08-078

Exploring Inventory Trends in Six U.S. Retail Segments

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Our paper describes inventory trends for both public and private U.S. firms in six retail segments between 1993 and 2005. This period coincided with the deployment of large-store formats, multiple store formats and extensive channel blurring in the U.S. retail industry. Our analysis is based on aggregate segment-level data from the Annual Retail Trade Survey (ARTS), the Monthly Retail Trade Survey (MRTS), and the U.S. Bureau of the Census end-of-month inventory survey. We find that the end-of-month inventory significantly increased in four of the six retail segments studied and that, after controlling for sales and macroeconomic factors, the positive time trends for the end-of-month inventory remained significant. Though all categories of macroeconomic factors investigated were found to be significant for at least one segment, only consumer price index, personal savings rate, and real gross domestic product were strongly significant. To explore further the dynamics of the segments and to provide an explanation for the increasing inventory trends, we examined the relationships between inventory, gross profit dollars, and gross margin return on inventory. We find that inventory is positively correlated to gross profit dollars but negatively correlated to gross margin return on inventory. This supports a potential explanation: Inventory trends may reflect the use of higher inventory levels by retailers to drive increased profits but with overall reduced gross profitability returns on the inventory investment. These results support the notion that the increased deployment of large-store, multiple store formats and the strategy of channel blurring by retailers, have generally increased both inventory levels and gross profit dollars across retail segments.

Key words: retailing industry segments; inventory; macroeconomic trends

1.   Introduction

Since the early 1990s, the retailing sector has undergone significant changes. As competition

intensified during the 1990s, retailers deployed strategies such as larger store formats, multiple store

formats, mergers and acquisitions, supply chain technologies, private-label products, and wider selections.

In 2007, the total end of the month inventory investment of all U.S. retailers, in real U.S. dollars,

averaged $496 billion; it had averaged only $272 billion in 1993.[1] In general, the specific set of strategies

adopted within each retail segment has been uniform across retailers within those segments and many of

these retail strategies had the potential to increase inventory holdings across retail segments or to

influence them indirectly. In this paper, we explore how inventory levels across specific retail segments

changed during the period of our study (1993-2005). We also examine the relationship between changes

in inventory levels and changes in retail segment sales and macroeconomic factors during the period.

Trends in inventory levels that remain after controlling for such relationships are attributed to the change

in retail strategies experienced over the period.

We investigate inventory holdings for six North American Industry Classification (NAIC) retail

segments and one subsegment—motor vehicles and parts dealers; furniture, home furnishings, electronics,

and appliances; building materials and garden equipment and supplies; food and beverages; clothing and

accessories; general merchandise; and department stores (a subsegment of general merchandise)—for the

period of 1993-2005 (see Table 1). We also investigate the influence of segment retail sales and other

macroeconomic factors on retail inventory. Specifically, we explore the impact of fourteen control

variables: federal interest rate, consumer price index (CPI), unemployment rate, personal savings rate,

consumer sentiment index, consumer confidence index, Purchasing Managers' Index, University of

Michigan inflation expectation, real disposable income dollars, Dow Jones index,[2] S&P 500 index, count

of new housing starts, real gross domestic product (GDP), and the conventional 30-year mortgage rate.

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[1] Calculated from data that was drawn from Retail Indicators Branch, U.S. Census Bureau, accessed Feb, 2008 from
http://www.census.gov/mrts/www/nmrtshist.html.
[2] Macroeconomic data for Dow Jones, S&P 500, housing starts, and conventional 30-year mortgage rate were
accessed June, 2006 from http://www.forecasts.org/data/data/djcompM.htm. Other data were gathered from Federal
Reserve economic data at http://research.stlouisfed.org/fred2 /data/.

We consider such a wide range of control variables because of the exploratory nature of our study and the diversity of retail segments being considered, while expecting that only some of those variables affect each retail segment. Although we do not generate strict hypotheses concerning the effect of these macroeconomic factors, we do relate our general expectations on their effects and briefly discuss findings.

The end-of-month inventory holdings significantly increased in four of the six segments. This trend was expected given the increased deployment of large store formats and the general expansion of retailers into overlapping product categories with other retailers. After controlling for monthly change in sales and other macroeconomic factors, we find that inventory holdings still show a positive trend for the same four segments. Furthermore, we did not find a positive relationship between sales growth and inventory for any of our segments. These results were surprising as we expected that inventory trends would have been driven by growth in sales over the period. We attribute the persistence of the trends to the retail strategies deployed over the period. We also find that inventory is positively correlated to gross profit dollars but negatively correlated to gross margin return on inventory and speculate on the dynamics underpinning the relationship between profitability and inventory. This finding suggests an additional explanation for the positive inventory trends observed: Inventory trends may reflect the use of higher inventory levels by retailers to drive increased profits but with overall reduced gross profitability returns on the inventory investment.

Our research contributes in at least four ways to the extant work on retailing. First, our finding that inventory increased after controlling for so many factors especially sales, and further that sales growth was not positively correlated with inventory is very interesting. Many of our controls, for example, sales and interest rates, are generally considered within the inventory management community to be primary drivers of inventory. Our findings suggest that across segments in retail, these factors are not always sufficient for one to understand inventory trends. Second, our study suggests that, within segments, higher inventory levels are being traded for increased gross profit and lower gross margin return on inventory. To our knowledge, this is a little studied dynamic in the inventory management literature within retail where the emphasis has been at the firm level and on a different tradeoff namely

between inventory turns and gross margin. Whereas this tradeoff between inventory turns and gross

margins relate to movement *along* so called efficient frontier return on investment curves, our findings

potentially relate more to movement *across* different frontier curves. Our research suggests the need for a

synthesis of both perspectives in order to provide a more satisfying treatment of the inventory dynamics

operating within retail. Third, we study both public and private firms at the segment level. Although

private retail companies held about 62% of retail inventories over the period of 1995-2004, prior research

focused only on public firms. Therefore, our analyses should yield more representative results for

inventory trends in retail. Fourth, we explore and identify macroeconomic factors that affect inventory

holdings within segments. Many of these macroeconomic variables have not been studied before; some

emerged from a comprehensive assessment of historical commentaries on these retail segments.

The rest of the paper is structured as follows: Section 2 presents a review of the literature and of

the trends in retailing during our period of study. Section 3 summarizes the survey sample and describes

the data used. Section 4 presents the analyses of inventory time trends. Section 5 explores the influence

of sales and macroeconomic factors. Section 6 analyzes the relationships between inventory and gross

profit dollars and between inventory and gross margin return on inventory. Section 7 presents

implications for managers.

2.   Review of Literature and Retail Strategy Trends

2.1.   Review of Literature

Although inventory has been one of the most-researched topics in operations management for the

past 40 years, empirical studies of inventory levels and inventory performance have only recently been

pursued with fervor. A review of the literature reveals three streams of operations management research

on inventory. First, there are studies of the impact of specific improvement techniques on the inventory

performance of manufacturing firms, for example, Balakrishnan et al. (1996) and Huson and Nanda

(1995). The second stream of research investigates general trends in inventory at the industry or firm level

without regard to any specific improvement concept; for example, Rajagopalan and Malhotra (2001) and

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Chen, Frank, and Wu (2007). The third stream of research seeks to understand the relationships between inventory performance and both operational drivers and stock-market performance, for example, Gaur, Fisher, and Raman (2005), Netessine and Roumiantsev (2005), and Hendricks and Singhal (2005).

None of the above studies examines inventory levels for both private and public retail firms. Our study attempts to evaluate inventory trends at the segment level for both private and public retail firms and thus the validity of our analysis is unaffected by unobserved firm births and deaths. Though unobserved, our interpretation of results makes use of the dynamics of net firm entry or exits. We also propose segment-level dynamics and macroeconomic factors that are related to those trends. Due to an unavoidable limitation of our data set, we ignore firm-level effects. For the retail industry, however, the strategy, operations management, and economics literatures suggest that segment-level effects would dominate firm-level effects. For example, McGahan and Porter (1997) report that industry effects explain more of the variance in profitability of public wholesale/retail firms than firm effects explain (41.79% versus 2%); Lai (2006) found the same for inventory levels for public retail firms (35.2% vs. 26.5% - retail industry). These papers are also examples of findings that suggest differences across industries with respect to profitability and inventory levels. In fact, the firm–industry relationship just described is reversed for the manufacturing industry. In the economics literature, the study of irreversible investments (those for which sunk costs cannot be recovered if market conditions change adversely) suggests that the segment effects due to aggregate uncertainties in future marginal profitability may dominate the effects of firm-level or idiosyncratic uncertainties (Dixit, 1992; Pindyck, 1993; Caballero and Pindyck, 1996). The dominance of such segment effects would be more applicable to inventory investments resulting from firm entry and exit than to changes in inventory levels within existing firms, since the former are more traditionally considered irreversible investments.

2.2. Retailing Trends in the 1990s and 2000s

In the early 1990s, retailing segments were characterized by vertical stratification with well-defined categories such as supermarkets (the places to buy food), drug stores (the places to buy medicine), and department stores (the places to buy higher-value and higher-priced goods). But with the rise of

channel blurring—whereby retail segments expanded their product assortments beyond traditional boundaries—consumers have been able, for example, to buy food at drug stores, warehouse clubs, discount stores, and supercenters as well as at supermarkets (Racher, 2004, 2005). Channel blurring is also associated with the emergence of larger store formats and multiple store formats. Wal-Mart built its first 125,000-square-foot supercenter in Washington, MO in 1988 and, by 2004, had rolled out 1,471 supercenters. Target opened its first SuperTarget in 1995 and has now built over 150 of them. The grocery industry has been significantly affected by the trend towards larger store formats, with supercenters replacing supermarkets and discount markets. Retail chains such as Kroger, H. E. Butt, Loblaw, and Weis Markets have all explored larger store formats (Veiders, 2006), differentiating their large-store formats from those of the discounters by adding specialty and local items (Toth, 2006).

While such growth strategies may have affected the retail industry's overall competitive environment and with expectation for an increase in inventory over the last decade, other factors were influencing inventory trends within the specific retail segments we studied.

Motor vehicles and parts. The period of our study saw heavy capital investment by auto manufacturers. Between January 1994 and June 2003, foreign automakers invested $12 billion to construct factories in China, partly because of its huge market potential. Despite the considerable investment in China, with European and Japanese car companies moving a significant proportion of their auto capacities to the Midwest, by the end of June 2003, investments in the United States totaled $6.1 billion (Levy, 2004). Such investment, along with other industry factors, increased inventory holdings. By the end of February 2003, the U.S. auto industry inventory of light vehicles stood at 79 days, well above the normal level of about 60 days (Levy, 2004). Foreign vehicles did not fare better, as the dollar's weakness made imported vehicles more expensive for American consumers, slowing their sales for foreign manufacturers and raising their inventory levels (Levy, 2003).

The auto parts replacement segment faced similar challenges. The top auto parts retailers, including AutoZone and the Pep Boys, added hundreds of new stores, yet demand grew slowly. The segment also experienced the introduction of large retail formats, such as AutoZone, Inc. (Souers and

Normand, 2005). However, automakers were increasingly replacing traditional mechanical parts with electronic and computerized components, which prevented do-it-yourself consumers from repairing their own cars. In addition, the improved quality of original equipment components was lengthening the time between replacements (Levy, 1999).

Apparel. The apparel sector's evolution proved a bit more complicated. Discounters, such as Target and Wal-Mart extended their product lines with branded apparel and their own private labels (Amobi, 2002). In response, department stores collaborated with apparel manufacturers and expanded their own assortments of branded goods, devoting large portions of their stores' square footage to concept shops displaying major lifestyle brands such as Tommy Hilfiger, Ralph Lauren, and Nautica Apparel (Fraser, 1998). Due to both higher levels of inventory and price competition, apparel retailers often marked down inventory to move items and reduce inventory. In 2001, 50.8% of total apparel spending was for sale items, up from 48.9% in 1998 (Amobi, 2002). As one would expect, the markdowns had a dampening effect on prices. U.S. consumer prices for apparel dropped steadily since 1999. According to U.S. Labor Department data, consumer prices for apparel declined annually from 1998 through 2003. In 2003, apparel prices fell 2.1% from 2002 levels (Driscoll, 2004, 25).

Electronic appliances. In the late 1990s and early 2000s, the electronic appliance segment experienced a wave of changes. Profit margins for personal computers and software decreased, possibly due in part to the expansion of mass merchants into the electronic goods business and to the advent of Internet retailers. This decline in turn precipitated a wave of store closings, consolidations, and restructuring among consumer electronics firms. The surviving specialty retailers, such as Best Buy and Circuit City, refrained from cutthroat pricing tactics and saw sales and profit growth move from single digits in 1998 to double digits in the first half of 1999 (Carini, 1999). These retailers also expanded very aggressively; for example, company data shows that Best Buy increased its store count by over 100% in the U.S. market (from 311 stores in 1999 to 631 stores in 2004) as well as increasing its proportion of larger-sized stores. Yet, despite the reduced use of cutthroat pricing tactics (Carini, 1999), prices in the electronics sector decreased during the decade ending in 2004 (Wagle and Normand, 2005).

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Household appliances. The trends in the household appliances, home goods and home improvement, and furniture subsegments seem to have been influenced by macroeconomic factors related to real estate. Homebuilding and homebuying activity rebounded in late 1995 and grew steadily, setting a record in 1998 and remaining strong in 1999 (Levy, 1999). Lower mortgage rates, which freed up disposable income and allowed consumers to buy bigger homes, has historically been positively correlated with sales growth for home appliances, home improvement, and furniture. This segment also experienced channel blurring as home-improvement specialty stores began stocking household appliances. Moreover, the leading home improvement chains pursued aggressive growth plans. Home Depot added 175 new stores in 2003 and in each of the two previous years introduced 200 plus new stores (Asaeda, 2004). As a result, Lowe's, Home Depot, and Best Buy increased their market shares, overtook Sears Roebuck, and have become the three largest household appliance retailers in the United States. Lowe's reported that sales of appliances, the firm's largest product category, rose 11% in 2002, 2003, and 2004 (Souers and Normand, 2005). Industry observers also postulated that the success of larger formats in this segment enabled Home Depot and Lowe's to gain market share in the appliance sector at the expense of Sears (Wagle, 2004).

Furniture. The furniture segment was affected by events beyond the housing market. The increasing shift of furniture production to China hurt prices and gross margins. U.S. imports of wooden bedroom furniture from China were $1.2 billion in 2004, up from just $29 million in 1996—an average annual growth of about 15%. During the same period, retail sales at furniture stores rose at a compound annual rate of just 5.2% to reach $56.7 billion, according to the U.S. Bureau of Labor Statistics. Between 1996 and 2004, while the consumer price index (CPI) increased 20.4% (not seasonally adjusted) in the U.S., the CPI for furniture and bedding decreased by 5.1% (Glynn, 2005). Since 2003, the growth in the house-building market has fallen in many parts of the U.S., depressing growth in the furniture segment.

3.   Survey Sample and Data Description

We use data from the Annual Retail Trade Survey (ARTS), the Monthly Retail Trade Survey (MRTS) of sales, and the U.S. Bureau of the Census survey of end-of-month inventory. The data cover the period 1993-2005 and were gathered from U.S. retail establishments and from firms offering services to retail establishments such as repair and installation. The retail establishments included store retailers, who operate fixed point-of-sale locations, and non-store retailers such as wholesalers and mail-order retailers.

U.S. law mandates the Annual Retail Trade Survey (ARTS) in order to document the state of the retail sector, which is defined as sectors 44 and 45 of the 2002 North American Industry Classification System (NAICS). The survey includes all retail establishments registered to conduct business in the U.S., both publicly traded companies and privately owned businesses operating under employer identification numbers (EIN). The Internal Revenue Service assigns EIN to companies formed in the U.S. A representative sample of 20,000 retail businesses—about 12,000 unique firms—receives the ARTS every year. That sample includes firms with the largest sales in their respective groups (certainty group) and a stratified random sample of firms, using their EIN numbers (non-certainty group). The dollar volume[3] response rate for ARTS is 90 percent.

In addition, the U.S. Census Bureau also gathers monthly data about retail-trade-sector sales via the MRTS, which is voluntary and includes about 4,000 unique firms, a subset of the sample used for the ARTS. To reduce the burden on firms participating in the monthly retail inventory surveys, only a segment of the ARTS sample is invited to participate in the monthly sales surveys. To compensate for EINs that are in the ARTS sample but are not used for the monthly surveys (MRTS), the non-certainty sample for the monthly surveys is appropriately weighted. The response rate for the monthly sales survey is 80% of the total dollar volume surveyed; the response rate for the end-of-month inventory surveys is 70% of the total dollar volume. The Census Bureau uses an imputation process to project the missing data from the trends of similar firms that did report their data.

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[3] The U.S. Census Bureau strictly protects the confidentiality of the respondents. It measures the response rate by the dollar volume of sales of those responding to the survey, not by the number of unique firms responding.

Our study uses a balanced panel. Due to the Census Bureau's confidentiality practices, we do not have access to the firm-level data. Consequently, our analysis is based on aggregate segment-level data. We use two data sets in our study. The first consists of 1,092 observations of end-of-month inventories and of fourteen macroeconomic variables and is used to estimate the temporal trends in inventory and the effect of macroeconomic factors. The inventories are valued using non-LIFO (last-in-first-out) methods. Hence, some establishments might use an average-cost method while others use the first-in-first-out (FIFO) method. The second data set consists of 72 yearly observations—across six retail segments for 12 years (1993-2004)—of average inventory, sales, cost of goods sold (COGS), gross profit, and purchases. We use this data set for our analyses of inventory's relationship to profitability.

4.   Inventory Trends

In this section, we investigate the temporal trends for inventory levels across the retailing segments studied.

Figure 1 shows an overview of the end-of-month inventory level (inflation-adjusted to 1993) and the number of months of sales in inventory for all six segments and the subsegment of department stores for the period 1993-2005. End-of-month inventory levels increased for all segments except the food and beverage segment and the department stores subsegment. Months of sales in inventory for retailing is higher than the average for all U.S. retail trade and manufacturing (our benchmark) for all the segments we studied except food and beverage. If we assume that a downward trend is positive, the general merchandise stores seem to have achieved the most improvement in months of sales in inventory while the inventory to sales ratio for all segments, except for the motor vehicle segment, decreased over time.

We investigate the inventory trends in each segment using the following logarithmic model:

$$\log I_{smt} \;=\; a_s \;+\; c_m \;+\; b_s\,(t-1993) \;+\; v_{smt}\,, \tag{1}$$

where I_{smt} is the end-of-month inventory in month m of year t for segment s; a_s and b_s are the intercept and slope, respectively; and the variable c_m captures month fixed effects. The model is similar to that

used by Chen, Frank, and Wu (2005). Initial OLS estimates reveal the presence of autocorrelation for both measures of inventory holdings, so residuals (υ_{smt}) are modeled using an AR(p) error correction:

$$v_{smt} = \sum_{i=1}^{p} \varphi_{is} v_{s,m-i,t} + \varepsilon_{smt} ,\qquad (2)$$

where $\upsilon^{-}_{smt} = \upsilon_{s,m-1,t}$ if m>1 and $\upsilon_{s,12,t-1}$ otherwise, and where φ_{is} is a parameter to be estimated and ε_{smt} are assumed to be independent and normally distributed. We estimate model (1) using the Yule-Walker estimation method.

Table 2 shows the results of the analyses for the real end-of-month inventory holdings. We find that the food and beverage segment and the department stores subsegment showed a decreasing temporal trend, the general merchandise segment showed no significant trend, and the other segments showed a significant upward trend. The results suggest that merger and consolidation activities may have had a greater effect on the food and beverage segment than the channel blurring effect did. We find that the largest buildup of inventories occurred in the motor vehicle and the building materials and garden equipment segments. The former effect may be due to the heavy capital investment in production capacity and to changing patterns in do-it-yourself auto repairs, while the latter effect seems to be related to the expansion of home improvement retailers into household appliances, fueled by the housing boom of the 1990s. The zero-growth trend in general merchandise is surprising, but seems to be associated with the negative growth of the department stores segment — which is a significant proportion of the general merchandise segment — that apparently masked the growth of discount and warehouse retailers. All the results were statistically significant at the 0.01% level and the total R-squared values were high.

These results, while useful, still do not tell us much about what influenced the inventory holdings trend from 1993-2005. We explore such factors in the next section.

5.   Impact of Macroeconomic Factors on Inventory Holdings

In this section, we explore the possible impact of sales and macroeconomic factors on segment inventory holdings trends.

Sales could affect inventory holdings in two primary ways. First, sales growth in retail is usually positively associated with inventory growth. Second, independent of a trend, the strength of sales in a particular month would also affect the inventory holdings at the end of that month; for example, unexpectedly high sales would reduce inventory holdings. We test for the relationship between inventory and sales using monthly differences in sales or sales growth as a dependent variable. We expect that the former effect should dominate.

We expect that macroeconomic factors may influence the entry of firms into segments and the exit of firms from segments and may drive inventory decisions across segments. For example, if interest rates fall, potential investors might conclude that the prospects for making profits in a particular segment are better, which in turn could encourage more firms to enter that segment. Given the lead times involved in entry and exit from segments versus the lead times involved in inventory decisions, longer lagged effects of these macroeconomic variables would be more likely to influence entry and exit from segments than shorter lagged effects would.

Our macroeconomic variables are categorized and briefly described below. Real dollar values, chained to the year 2000, are used for the analyses.

a. *Prices*. The *Consumer Price Index (CPI)* measures the changes in the prices of commodities, fuel oil, electricity, utilities, telephone services, food, and energy in the U.S. The CPI also includes excise and sales taxes because they are expenditures for the customer. The *inflation rate* captures the changes in prices of consumer commodities; we use the University of Michigan's inflation expectation index. When prices are high, demand is expected to fall so retailer replenishment should fall and inventory levels should decrease.

b. *Cost of capital*. The *federal funds rate* is used by the U.S. Federal Reserve Board of Governors to influence the borrowing activities of banks. We expect that an increase in this rate would be associated with a decrease in inventory holdings.

c. *Customer purchasing activity*. The purchasing activity of consumers is determined by their disposable incomes and the propensity to save. We use the *real disposable income* and *personal*

saving rate to capture these effects. An increase in disposable income or decrease in personal savings rate should be generally associated with expectations of increase in demand and therefore an increase in inventory holdings.

d. *Perceptions of the economy*. The *consumer confidence index* and *consumer sentiment index* capture customer perceptions of the economy. We use the Conference Board's index for the former and, again, the University of Michigan's index for the latter. Both are based on household surveys of opinions on current and future economic conditions. For retailers, the *Purchasing Managers Index* (PMI), reported by the Institute for Supply Chain Management, is a measure of the perception which purchasing managers have of the economy. Positive perception of the economy, on the part of purchasing mangers or of customers, should be associated with an increase in inventory holdings.

e. *State of the economy*. Real *gross domestic product* (GDP), as reported by the U.S. Bureau of Economic Analysis, measures income or output for the U.S. economy. We also use the *U.S. unemployment level* as a direct indicator of the state of the economy. Low levels of economic activity should be associated with a decrease in inventory holdings.

f. *Stock indices*. The *Dow Jones index* and the *Standard & Poor 500* (S&P 500) measure the value of selected U.S. stocks. Both are commonly used by the media as surrogate indicators of the state of the U.S. economy. An increase in these stock indices should be associated with an increase in inventory holdings.

g. *Housing industry*. We capture housing industry activity with the *30-year mortgage rate* and the number of *new housing starts*. An active housing market is expected to be associated with an increase in inventory holdings.

The data for sales and macroeconomic factors are monthly time series. To reduce the effects of multi-collinearity, we detrend the macroeconomic variables by taking differences. We use 1-month and 12-month lagged dependent variables to capture possible lead times in both firm entry and firm exit decisions and to capture the effect of common short-term and long-term inventory decisions.

We use equation (3) for our analyses:

$$\log I_{smt} = u_s + w_m + b_s(t-1993) + c_s \log\!\left(S_{smt}/S_{smt}^{-}\right) + \sum d_{ks} \log\!\left(E_{kmt}/E_{kmt}^{-}\right) + \upsilon_{smt},$$ (3)

where the variable u_s represents the group fixed effects, w_m captures the month fixed effects, b_s is the coefficient for the time trend, and c_s is the coefficient on differences in sales. $S_{s,mt}$ is sales for segment s in month m of year t, where $S^{-}_{smt} = S_{s,m-1,t}$ if m>1 and $S_{s,12,t-1}$ otherwise. k is the index depicting the macroeconomic factors, d_{ks} is the coefficient for segment s, and E_{kmt} is the macroeconomic factor type (such as inflation rate or GDP) for segment s, month m, and year t. Again, $E^{-}_{kmt} = E_{k,m-1,t}$ if m>1 and $E_{s,12,t-1}$ otherwise. Finally, υ_{smt} is the residual.

Initial OLS estimates reveal the presence of autocorrelation (Durbin-Watson statistics) and heteroscedasticity (Lagrange Multiplier Test; Engle, 1982), so residuals (υ_{smt}) are modeled using the AR-ARCH regression model (Weiss 1984) shown below:

$$
\begin{aligned}
\upsilon_{smt} &= \varepsilon_{smt} - \sum_{i=1}^{f_s} \varphi_{is}\upsilon_{s,m-i,t} \\
\varepsilon_{smt} &= \sqrt{h_{smt}}\, e_{smt} \\
h_{smt} &= \varpi_s + \sum_{i}^{q_s} \alpha_{is}\varepsilon^2_{s,m-i,t}
\end{aligned}
$$ (4)

This model combines an autoregressive (AR(p)) model with autoregressive conditional heteroscedasticity (ARCH(q)) errors (Engle 1982, 2001). The ARCH(q) error-correction model is a short-memory process that uses the most recent q-squared residuals to estimate the changing variance. AR-ARCH regression models combine the advantages of AR models, which target more on the conditional mean of υ_{smt} (given the past), and ARCH models, which concentrate on the conditional variance of υ_{smt} (given the past). The statistical and/or probabilistic properties of such models have been investigated by Weiss (1984) and Borkovec and Klüppelberg (2001), among others.

In (4), φ_{is}, ω_s, and α_{is} are parameters to be estimated while e_{smt} are assumed to be independent and standard normal in distribution. These so-called ARCH effects are common in macroeconomic time series, with Weiss (1984) reporting ARCH effects in logarithmic transforms of a number of

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macroeconomic time series, including price indices, industrial production, output per hour, and national income. In addition, ARCH models—and their extensions, such as GARCH (Bollerslev, 1986)—are widely used to model financial time series (see Bollerslev, 1992). We estimate model (3) using a maximum likelihood estimation method. Normality tests (Bera and Jarque, 1982) for e_{smt} did not reject the null hypothesis of normality at the 5% significance level. The results of our analysis are captured in Table 3.

Results

Time Trends

Table 3 shows that our analysis generally confirms the time trends described in Section 4. We find an insignificant positive trend for the general merchandise segment, a significant negative trend for the food and beverage segment, and significant positive trends for the other four segments. The department stores subsegment shows a negative significant trend.

Extending the findings of Chen, Frank, and Wu (2007) for publicly traded retail firms, we find that inventory holdings increased in several retail segments between 1993 and 2005 across both public and private U.S. retail firms. However, our findings also differ from theirs. Chen, Frank, and Wu conclude, before controlling for macroeconomic factors, that only two out of fourteen retail segments exhibited declining trends in inventory days from 1981-2004. Specifically, they find no significant trends for the furniture and home, building materials and equipment, grocery stores, and clothing and accessories segments. Of the three panel models that they investigated, only one showed a significant positive trend for the motor vehicle and parts and the general merchandise segments. We, in contrast, find strong and significant time trends for most of these segments both before and after we control for the effect of macroeconomic variables. Four of the six retail segments that we investigated exhibited significant time trends. The positive time trends remained even after we controlled for changes in macroeconomic factors and changes in sales. The food and beverage segment exhibited a strong negative trend. This suggests that, during 1993-2004, privately held retail firms, whose inventories make up about half of the entire U.S. retail inventory holdings, may have experienced a stronger increase in end-of-month inventory than

did publicly held firms. However, the difference between our results and those of Chen, Frank, and Wu might be attributable to the two studies' different time periods. While our reference period begins with 1993, the beginning of the era of channel blurring, Chen, Frank, and Wu began with 1981.

Relationship to Monthly Sales

The coefficients of sales growth provide unexpected insight into the effect of sales on inventory trends. Table 3 shows that sales growth was significant for only two segments, building materials and equipment and food and beverage, with a negative coefficient in both cases. Sales growth in the department stores subsegment also showed a significant negative relationship to end-of-month inventory. Underlying the surprise in this result is the positive relationship that we expected between inventory and sales growth. Though the result does not absolutely negate the expected positive relationship between inventory and sales, it does introduce some doubt about this relationship and as a result, some support for considering other drivers such as change in the retail strategies discussed in section 2.

Impact of Macroeconomic Variables

In interpreting the results for macroeconomic factors, we make some helpful simplifications. First, we interpret the results by macroeconomic category types. For example, all the macroeconomic factors categorized as stock market indices are interpreted together to reveal the relationship between end-of-month inventory and the stock market. Second, we consider macroeconomic variables that significantly impact three or more retail segments as being particularly relevant. Third, given the large number of factors considered in our model, we interpret regression coefficients whose values are higher than 0.1 as strong and concentrate our interpretation on these findings. Fourth, if the regression coefficients for a macroeconomic factor suggest a general increase (decrease) in strength from 12-month lags to 1-month lags, we consider such a factor to be near-term (long-term) dominant.

In summary, although most of our macroeconomic factors were relevant at both 1-month and 12-month lags, only three—consumer price index, personal savings rate, and real gross domestic product— had coefficients greater than 0.1 at both the 1-month and 12-month lags and all three can be considered near-term dominant. At 1-month lags, month-to-month increases in consumer price index and real gross

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domestic product are generally negatively associated with end-of-month inventory, while month-to-month increases in personal saving rate are generally positively associated with end-of-month inventory. At 12-month lags, consumer price index is still negatively associated with end-of-month inventory, real gross domestic product is not relevant but has strong positive coefficients for two segments, and personal savings rate has no dominant relationship across segments.

One interpretation of the result for the consumer price index is that retailers consider an increase in CPI as an indicator of greater uncertainty surrounding profitability or of lower projected profitability due to reduced demand, either of which would discourage both firm entry into a new segment and short-term expansion within a segment. With respect to real gross domestic product, the results are unexpected, as a strong economy should encourage expansion, and suggest that retailers may generally ignore changes in real gross domestic product in the near term. Similarly, the results with respect to the personal savings rate are unexpected, as an increase in personal savings rate should discourage expansion within segments, and suggest that retailers may generally ignore changes in personal savings rate in the near term.

6.   Examining the Relationship between Inventory and Profitability

As argued in the introduction, segment trends in inventory holdings could be determined by profitability within segments, with inventory investments naturally being expected to move in the direction of profitability. Profitability can be measured by margin or by return on assets or equity or it may even be approximated by sales growth (Gaur, Fisher, and Raman, 1999). We examine the relationship between inventory and gross profit dollars and between inventory and gross margin return on inventory (GMROI) within segments to provide an explanation for the inventory trends observed.

6.1.   Development of Hypotheses

Our examination of inventory trends in Section 5 suggests that inventory holdings have increased over the period studied. Such inventory gains are the result either of a net entry of competitors into retail segments or of decisions to maintain higher levels of inventory. Net entry of competitors into retail segments can be driven by the lure of higher gross profits or higher return on inventory investments.

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Decisions to maintain higher levels of inventory can be financed by increased levels of gross profits or by higher return on inventory investments.

We posit the following:

Hypothesis 1: *Average annual inventory will be positively correlated with gross profit dollars in retailing segments.*

Hypothesis 2: *Average annual inventory will be positively correlated with gross margin return on inventory in retail segments.*

These hypotheses are directly motivated by the general positive trends we find in inventory across retail segments. We recognize, however, that inventory growth could be negatively correlated to profitability; for example, if a retailer changes its replenishment strategy to smaller order sizes, lower inventory levels, and more frequent deliveries. Alternatively, a retailer's profits could decrease while inventory levels grow. For example, if a firm enters a segment already suffering from stagnant demand, oversupply can provoke price competition, which decreases profits and causes high inventory level. In such a case, the rise in inventory level might also be associated with price and profit uncertainties. For example, in a saturated market, if a wait-and-see attitude prevails, especially among retailers that should exit the segment, inventory level could be expected to be high while profitability falls (Caballero and Pindyck, 1996). Such a trend could also be triggered if enough actors in a segment use inventory levels to create a barrier to entry.

We use gross profit dollars as a measure for a number of reasons. First, we hope to complement the retail inventory literature, in which gross profit dollars has not been studied as much as gross margin rate (gross profit dollars as a proportion or percentage of sales). Second, the financial interpretation of gross margin rate depends on inventory turns since, for example, a gross margin rate of 30% with 10 turns per fiscal year results in lower gross profit dollars *ceteris paribus* than a 20% gross margin rate with 20 turns per year. Hence, gross margin rate requires additional information to help determine a ranking on a dimension central to the success of retailers whereas gross profit dollars does not. However, one can generally use gross profit dollars to rank retailers. Finally, our data, as shown in Figure 2, show that gross

margin rate (percent) has been flat in the retail segments studied, while gross profit dollars and GMROI have not. Similar commentary on gross margins for public companies can be found in Gaur, Fisher, and Raman (2005: 190).

6.2   Data Set and Definitions of Variables

Our data set consists of 72 yearly observations—across six retail segments for 12 years (1993-2004)—of average inventory, sales, COGS, gross profit dollars, gross margin percent, and purchases. Figure 2 provides graphs of COGS, average end-of-month inventory, annual real purchases, gross profit dollars, gross margin percent, and GMROI. The costs of goods sold were calculated from inventory records (or, in case of missing values, from comparable projections), not from accounting records. This eliminates the effect of indirect costs such as occupancy, warehousing, and distribution, which are often aggregated into accounting data (see Gaur, Fisher, and Raman, 2005). Finally, the measures GMV_{st}, S_{smt}, I_{smt}, and P_{st} (defined below) are taken from the reported data of the Annual Retail Trade Survey and the U.S. Census Bureau end-of-month inventory survey.

Defining our variables of interest, let:

I_{smt} denote end-of-month inventory of segment s in month m of year t, valued at cost using a non-LIFO method and reported on or transformed to December 31.

$\hat{I}_{st}$ denote average end-of-month inventory for segment s and year t.

S_{smt} denote sales net deductions, such as refunds and excluding taxes, for segment s in month m of year t.

$\hat{S}_{st}$ denote annual sales net for segment s and year t.

P_{st} denote the annual purchases made in segment s in year t. This variable excludes all purchases not intended for resale and includes inventory in the retailer's warehouses and inter-company transfers (at cost value).

CGA_{st} denote cost of goods available for sale in year t in segment s. This variable is the sum of the preceding year's end-of-year inventories and the current year's annual purchases: $CGA_{st} = P_{st} + I_{s12(t-1)}$.

CGS$_{st}$ denote the calculated cost of goods sold. We derive this variable by deducting the end-of-year

(month 12) inventory I$_{s12t}$ from the total cost of goods available for sale in year t in segment s

(CGA$_{st}$): CGS$_{st}$ = CGA$_{st}$ - I$_{s12t}$.

GMV$_{st}$ denote the gross profit dollars of segment s in year t in dollar value: GMV$_{st}$ = $\hat{S}_{st}$ - CGS$_{st}$.

GMROIst denote the gross margin return on inventory investment of segment s in year t:GMROIst =

GMVst/ $\hat{I}$st .

6.3   Model Specification and Analysis

To test Hypothesis 1, we examine model (5) below, using a log linear model to reduce the effect of

specification error:

$$\log (\hat{I}_{st}) = F_s + C_t + \beta_1 \log (GMV_{st}/ GMV_{st-1}) + \beta_2 \log (CGS_{st}/ CGS_{st-1}) + \beta_3 \log (P_{st}/ P_{st-1}) + \upsilon_{st}, \quad (5)$$

where F_s are segment fixed effects and C_t are year fixed effects. β_1 captures the sign of the correlation

between inventory and gross profit dollars. We control for differences in cost of goods sold as we did in

our analysis of inventory trends. We also control for annual purchases, since this is a direct source of

inventory. Since the coefficient β_3 captures the associated effect between annual purchases and inventory,

it is a measure of the efficiency of inventory replenishment; for example, a negative coefficient implies

that an increase in purchases is associated with a decrease in inventory.

Again, because of the presence of autocorrelation and heteroscedasticity, errors (υ_{st}) are modeled

using an AR-ARCH regression:

$$\upsilon_{st} = \varepsilon_{st} - \sum_{i=1}^{f} \varphi_i \upsilon_{st-i}$$

$$\varepsilon_{st} = \sqrt{h_{st}} e_{st} \qquad\qquad (6)$$

$$h_{st} = \varpi + \sum_{i}^{q} \alpha_i \varepsilon_{st-i}^2$$

To test Hypothesis 2, we examine model (7) below:

$$\log (\hat{I}_{st}) = F_s + C_t + \beta_1 \log (GMROI_{st}/ GMROI_{st-1}) + \beta_2 \log (CGS_{st}/ CGS_{st-1}) +$$

$$\beta_3 \log (P_{st}/ P_{st-1}) + \upsilon_{st} . \qquad\qquad (7)$$

Comparing models (5) and (7), we see that the only difference is that the difference in gross margin has been replaced with the difference in gross margin return on inventory.

6.4. Results

Gross Profit Dollar and GMROI

The results of our analyses of models (5) and (7) are presented in Tables 4 and 5. Our results provide weak support for Hypothesis 1 and no support for Hypothesis 2. For model (5), the coefficient β_1 has value 0.057, which is significant at the 10% level. For model (7), the coefficient β_1 has value -0.276, which is significant at less than the 0.1% level. These results support an argument that the general upward inventory trends seen in retail segments during the period of study could be explained by an associated increase in profitability in absolute terms but not by an increase in GMROI, a measure of return on investment. This suggests that inventory levels and/or level of competitors in retail segments were at a point where there were generally weak but positive returns on gross margin from inventory growth, but that these returns were generally lower than the investment in inventory. One possible explanation for this is that inventory investments have been generally successful in driving better customer service by reducing lost sales but are not so successful in driving higher store traffic.

The results do, however, seem to indicate that increasing levels of inventory are linked to rising gross profit dollars. This results stands in seeming contrast to findings from manufacturing, where just-in-time programs and other approaches based on reducing inventory are generally associated with improved performance. The contrast may be explained by the different roles firms play in these two sectors and in how customers reward these firms. Generally, manufacturers play a build-to-order role and thus are rewarded for consistently being able to provide goods with a mutually agreed upon lead-time. In such settings, some argue that excess inventory can hinder the continued development of this capability. Retailers are more and more a one-stop destination for the instant gratification of getting the product you want right now and nearby rather than later on or further away. In such a setting, it is easy to argue that higher inventory is better than lower; our data seem weakly to confirm that argument.

Purchases

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The significant negative coefficient on purchases of -0.726 for model (5) and the negative but not significant coefficient of -0.074 for model (7) moderately suggest some degree of proficiency for inventory replenishment within retail. Ordinarily, an increase in the number of firms entering a segment and an increase in the expansion of existing firms would require an increase in the level of replenishment stocks; that is, in the annual purchases for the segment. Consider, however, the contribution of anticipatory buying on inventory holdings assuming holiday, seasonal, or other demand trends that can be anticipated within each retail segment. Such anticipatory buying—for example, buying that targets a constant number of months of sales in inventory (Kahn and McConnell, 2002)—leads one to expect that purchases will be made ahead of demand in a manner that corresponds to anticipated sales. This will cause increases in purchases to correspond to increases in inventory turns or to decreases in inventory. The confirmation of this relationship does suggest such capability to forecast demand. It would also suggest improved logistics and efficient replenishment systems at the segment level (Kapuscinski et al., 2004; Myers et al., 2004; Lutz et al., 2003). Our review of industry trends suggests that retailers have invested in relationships with suppliers, in modern technology such as electronic data interchange (EDI) and in supply-side programs such as Quick Response in order to streamline replenishment (Asaeda, 2005; Izmirlian, 1999; Sack, 1999).

7.   Managerial Implications

Our study produced several results. We find that the end-of-month inventory holdings increased in four of the six retail segments studied from 1993-2005and that controlling for sales and macroeconomic factors generally reinforces these positive time trends. Furthermore, unexpectedly sales growth was not found to be positively related to inventory. We suggest that retail strategies, such as the deployment of large and multi-format stores, acquisitions, and store closings may have contributed to a net positive inventory trend. Though all the categories of macroeconomic factors were found to be relevant, only prices, namely the CPI index, personal savings rate, and real GDP were found to be strongly so and near dominant with the effect for 1-month lags generally larger than 12-month lags. At 1-

month lags, CPI and real GDP are generally negatively associated with end-of-month inventory, while the personal savings rate is generally positively associated with end-of-month inventory.

In order to provide additional explanation for our findings on inventory trends, we examined the relationships between inventory and gross profit dollars and between inventory and gross margin return on inventory. We find that inventory is positively correlated to gross profit dollars but negatively correlated to gross margin return on inventory. This supports a potential explanation that higher inventory is contributing to profitability at the expense of gross margin rate. We also find a negative correlation between inventory and purchases, a result with interesting managerial implications.

Our findings on the relationship between inventory and gross profit dollars seem to underscore a difference between the role of inventory in retailing and its role in manufacturing, where fewer inventories is considered better. This difference, we argue, is based on the fact that retail customers now seem to reward one-stop shops, a preference which retailers themselves have encouraged. However, the negative correlation between inventory and GMROI also suggests that inventory levels and/or level of competition in retail segments were at a point where investment in inventory exceeds the returns on gross margin from inventory growth. It may be that inventory investments were improving sales more by reducing lost sales than by driving higher store traffic.

While the negative correlation between changes in purchases and changes in inventory suggests that retailers have adequate processes for managing replenishment, in part due to improved supply chain management technologies, it does not imply that there is no room for improvement. Potentially beneficial replenishment strategies are still being identified, such as better coordination between retailers and suppliers (Controller's Report, 2006), common replenishment periods (Viswanathan et al., 2001; Piplani and Viswanathan, 2004), better information-sharing (Kulp, 2002), alignment of incentives (Piplani and Fu, 2005) reduction of replenishment lead time and elimination of lead-time variability (Chopra and Reinhardt, 2004), and improved retail store execution (Raman, DeHoratius, and Ton, 2001). Such strategies will raise profitability expectations for inventory investments, so we would hypothesize that the

implementation of these strategies will result in increased retail inventories rather than decreased inventories.

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Figure 1: Mean Monthly Month-of-Sales in Inventory and End-of-Month Inventory (Retailing versus Total Manufacturing and Total Retail Trade)
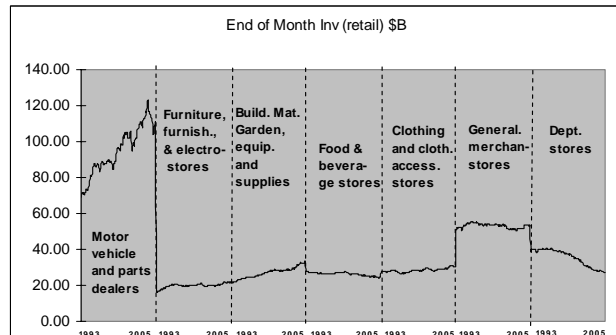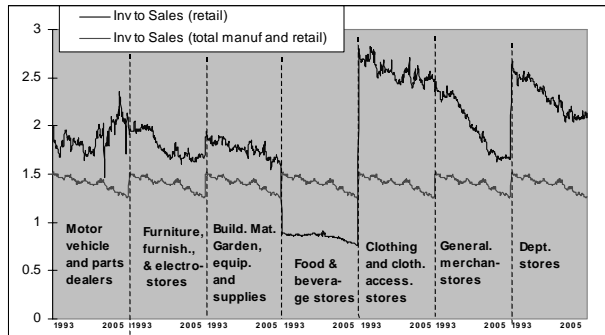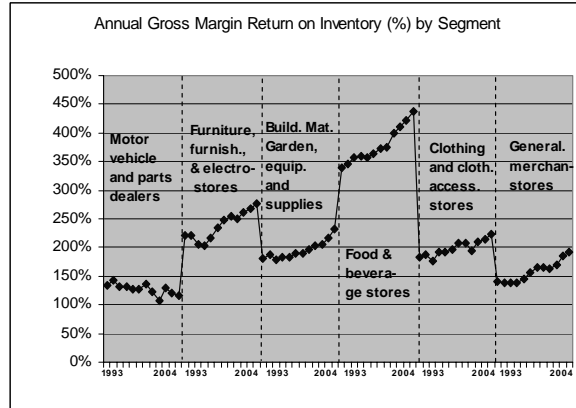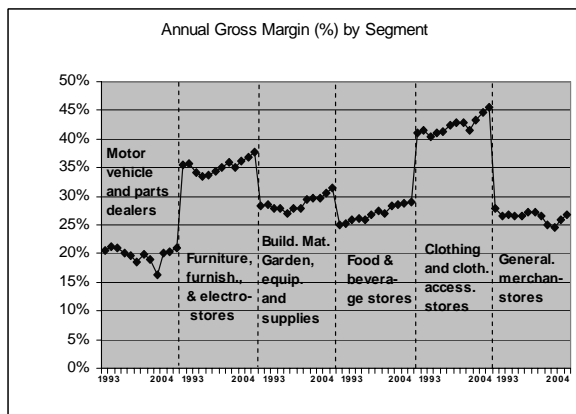
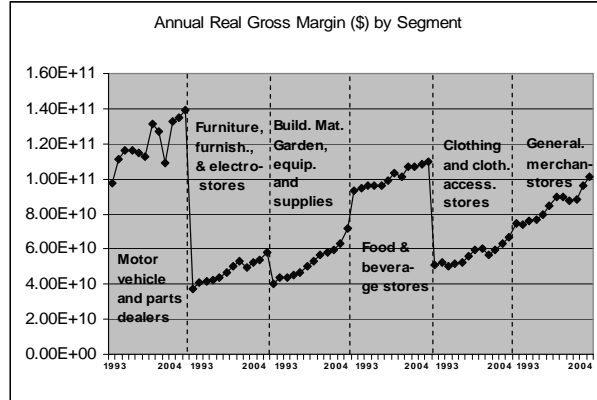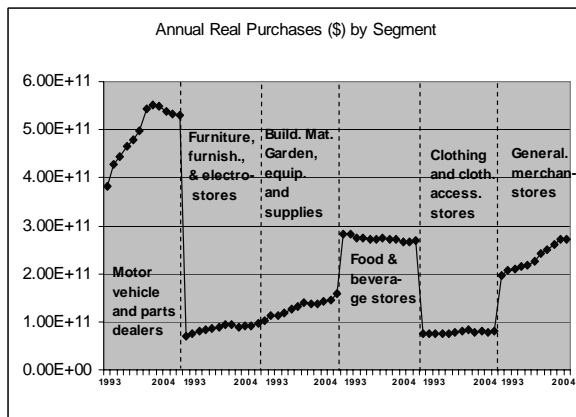

Figure 2: Graphs of Annual Data by Segment

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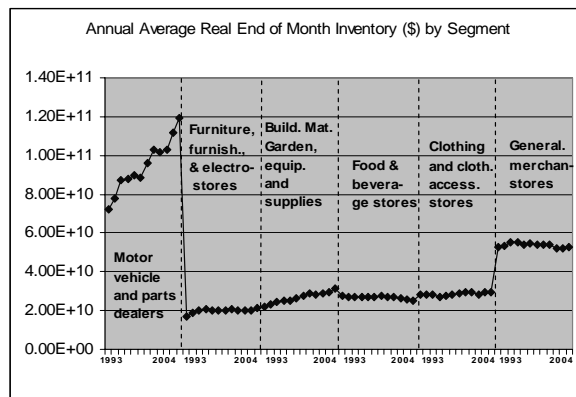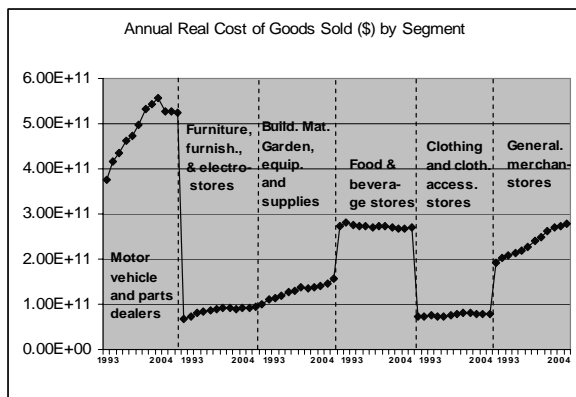
Table 1 Classification of Data by Retailing Sector NAICS Codes

Retail Segments	NAICS codes	Kind of Businesses
Motor vehicle and parts dealers	441	Auto parts and accessories; used and new car dealers
Furniture and home furnishing stores; electronics and appliance stores	442, 443	Electronics, household appliance; furniture and home furnishing stores
Building materials, garden equipment and supply dealers	444	Hardware stores; building materials stores; garden equipment stores
Food and beverages stores	445	Grocery stores; beer, wines stores
Clothing and clothing accessories stores	448	Men's, women's and family clothing; shoes; jewelry
General merchandise	452	Department stores, warehouse clubs, discount stores
Department stores	4521	Department stores (only)

Table 2: End-of-Month Inventory Trends by Segment (with AR(p) Error Correction)

	Motor vehicle	Furniture and electr.	Building and equip.	Food and beverage	Cloth. and cloth. accessories	General merchandise	Department stores
Total R-square	98.92%	96.69%	99.62%	97.47%	94.87%	90.08%	99.63%
Intercept	25.008	23.583	23.783	24.051	24.018	24.695	24.481
	0.026****	0.026****	0.017****	0.017****	0.018****	0.014****	0.031****
(T-1993)	0.036	0.016	0.031	-0.009	0.008	0.000	-0.031
	0.003****	0.003****	0.002****	0.002****	0.002****	0.002	0.004****
Month Fixed Effects							
Jan	-0.016	-0.007	-0.008	0.002	-0.004	-0.001	0.010
	0.009*	0.006	0.003**	0.003	0.004	0.004	0.004**
Feb	-0.012	-0.005	-0.004	0.001	-0.002	0.000	0.008
	0.008	0.005	0.003	0.002	0.004	0.003	0.004**
Mar	-0.009	-0.006	-0.004	0.000	-0.003	0.001	0.007
	0.007	0.004	0.003	0.002	0.003	0.003	0.003**
Apr	-0.006	-0.003	-0.001	0.000	-0.001	0.001	0.005
	0.004	0.003	0.002	0.002	0.002	0.002	0.002**
Jun	0.003	0.002	0.004	-0.001	0.001	0.003	0.002
	0.004	0.003	0.002**	0.002	0.002	0.002	0.002
Jul	0.003	0.004	0.005	-0.002	0.000	0.001	-0.003
	0.007	0.004	0.003**	0.002	0.003	0.003	0.003
Aug	0.008	0.005	0.011	-0.002	0.001	0.002	-0.005
	0.008	0.005	0.003****	0.002	0.004	0.003	0.004
Sept	0.013	0.004	0.012	-0.003	0.001	0.001	-0.008
	0.009	0.005	0.003****	0.003	0.004	0.004	0.004*
Oct	0.007	0.007	0.015	-0.006	0.003	0.000	-0.011
	0.009	0.006	0.004****	0.003**	0.004	0.004	0.004**
Nov	0.015	0.010	0.019	-0.005	0.006	0.003	-0.012
	0.010	0.006	0.004****	0.003*	0.005	0.004	0.005***
Dec	0.017	0.012	0.022	-0.006	0.006	0.003	-0.014
	0.009**	0.006**	0.004****	0.003*	0.004	0.004	0.005***
Auto-regressive Error Model Parameters							
φ_1	-1.136	-0.936	-0.942	-0.955	-0.927	-0.920	-0.967
	0.082****	0.030****	0.028****	0.025****	0.032****	0.033****	0.022****
φ_1	0.230	-	-	-	-	-	-
	0.082***						

*, **, ***, and **** denote statistical significance at the 10%, 5%, 1%, and 0.1% levels, respectively. Standard errors are provided in second row of each cell.

Table 3: Results of Sales and Macroeconomic Analysis of Inventory

		Motor vehicle	Furniture and electr.	Building and equip.	Food and beverage	Cloth. and cloth. access.	General merch.	Depart. stores
Total R-square		**99.19%**	**96.24%**	**99.58%**	**96.58%**	**92.47%**	**92.35%**	**99.74%**
Constant		**24.975** **0.024******	**23.498** **0.083******	**23.770** **0.007******	**24.023** **0.005******	**24.052** **0.007******	**24.688** **0.087******	**24.445** **0.070******
(T-1993)		**0.042** **0.002******	**0.025** **0.007******	**0.033** **0.001******	**-0.006** **0.001******	**0.005** **0.001******	0.004 0.005	**-0.028** **0.004******
%Δ Sales		-0.014 0.019	0.035 0.057	**-0.087** **0.008******	**-0.039** **0.020****	0.022 0.021	-0.013 0.024	**-0.086** **0.022******
	1-Month Lag							
Δ Price	Consumer Price Index	**-1.211** **0.397***	-0.602 0.401	**-0.833** **0.114******	**0.205** **0.084***	**-1.350** **0.196******	**-0.529** **0.119******	**-0.545** **0.155******
	Inflation Index	0.004 0.003	**0.010** **0.004****	**0.005** **0.000******	0.000 0.001	**0.012** **0.003******	-0.002 0.003	**0.007** **0.002***
Δ Cost of Capital	Federal Interest Rate	**0.092** **0.019******	**0.038** **0.021***	0.004 0.006	**0.012** **0.006****	**-0.031** **0.008******	**0.026** **0.008******	**0.022** **0.007******
Δ Customer Purchasing Activity	Real Disposable Income	**-0.011** **0.003******	**-0.008** **0.003****	**0.005** **0.001******	**-0.007** **0.001******	**0.007** **0.003***	-0.002 0.002	0.000 0.001
	Personal Savings Rate	0.075 0.094	-0.009 0.097	0.006 0.014	**-0.145** **0.021******	**0.253** **0.069******	**0.229** **0.046******	**0.231** **0.026******
Δ Perceptions of Economy	Consumer Sentiment	0.014 0.013	0.011 0.019	**-0.028** **0.004******	**-0.012** **0.004***	**0.024** **0.011****	**-0.018** **0.005******	**-0.016** **0.006***
	Consumer Confidence	-0.014 0.010	0.016 0.012	**-0.010** **0.003******	**-0.019** **0.003******	0.000 0.009	0.004 0.005	0.008 0.005
	Purchasing Manager's Index (PMI)	-0.013 0.015	-0.006 0.022	-0.004 0.005	**0.029** **0.005******	-0.020 0.014	**-0.035** **0.007******	**-0.036** **0.007******
Δ State of Economy	Real Gross Domestic Product	**-0.759** **0.141******	0.234 0.288	**-0.226** **0.070******	**-0.138** **0.052***	0.170 0.137	**-0.329** **0.095******	**0.156** **0.093***
	Unemployment Rate	**0.045** **0.019****	0.025 0.022	-0.024 0.005****	-0.004 0.006	-0.022 0.020	0.001 0.008	**0.022** **0.008***
Δ Stock Indices	Dow Industrial Index	**0.081** **0.024******	**-0.077** **0.042***	**-0.029** **0.007******	**0.028** **0.009******	-0.002 0.026	**0.082** **0.015******	**0.088** **0.014******
	S&P500 Index	**-0.080** **0.026***	**0.115** **0.038***	**0.019** 0.007***	-0.013 0.009	**-0.061** **0.026****	**-0.080** **0.015******	**-0.091** **0.011******
Δ Housing Industry	30 yr Mortgage Rate	0.022 0.021	-0.001 0.026	**-0.032** **0.006******	**0.052** **0.006******	-0.028 0.015	0.010 0.009	-0.012 0.008
	Housing Starts	**0.030** **0.009******	**0.022** **0.008***	**-0.013** **0.003******	**0.020** **0.003******	**-0.019** **0.007****	0.002 0.005	-0.006 0.004
	1-Year Lag							
Δ Price	Consumer Price Index (CPI)	0.154 0.312	0.084 0.474	**-0.284** **0.115***	**-0.253** **0.089***	**-0.626** **0.257***	**-0.485** **0.157***	**-0.728** **0.194******
	Inflation Index	0.000 0.002	0.004 0.004	**0.003** **0.001***	**0.005** **0.002***	**0.011** **0.004******	0.001 0.001	-0.001 0.002
Δ Cost of Capital	Federal Interest Rate	**-0.051** **0.011******	-0.002 0.020	-0.005 0.004	**-0.008** **0.004****	-0.010 0.010	0.009 0.006	0.012 0.007
Δ Customer Purchasing Activity	Real Disposable Income	**0.008** **0.002******	-0.001 0.005	-0.001 0.001	**0.005** **0.001******	**-0.006** **0.002***	0.001 0.001	**-0.004** **0.001***
	Personal Savings Rate	-0.105 0.071	**-0.139** **0.075***	0.029 0.019	**-0.047** **0.014******	**-0.111** **0.050****	**0.050** **0.030***	**0.110** **0.029******
Δ Perceptions of Economy	Consumer Sentiment	-0.032 0.022	0.007 0.020	0.002 0.004	**0.012** **0.006***	0.007 0.012	-0.007 0.007	**-0.022** **0.007***
	Consumer Confidence	0.014 0.010	0.001 0.014	0.000 0.003	-0.003 0.003	**0.033** **0.006******	**-0.013** **0.004******	-0.006 0.005
	Product Manager's Index	-0.002 0.011	**-0.035** **0.017****	-0.001 0.004	0.004 0.004	**-0.036** **0.013***	**-0.012** **0.006***	-0.005 0.006
Δ State of Economy	Real Gross Domestic Product	0.046 0.221	-0.154 0.252	**0.324** **0.079******	**0.360** **0.081******	-0.229 0.191	-0.109 0.093	0.122 0.111
	Unemployment Rate	-0.018 0.022	0.000 0.027	**0.027** **0.005******	-0.004 0.006	-0.019 0.018	-0.006 0.009	0.004 0.009
Δ Stock Indices	Dow Industrial Index	**0.051** **0.026****	**0.113** **0.046***	**0.026** **0.008******	**-0.031** **0.008******	**-0.100** **0.027******	**-0.058** **0.016******	-0.023 0.015
	S&P500 Index	0.010 0.025	-0.066 0.041	**-0.021** **0.007***	**0.027** **0.008******	**0.081** **0.025******	**0.055** **0.013******	0.022 0.014
Δ Housing Industry	30 yr Mortgage Rate	**0.077** **0.019******	-0.031 0.032	**0.032** **0.006******	**0.017** **0.005***	-0.018 0.013	0.001 0.007	0.003 0.011
	Housing Starts	**-0.025** **0.006******	0.002 0.011	0.001 0.002	**-0.014** **0.002******	**0.017** **0.006***	-0.005 0.004	**0.008** **0.004****

Table 3 (Contd)

cell.	Motor vehicle	Furniture and electr.	Building and equip.	Food and beverage	Cloth. and cloth. access.	General merch.	Depart. stores
Month Fixed Effects							
w$_1$ (Jan)	**-0.022** **0.006******	**-0.017** **0.005******	**-0.013** **0.002******	**0.003** **0.001*****	**-0.007** **0.003****	-0.003 0.002	**0.014** **0.003******
w$_2$ (Feb)	**-0.013** **0.006****	**-0.012** **0.005*****	**-0.014** **0.001******	0.001 0.001	-0.004 0.003	**0.004** **0.002****	**0.013** **0.002******
w$_3$ (Mar)	**-0.010** **0.004****	-0.007 0.005	**-0.012** **0.001******	-0.001 0.001	**-0.008** **0.002******	0.001 0.001	**0.007** **0.002******
w$_4$ (Apr)	**-0.007** **0.003****	-0.005 0.004	**-0.007** **0.001******	0.000 0.001	**-0.009** **0.002******	**0.004** **0.001*****	**0.007** **0.001******
w$_5$ (Jun)	**0.006** **0.003****	-0.001 0.003	**0.005** **0.001******	**-0.002** **0.001****	-0.002 0.002	**0.003** **0.001***	**0.003** **0.001******
w$_6$ (Jul)	0.000 0.004	0.000 0.004	**0.010** **0.001******	0.001 0.001	-0.002 0.002	0.001 0.002	0.000 0.002
w$_7$ (Aug)	-0.003 0.006	0.004 0.004	**0.017** **0.001******	-0.002 0.001	-0.002 0.002	0.000 0.002	**-0.004** **0.002****
w$_8$ (Sept)	-0.004 0.007	0.003 0.005	**0.015** **0.002******	**0.002** **0.001***	-0.003 0.002	0.000 0.002	**-0.007** **0.002*****
w$_9$ (Oct)	-0.007 0.007	0.003 0.005	**0.019** **0.002******	**-0.002** **0.001***	0.002 0.003	0.003 0.003	**-0.010** **0.003******
w$_{10}$ (Nov)	0.003 0.008	0.006 0.005	**0.020** **0.003******	**-0.002** **0.001***	-0.001 0.003	**0.008** **0.003*****	**-0.009** **0.003*****
w$_{11}$ (Dec)	**0.014** **0.007****	0.007 0.005	**0.022** **0.003******	-0.001 0.001	-0.001 0.004	0.005 0.003	**-0.009** **0.003*****

	Motor vehicle	Furniture and electr.	Building and equip.	Food and beverage	Cloth. and cloth. access.	General merch.	Depart. stores
AR-ARCH Error Model Parameters							
φ_1	**-1.529** **0.097******	**-0.980** **0.107******	**1.003** **0.066******	**-0.934** **0.011******	**-1.062** **0.103******	**-0.994** **0.007******	**-1.269** **0.073******
φ_2	**0.603** **0.096******	0.000 0.150	-0.128 0.089		-0.219 0.140		**0.278** **0.072******
φ_3		**0.267** **0.127****	**0.163** **0.054*****		0.117 0.130		
φ_4		**-0.0284** **0.094*****			**0.269** **0.097*****		
ω			-	-	-	-	-
α_1	**0.967** **0.363*****	**0.4524** **0.179****	**0.004** **0.007******	-	**1.556** **0.354******	**2.607** **0.515******	**1.753** **0.435******
α_2	**0.367** **0.221***	-	**4.123** **1.177******	**2.215** **0.292******	**0.990** **0.302******	-	-
α_3	-	-				**0.074** **0.041***	-
α_4	-	**0.209** **0.111***					**0.129** **0.066****
α_5	-	**0.743** **0.287*****					-
α_6	-	-					-
α_7	**0.3731** **0.203***	-					-

Table 4: Analysis Results for Model (5)

	Coef.	Std. Err.
Constant	**24.767******	**0.051**
COGS Diff	0.333	0.208
Gross Profit dollars Diff	**0.057***	**0.033**
Purchase Diff	**-0.726******	**0.166**
Segment 1 (F_1)	**0.729******	**0.055**
Segment 2 (F_2)	**-0.923******	**0.031**
Segment 3 (F_3)	**-0.567******	**0.047**
Segment 4 (F_4)	**-0.717******	**0.016**
Segment 5 (F_5)	**-0.608******	**0.038**
Y1994 (C_1)	**-0.356****	**0.175**
Y1995 (C_2)	**-0.317****	**0.144**
Y1996 (C_3)	**-0.270****	**0.118**
Y1997 (C_4)	**-0.238****	**0.096**
Y1998 (C_5)	**-0.198****	**0.085**
Y1999 (C_6)	**-0.152***	**0.083**
Y2000 (C_7)	**-0.154***	**0.083**
Y2001 (C_8)	**-0.154***	**0.081**
Y2002 (C_9)	**-0.111****	**0.043**
Y2003 (C_{10})	**-0.089******	**0.018**
φ_1	**-0.861******	**0.022**
φ_8	**0.216******	**0.054**
ω	0.000	0.000
α_1	0.093	0.211
α_2	**2.589*****	**0.981**
R-Square	99.80%	

*, **, ***, and **** denote statistical significance at the 10%, 5%, 1%, and 0.1% levels, respectively.

Table 5: Analysis of Inventory Turnover Model (7)

	Coef.	Std. Err.
Constant	**24.810******	**0.050**
COGS Difference	**-0.451****	**0.211**
GMROI Difference	**-0.276******	**0.046**
Purchase Diff	-0.074	0.203
Segment 1 (F_1)	**0.620******	**0.037**
Segment 2 (F_2)	**-0.936******	**0.040**
Segment 3 (F_3)	**-0.676******	**0.026**
Segment 4 (F_4)	**-0.760******	**0.032**
Segment 5 (F_5)	**-0.625******	**0.034**
Y1994 (C_1)	**-0.266******	**0.165**
Y1995 (C_2)	-0.200	0.123
Y1996 (C_3)	-0.151	0.094
Y1997 (C_4)	**-0.147****	**0.074**
Y1998 (C_5)	-0.107	0.072
Y1999 (C_6)	-0.101	0.077
Y2000 (C_7)	-0.127	0.079
Y2001 (C_8)	-0.057	0.072
Y2002 (C_9)	-0.014	0.030
Y2003 (C_{10})	-0.003	0.010
φ_1	**-0.719******	**0.051**
φ_8	**0.312******	**0.051**
ω	**-**	**-**
α_1	**-**	**-**
α_2	**-**	**-**
α_3	**2.643******	**0.714**
R-Square	99.74%	

*, **, ***, and **** denote statistical significance at the 10%, 5%, 1%, and 0.1% levels, respectively.