusing on mergers investigate two crucial questions; why mergers occur and how beneficial a merger has been.

Executives may engage in mergers[1] for various reasons, which are categorized by researchers as rational and behavioral motives. Bower (2001) states five rationales for the bidding firm that are concluded by investigating all large U.S. merger deals between 1997-1999. These rationales in the decreasing order of their relative importance are to eliminate the overcapacity in the industry to decrease competition, to extend the product line and target market, to expand the local company by geographically rolling up, as a substitution to R&D investments, and to expand into converging and emerging industries. Andrade *et al.* (2001) mention that a reaction to unexpected shocks to industry structure such as technological

[1] Our use of the term mergers refers to both mergers and acquisitions throughout the paper.

innovations, change in oil prices or deregulation raises as a strong reason to merge activities. All these rationales stem from the long-term strategic advantages expected by using the combined power of the merger either to decrease costs or increase revenues.

Executives' motives to engage in mergers are also explained by quasi-irrational behavioral aspects. Roll (1986) explain hubris as one motive. Bogan and Just (2009) provide evidence for the existence of confirmation bias in executives' merger decisions, which is putting too much importance to information to support one's view. Incentive conflicts between executives and shareholders may also motivate mergers, which allow executives to generate value for themselves at the expense of shareholders (Hartzell *et al.* 2004).

Bernile and Bauguess (2010) study the U.S. mergers deals that are accompanied by management forecasts of the merger gains due to common synergies. 88% of the synergies' forecasts is on expected cost savings by the merger. The projected cost savings are expected to be through more efficient use of layouts, production capabilities, and administrative work, R&D expenditure, as well as the increased purchasing power. As exploiting the consolidated power of merged firms is observed to be a significant motive to engage in merger activities, it is expected that if the synergies can be achieved by mergers, the consolidated power should be also employed in inventory management.

Inventories can constitute an important part of the current assets such as 53% for retailers (Gaur *et al.* 2005), so their good management can be crucial for the overall performance of a firm including its market valuation (Hendricks and Singhal 2009). After the merger, inventory decisions for merged firms can be managed by a joint agent for similar inventory items. In fact, according to the well-founded inventory theory, the consolidation of stocks for multiple random demand groups benefit from decreased total demand uncertainty, which is called *inventory pooling*. The seminal work in operations management literature, Eppen (1979), showed that when the inventory decisions for several demand sources are done together, (i) total inventory related costs can be decreased by decreasing the optimal safety stock and (ii) savings in inventory costs are negatively correlated with the correlation among demand sources. Chen and Lin (1989) and Corbett and Rajaram (2006) validate Eppen (1979)'s conclusions (i) and (ii) on normally distributed demands with arbitrary distributions, respectively. For an extensive review on inventory pooling studies, see Cai and Du (2009) and Yang and Schrage (2009)

Expected that merged firms facilitate common resources, it is intuitive for the merged firms to realize inventory pooling benefits. So far, both merger and inventory pooling literatures are almost silent on the inventory related performance measures around the mergers. In finance literature, synergies and performance improvements formed by mergers are measured by changes in cash flows (Healy *et al.* 1992), market share (Mueller 1985), accounting measures such as return on assets and return on equity

(Mueller 1980, Ravenscraft and Scherer 1989), total sales and before tax profits (Gugler *et al.* 2003), and stock returns called abnormal returns measured in three-day around the merger and also in a longer run (Jensen and Ruback 1983, Andrade *et al.* 2001, Rau and Vermaelen 1998). Literature shows evidence that target firm benefits more from the merger than the bidder firm (Andrade *et al.* 2001, Jarrell *et al.* 1988). Jarrell *et al.* (1988) indicate that as the number of bidder firms increases the returns to bidders decreases. Tuch and O'Sullivan (2007) provide a review of studies on merger benefits. For a comprehensive review on mergers, see Scherer (1988), Andrade *et al.* (2001), and Bruner (2004).

To the best of our knowledge, Louis (2004) and Davila and Wouters (2007) are the two works empirically testing inventory pooling benefits by using firm-level data. Louis (2004) studies changes in inventory performance of firms engaged in merger. The author compared the inventory turnovers of bidder firms one year prior with one year following the announcement. The author expected to observe low inventory turnover around the merger, because bidder may build up inventories before the merger expecting high demand expectations, but actual sales may turn to be low resulting in low inventory turnover. However, the author found no evidence that the bidder firms' inventory turnovers change around the merger. Davila and Wouters (2007) gathered data from a U.S. disk drive manufacturer that a implemented a new program to delay the customer customization processes such as labeling and customer-specific tests to a later stage in production, called postponement. It is theoretically shown that in various settings, the inventory for common body units of different final products can be decreased through postponement (Alfaro and Corbett 2003). Thus, Davila and Wouters (2007) test the effect of the postponement level on inventory turns and service levels by using the company data for an 18-month period. Results indicate that while higher levels of postponement resulted in higher service levels, but no evidence could be shown on the inventory turns.

Studies on operational decisions and impacts of mergers are still scarce. Gupta and Gerchak (2002) build an analytical model to study the valuation of target firms by the bidder by considering production characteristics such as capacity and flexibility. They show that bidder firm's characteristics also affect the value of the target firm and the operational synergies expected from the merge. Iyer and Jain (2004) study the expected decrease in inventory costs in a merger of two production-inventory systems by using a queueing model. Alptekinoğlu and Tang (2005) study an analytical model to investigate the cost benefits that are expected to be realized in multi-channel distribution systems by centralized ordering and demand allocation decisions. They show the possible use of their model for a consolidated distribution channel after a merge of two retailers. Güneş and Yaman (2010) provide an integer programming formulation to solve the supply-demand match problem of the merged hospitals and obtain the expected benefits by running the model for a subset of Turkish hospitals merged. Harris II *et al.*

(2000) empirically investigate the technical efficiency, which is calculated by using outputs and inputs, among the mergers of U.S. hospitals.

Whether merged firms realize inventory pooling benefits is an open and important question to show empirical evidence for inventory theory in mergers. Besides, inventory efficiency can also be used as another variable to measure merger performance in addition to those often used in literature to explain impacts of mergers. Gugler *et al.* (2003) examine the effects of mergers on both sales and profits realized by merged firms. They conclude that merged firms in general experience increase in profits, but rather decrease in sales. Mueller (1997) also reports empirical findings on increase in firm profitability by merger. Increase in profits and decrease in sales is concluded as the result of the increased market power by the merger. In fact, inventory efficiency gains by mergers can also explain these observed changes in profitability and sales. Although sales may decrease after merger due to various reasons, the increased inventory performance can lead to significant decreases in inventory related costs that would be reflected by increase in profits. As the inventory related costs may not be observable as explicitly as production costs, decrease in inventory costs may not be reflected to decrease price, so to increase sales, as expected by researchers. Thus, showing any increase in inventory performance as an effect of mergers may help to explain why many mergers realized increase in profits, while sales decrease.

If there are inventory pooling benefits realized by mergers, then what are the factors affecting the magnitudes of these benefits? To empirically investigate the questions on the impacts of mergers on inventory performance, we use firm-level data covering a sample of 115 same-industry mergers over a 23-years period. We study pre and post inventory turnovers around the mergers. Inventory turnover is the ratio of the sales to average inventory, which is often used as a inventory-related performance measure. We examine whether the inventory turnover improves after the merger. Following the theory proposed by Eppen (1979), we also study the effect of demand correlation between the bidder and target firms on the inventory turnover increase realized by the merger.

We also examine the relation between the stock market reaction to merger announcements and the inventory pooling benefits obtained through mergers. In a capital market, stock prices are quickly adjusted right after a merger announcement reflecting any expected value changes(Andrade *et al.* 2001). Short-run reactions are measured a few days around the day of the merger announcement. We investigate whether short-run stock price reactions to mergers incorporate inventory pooling benefits obtained by mergers.

Inventory pooling theory measures the inventory performance in terms of inventory related costs such as holding and stock-out penalty costs by assuming stationary demand in time. However, in practice, demand is often non-stationary in time because of seasonality, economical factors, competition, change in customer preferences, and many other factors. Moreover, because of customers' perceptions on merged firms and change in company performance after the merger, demand rate may change (Gugler *et al.* 2003). Thus, a non-negligible part of the change in inventory costs can be devoted to the change in demand, which makes it difficult to isolate the effects of inventory pooling. In this study, we use inventory turnover to measure inventory pooling effects. By using inventory turnover, the change in inventory due to change in demand rate can be mostly avoided.

The rest of this article is organized as follows. §2 explains the basic inventory pooling theory. Then the hypotheses of the inventory pooling effects that would be observed in mergers are developed. The data source, data refinement, and variables used in the analysis are explained in §3. In §4, methods used for the analyses are explained along with the results concluded from the analyses. §5 concludes the paper by summarizing the findings of this study and stating further questions open for investigation.

2 Hypotheses Development

In most general terms, risk pooling is aggregating individual resources each kept for its corresponding random variable. The term risk refers to the random nature of variables that require these resources. The idea behind risk pooling is that the amount of a resource needed to cover a random variable is proportional to the variation of the variable. On the other hand, the aggregate random variable, which is obtained by aggregating random variables, would have a lower variation compared to the sum of individual variations of these variables. Thus, the amount of resource needed to satisfy the aggregate random variable can be less than the total amount of resources required individually. Health insurance is a typical example of financial risk pooling. Each individual pays a small premium to form a large pool of available resource that could be used to recover individuals' health problems. Pooling the risks of random health problem occurrences, the total amount needed to recover these random problems can be decreased.

Inventory pooling is also a risk pooling strategy often utilized in supply chains. By forming a pool of inventories each needed to satisfy random demand sources, demand satisfaction risks can be pooled. Thus, either total inventory needed to satisfy a certain service level can be decreased or with the same inventory level higher total service levels can be achieved, where both aim to decrease total costs and/or increase profits. In its most basic form, inventories of the same product kept for several demand sources can be physically pooled by keeping stock at a single location such as two retailers keeping all their inventories at a common location to satisfy their customer demands (Anupindi and Bassok 1999). Inventory pooling benefits can be also obtained by keeping separate inventories, but sharing units in case of a stock-out at one of the locations. Inventory sharing, also called, virtual pooling, is observed in various industries (Çömez *et al.* 2010a) and theoretically shown to decrease expected inventory costs and/or increase expected profits by researchers, but not generally decrease inventory levels (Grahovac and Chakravarty 2001, Çömez *et al.* 2010a).

Under product substitution either by customer preference or firm effort, inventories for the fully or partially substitutable products can be pooled (Smith and Agrawal 2000). Yang and Schrage (2009) mention that L.L. Bean asks customers their second choice product in customer order form for catalog sales. They show conditions on demand distribution, demand substitution rate, and demand correlation under which optimal inventory levels increases after pooling.

Postponement and component commonality are two other strategies that can be followed in production to benefit from inventory pooling. Postponement is delaying the differentiation of the basic product body further down in production to obtain final products (Davila and Wouters 2007). A well-known example is the postponement applied by HP to localize printers according to country-specific requirements such as electric plugs, where the basic printer body is common for all target markets (Lee *et al.* 1993). The idea is to keep a common inventory for the basic product body until a more precise forecast for final customer demand can be gathered, instead of keeping differentiated inventories for a longer time period. Similarly, by a smart product design common components can be used for several different end products, so that variations in different end products demands can be aggregated while managing the common component inventory (Doğramacı 1979, Xiao *et al.* 2010). Baker *et al.* (1986) show that for a given service level, pooling decreases common component inventories, albeit the increase in product-specific component inventories.

To develop the hypotheses, we propose the mathematical framework for the basic inventory pooling scenario, which is introduced in Eppen (1979). Let there is a single ordering season during which random demands for a single product type are realized from n different sources. The problem in a decentralized system is to determine inventory levels to stock for each demand source at the beginning of the season to minimize the inventory related costs for each demand separately. Inventory costs consist of holding cost for the remaining inventory at the end of the season and penalty cost for the unsatisfied demand during the season. The other option is to consider a centralized system by pooling inventories such that a single inventory stocking decision is made at the beginning of the season and demands from all n streams are satisfied from central inventory during the season. Thus, to find the central optimal inventory level, total holding and penalty costs resulting from satisfaction of demand from n sources are to be minimized.

Let D_i be the random demand from source i during the season with probability density $f_i(\cdot)$, cumulative distribution $F_i(\cdot)$, mean μ_i, and standard deviation σ_i, for $i \in \{1, 2, ..., n\}$. Holding and penalty costs are linear functions of total unsold inventory and unsatisfied demand, respectively. Let h be the holding cost per unit inventory and p is the penalty cost per unit demand. Then, the problem in the decentralized system is to find the optimal stocking level Q_i^* to satisfy random demand D_i by minimizing the total holding and penalty cost $H(.)$, for $i \in \{1, ..., n\}$.

$$\min_{Q_i} H(Q_i) = \int_0^{Q_i} h(Q_i - D) f_i(D) dD + \int_{Q_i}^{\infty} p(D - Q_i) f_i(D) dD. \tag{1}$$

In the centralized (pooled) system, the objective is to find the optimal stocking level Q_C^* to satisfy the random pooled demand D_C by minimizing the total holding and penalty cost $H_C(.)$. Pooled demand is the sum of demands from all sources, so

$$D_C = \sum_{i=1}^{n} D_i,$$

which has a probability density function $f_C(.)$ and cumulative probability distribution $F_C(.)$ D_C has a mean

$$\mu_C = \sum_{i=1}^{n} \mu_i,$$

and standard deviation

$$\sigma_C = \sqrt{\sum_{i=1}^{n} \sum_{j=1}^{n} \sigma_{ij}} = \sqrt{\sum_{i=1}^{n} \sigma_i^2 + 2 \sum_{i=1}^{n-1} \sum_{j=i+1}^{n} \sigma_i \sigma_j \rho_{ij}},$$

where $\sigma_{ij} = \sigma_i \sigma_j \rho_{ij}$ is the covariance of D_i and D_j and ρ_{ij} is the correlation coefficient. Then the centralized stocking problem is

$$\min_{Q_C} H_C(Q_C) = \int_0^{Q_C} h(Q_C - D) f_C(D) dD + \int_{Q_C}^{\infty} p(D - Q_C) f_C(D) dD. \tag{2}$$

There are two main questions regarding the pooling effect. How does the total optimal cost in the decentralized system $H_D^* = \sum_{i=1}^{n} H(Q_i^*)$ compared to the total optimal cost after centralization H_C^*? How does the total optimal stocking level in the decentralized system $Q_D^* = \sum_{i=1}^{n} Q_i^*$ compared to the total optimal stocking level after centralization Q_C^*? In following, determinants of the changes in total cost and total stocking levels such as system parameters are also to be investigated. Eppen (1979), Chen and Lin (1989), Chang and Lin (1991) and Alfaro and Corbett (2003) analytically show that inventory pooling can reduce inventory costs, while Lin *et al.* (2001) show that pooling increases profits. Anupindi and Bassok (1999) show that pooling may not always increase expected sales. Gerchak and He (2003), Benjaafar *et al.* (2005), and Corbett and Rajaram (2006) study the sensitivity of cost benefits by pooling to system parameters such as demand variability, system utilization, and demand correlation, respectively.

In this study, we focus on inventory levels, not inventory costs or profits, because theoretical inventory cost computation considers the cost of stocking out and/or profit from unit sales, which are difficult to be tested for empirical evidence by using secondary data. Although stock-out cost mainly refers to the loss profit from an unsatisfied demand, it may include the customer goodwill loss and negative effects on future sales as well. Therefore, here we focus on effects of pooling on inventory levels theoretically and empirically.

To study the change in optimal stocking levels by pooling, we need to compare Q_D^* to Q_C^*. The solution to the problem (1) is

$$Q_i^* = \min\{Q_i \geq 0 : F_i(Q_i) \geq \frac{p}{p+h}\}. \tag{3}$$

(3) states that the optimal stocking quantity Q_i^* should be chosen such that minimum probability of not-stocking-out during the season to satisfy demand D_i should be $p/(p+h)$, which is also called *cycle service level.* Similarly, the optimal stocking level in the centralized system is obtained by solving (2) such that

$$Q_C^* = \min\{Q_C \geq 0 : F_C(Q_C) \geq \frac{p}{p+h}\}. \tag{4}$$

Eppen (1979) study normally distributed demands, in which case the total optimal stocking levels in decentralized and centralized systems can be written as

$$Q_D^* = \sum_{i=1}^{n} Q_i^* = \sum_{i=1}^{n}(\mu_i + \bar{z}\sigma_i) \tag{5}$$

$$Q_C^* = \mu_C + \bar{z}\sigma_C = \sum_{i=1}^{n} \mu_i + \bar{z}\sqrt{\sum_{i=1}^{n}\sigma_i^2 + 2\sum_{i=1}^{n-1}\sum_{j=i+1}^{n}\sigma_i\sigma_j\rho_{ij}}. \tag{6}$$

$\bar{z}$ is the standard normal variable that corresponds to cumulative probability of $\frac{p}{p+h}$. As the cycle service level $p/(p+h)$ is the same for all demand sources and the centralized system, the same $\bar{z}$ is used in both (5) and (6).

According to (5) and (6) and known that the correlation coefficient $\rho_{ij} \in [-1, 1]$, it is easy to conclude that when demands are normally distributed, the optimal stocking level in centralized system cannot be greater than the total optimal stocking level in decentralized system: $Q_C^* \leq Q_D^*$. This result is first shown by Eppen (1979) and then confirmed by Baker *et al.* (1986) and Stulman (1987) with service level constraint.

On the other hand, when demands are not normally distributed, inventory pooling may not lead to decrease in optimal inventory levels, but increase. Gerchak and Mossman (1992) illustrate this counter result by an example with exponential demands. Consider $n = 2$ and assume that demands at these sources are independent. From (3), $Q_D^* = F_1^{-1}(\frac{p}{p+h}) + F_2^{-1}(\frac{p}{p+h})$, where $F^{-1}(.)$ is the inverse cumulative probability function. Optimal stocking level in centralized system is obtained from (3), $Q_C^* = F_C^{-1}(\frac{p}{p+h})$. Gerchak and Mossman (1992) show that for demands each having exponential distributed with mean 1, when the service level is not high, $\frac{p}{p+h} \leq 0.72$, then pooling increases the optimal stocking level: $Q_C^* \geq Q_D^*$. Chen and Lin (1990) also show a counter result by using the model in Stulman (1987) as they obtain an increase in inventory levels after pooling when the service level is 86%. Yang and Schrage (2009) generalize these results on inventory level effects of pooling. They analytically show that when demand distributions are right skewed, mean is greater than the median, optimal inventory level after pooling may increase, which is called *inventory anomaly*. On the other hand, if the stocking level is optimized under a service level constraint, then inventory anomaly does not occur.

In a merger, if target and bidder of the merger start functioning under a single firm after the merger, it is possible that this merged firm may consolidate inventory decisions. Then, one or more of inventory pooling strategies such as physical centralization of stocks, virtual pooling, or component commonality can be applied. Although it is not reported whether merged firm utilizes any inventory pooling strategies or not, it can be investigated whether any significant inventory level performance is observed after the merger compared to pre-merger performances of target and bidder firms. Given the mixed analytical results on benefits of pooling on inventory levels, we can state our first hypothesis on inventory pooling benefits that can be observed in merged firms.

H1: *The post-merger inventory level performance for the merged firm is higher than the combined pre-merger inventory level performance of bidder and target firms.*

If pooling decreases the stocking levels, then the next question is what are the determinants of this pooling effect One possible system parameter that can impact pooling benefit is the dependence between the demands pooled. According to the optimal stocking level calculations in (5) and (6), as the correlation coefficient ρ_{ij} increases from -1 to 1, Q_C^* increases, while Q_D^* is constant. Known that $Q_C^* \leq Q_D^*$ for all ρ_{ij}, then the inventory decrease by pooling decreases in correlation between demands. The highest decrease in inventory levels by pooling can be obtained when demands at sources are perfectly negatively correlated $\rho_{ij} = -1$, for $i \in \{1, ..., n\}$. On contrary, if demands are perfectly positively correlated $\rho_{ij} = 1$, then $Q_C^* = Q_D^*$, i.e, inventory pooling does not change total stocking level. Benjaafar *et al.* (2005) and Corbett and Rajaram (2006) study effects of demand correlation among sources on cost benefits of pooling and conclude that the benefit of pooling decreases in demand correlation. These results lead to our second hypothesis.

H2a: *The ratio of the post-merger inventory level performance to the pre-merger combined inventory level performance decreases in the demand correlation of bidder and target firms.*

H2b: *The difference between the post-merger and pre-merger combined inventory level performances decreases in the demand correlation of bidder and target firms.*

Variabilities of demands pooled is another factor that may impact the expected benefits from pooling. The decrease in stocking levels by pooling is achieved by the change in safety stock after pooling, which are the seconds terms in (5) and (6), as the first terms in both equations are equal. Safety stock is a function of demand variabilities, thus intuitively demand variabilities should affect the benefit of pooling. Suppose that demands are normally distributed, so that optimal stocking levels in decentralized and centralized systems are (5) and (6), respectively. Let unpooled demands be independent each with the same standard deviation $\sigma = \sigma_i$, for $i \in \{1, ..., n\}$. Then the decrease in total stocking level after centralization is

$$Q_D^* - Q_C^* = \bar{z}(\sum_{i=1}^{n} \sigma - \sqrt{\sum_{i=1}^{n} \sigma^2}) = \bar{z}\sigma\sqrt{n},$$

which is increasing in standard deviation σ. If not the difference, but the ratio of Q_D^* and Q_C^* is taken, still standard deviation increases the effect of pooling on inventory level performance. The magnitude of standard deviation can be used as an indicator of variability by itself. On the other hand, coefficient of variation, $C_v = \sigma/\mu$, which is a normalized measure of dispersion, is also used to define the variation wrt mean demand rate. With normally distributed demands, the decrease in inventory levels by pooling increases in variability, both when it is measured by solely standard deviation and coefficient of variation.

There are also theoretical counter examples to the relation between the variabilities of individual demand sources and the effectiveness of pooling. Gerchak and He (2003) provide an example in which increasing demand variabilities decreases the cost benefit of pooling. They also provide a problem setting where increased variability in fact increases the cost decreases provided by pooling. Benjaafar *et al.* (2005), focusing on cost benefits of pooling, conclude that higher the demand variability, reduce the benefit of pooling.

The analytical results on the relation between demand variability and expected benefits of pooling is mixed. However, intuition is more leaned on the idea that pooling strategy is used to hedge demand uncertainty, so the benefit of pooling should be increasing with the variability of demand sources, which is the indicator of uncertainty. Accordingly, we hypothesize that if inventory performance benefits are realized by a merged firm, the level of benefit should be higher for the mergers where target and bidder firms have higher before-merger demand variabilities.

H3a: *The ratio of the post-merger inventory level performance to the pre-merger combined inventory level performance increases in the demand variabilities of bidder and target firms.*

H3b: *The difference between the post-merger and pre-merger combined inventory level performances increases in the demand variabilities of bidder and target firms.*

Then the basis for the theorem for the relation between inventory pooling benefit and market reaction to mergers.

3 Data Description

We follow the methodology of Tanyeri (2006), Cornett *et al.* (2009), and Unver-Fescioglu and Tanyeri (2010) to identify merger deals in Security Database Corporation's (SDC) US mergers and acquisition database that show an intent to transfer control rights. Sample deals include bidders and targets that are nonfinancial, US-based, publicly-listed firms. We also require bidder and target firms to operate in related industries so that inventories of bidder and target firms are of comparable types. We only keep firms operating in the same industry (as defined by two-digit SIC code). Andrade *et al.* (2001) report that beginning in the 1970s, there is an increasing percentage of same-industry mergers, which may be a result of industry-level deregulation. Same-industry mergers reached 50 % by 1990s. We impose two additional filters on the sample to ensure that bidder and target firms operate as a single firm after the merger. First, we drop deals that are not completed. Second, we proxy the merging of bidder and target operations into a single firm by whether the bidder and target firms continue publishing separate financial statements. If the target keeps publishing separate financial statements three years after the merger announcement, we drop the deal.

We compile financial statement data using the CRSP-COMPUSTAT quarterly database. We collect quarterly data on cost of goods sold, inventory and sales (data items 2, 30, and 38, respectively) for the six year period covering three years prior to three years after merger announcements. For a deal to be included in the sample, both the bidder and target should have non-missing data on all three variables. These filters produce a final sample of 115 deals. We use EVENTUS and SDC databases to collect information about bidder and target stock returns and merger terms.

4 Data Analysis and Results

Eppen (1979) shows that when inventory decisions for several random demand sources are centralized as a single decision, the total inventory needed can decrease wrt to the decentralized system. In a decentralized system, to satisfy each random demand source, a certain amount of safety stock should be kept. When random demands are to be satisfied from a central inventory, some of the random variations in demand can be canceled-out within the system, thus leading to a lower total safety stock requirement. Our first hypothesis investigates whether the merged firm realizes decreases compared to pre-merger operations of bidder and target firms.

We use inventory turnover (IT) to measure inventory pooling effects. We compute IT of the merged firm and the combined IT of bidder and target firms before the merger. The IT of the merged firm is the ratio of annual total cost of goods sold to average annual inventory. The IT of the merged firm is calculated for each of the three consecutive years following the merger announcement. The pre-merger combined IT is the ratio of sum of annual bidder and target cost of goods sold to the sum of bidder and target average inventories. We calculate pre-merger combined IT three years prior to merger announcement to isolate the pre-merger effects on individual performances that can be observed close to merger.

T-tests show that the IT of the merged firm is significantly larger than the combined pre-merger IT of firms. Our results support the theory that centralized inventory decisions result in improved inventory performance.

We extend the premise of inventory efficiency by using the model proposed by Eppen (1979). We analytically show that the IT of the centralized system cannot be smaller than all of the ITs of the decentralized inventories. Accordingly, we pose the question whether the merger improves the individual pre-merger inventory performances of at least one of the bidder or target firm. We define the pre-merger IT of bidder (target) firms as the ratio of bidder (target) cost of goods sold to average inventory lagged three years from the merger announcement.

H2: *The post-merger inventory turnover of the merged firm is greater than at least one of the pre-merger individual inventory turnovers of bidder or target firms.* **This hypothesis is redundant if we can prove H1**

Results of T-tests support the theory that the post-merger IT is significantly greater than at least one of pre-merger individual ITs.

Eppen (1979) shows that the magnitude of the inventory decrease provided by the centralized inventory decision is inversely related with the correlation of the demand sources. Thus, the systems where individual sources have negatively correlated demand can benefit more from centralized inventory decisions. The third hypothesis tests this theory by examining whether demand correlation between bidder and target firms prior to merger affect the ratio of the post-merger IT to pre-merger combined IT.

We run regressions of post-merger to pre-merger combined IT ratio on pre-merger demand correlation and control variables. The coefficient for demand correlation is negative and significant. The same results hold in regressions of the difference between post-merger and pre-merger combined ITs. These results support the findings of Eppen (1979) in mergers.

The fourth hypothesis analyzes whether anticipations about inventory-related efficiencies affect how investors react to merger announcements. We proxy investor anticipations about post-merger inventory efficiencies by using realized changes in IT. We measure investor reactions to merger announcements using bidder and target abnormal returns around merger announcements. We compile bidder and target abnormal returns in the 7-day window surrounding merger announcements using EVENTUS database. EVENTUS calculates abnormal returns by benchmarking realized bidder and stock returns (percentage change in stock price) in the event window against a model of normal returns. EVENTUS uses the market model to estimate normal returns using daily data in one year prior to the merger announcement. We compile merger terms such as the dollar value of the merger and whether the bidder used his own equity to purchase the target using SDC database.

H4: *Bidder firms enjoy higher abnormal returns around merger announcements, if the post-merger IT is greater than the pre-merger combined IT.*

We run regressions of bidder abnormal returns on post to pre combined IT ratio and control variables. We find that the coefficient of the IT ratio is statistically and economically significant. Findings are inline with investors incorporating anticipations about inventory efficiencies into stock prices around merger announcements.

5 Conclusion & Notes

- The effect of mergers on inventory turnover is investigated by comparing the change in the inventory turnover rate of the merged firms to the mean change in the inventory turnover rate in the industry of the merged firms. This methodology is similar to the one used in Gugler, Mueller, Yurtoglu, and Zulehner-IJIOrganization-2003 to measure the sales and profit change after mergers. (They did comparison to the weighted median sales and profit change in merged firms' industries with the same 2-digit ISIC). Chen, Frank, and Wu-MS-2005 also measure inventory performance of a firm wrt mean inventory days of firm's 3-digit SIC industry in the same year. (While they are checking the change in inventory performance in time, they check median ratio, because mean ratio is not doing good.) We need such an industry adjustment, because we know through analysis of our descriptive statistics and the results given by Gaur *et al.* (2005) with firm-level data for retailers and Rajagopalan and Malhotra (2001) with industry-level data for manufacturing industries that inventory turns significantly changes in time some with a negative and some with a positive trend both in firm-level and industry-level. Because of time trends of inventory turns and large variation in time trends among industries, we compare the inventory turn change of the merged firms around a merger with the mean inventory turn change in the merged firms' industry within the same time bucket.

- If we compare target turnover to bidder before merger, we need motivation on how bidders select targets such as to achieve operational synergies potentially well-operating targets could be selected.
- Studies on effect of merger on productivity/efficiency:
  - Harris II, Ozgen, Ozcan-JORS-2000 study effect of hospital mergers on technical efficiency
  - Bernad, Fuentelsaz, Gomez-Omega-2010 study effect of mergers on bank efficiency. They make a regression model to define output as a function of labor, asset and merger. Results:in half of the cases productivity increases after merger.
  - In fact, there are many studies on merger and productivity change relation in specific industries such as US road, meat, electricity, telecommunications etc.
  - So far, I could not find any study on merger-productivity relation in various industries together.
- **Limitation:** Theory is on product-level. With secondary sources, it is difficult to obtain product-level data, thus we use firm-level data, thus aggregate over all types of products and inventories, which may include finished products as well as work-in-process and raw materials.
- **Limitation:** There can be other variables included in the regression to explain the change in inventory turnover around the merger. But we focused on investigating inventory pooling benefit, so did not include much other variables. Check the explanation given in conclusions of Randall, Netessine, and Rudi-MS-2006.
- **Limitation:** Controlling for accounting changes!!!

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