Inventory and the Stock Market

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Abstract

About inventory models, a concern is "often made [that] any resemblances between the models constructed and reality are purely coincidental." One set of factors not usually considered in textbook models of inventory decisions is suggested by well-documented evidence in macroeconomics, that the stock market affects investment decisions. Does the stock market also affect inventory decisions, and how? I study four hypotheses. The first is that the market could be a side-show, with no impact on firms' decisions. The second is that the market influences inventory decisions via a financing channel. When the market over-values firms, firms can get easier and cheaper financing, and tend to increase their inventory. The third is a dissipation channel. When the market over-values firms, firms are less disciplined and let inventories rise. The last is a catering channel. When the market discounts high-inventory firms, firms decrease their inventory, and vice versa. I report evidence that rejects the first, weakly supports the second and third, and strongly supports the fourth hypotheses. This evidence contributes to an emerging area for empirical research, at the intersection of finance and operations management.

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1.1. Introduction

I study four hypotheses of how the stock market could affect firms' inventory decisions. The first is that the market could be a *side-show* (e.g., Morck, et al. (1990)), with no impact on firms' decisions. The second is that the market influences inventory decisions via a *financing channel*. When the market over-values firms, firms can get easier and cheaper financing, and tend to increase their inventory (e.g., Stein (1996) and Baker, et al. (2003) have similar stories for capital expenditure and dividend policies). The third is a *dissipation channel*. For example, when the market over-values firms, firms are less disciplined and let inventories rise, along the lines of Jensen (1986). The last is a *catering channel*. When the market discounts high-inventory firms, firms decrease their inventory. When the market places a premium on inventory, firms increase their inventory (e.g., see Baker and Wurgler (2004) for catering to a dividend premium).

The data shows that the stock market does not appear to be just a side-show. That is, while firms make inventory decisions based on fundamentals such as operational and sales parameters, they also make these decisions with a view to the stock market. I find weak evidence for the financing and dissipation channels, and strong evidence of catering.

The evidence contributes to empirical research in what might be called "operations finance." At this intersection of finance and operations management, a recent set of pioneering papers document how the stock market reacts to firms' operational performance (e.g., Chen, et al. (2005); Gaur, et al. (2005); Hendricks and Singhal (2005)). These papers have a parallel in one major theme of finance: asset pricing. In this paper, I document the opposite, of how firms might manage operations with a view to the capital markets (see also Netessine and Roumiantsev (2005)). This is in line with another major theme of finance: corporate finance. As a clarifying note, I focus on the stock market rather than other capital markets (e.g., the debt market), because the former is the most prominent and because debt financing is related to stock market valuation, as I explain below.

1.2. Inventory Decisions and the Stock Market

The textbook model of inventory decision-making is based on fundamental parameters such as financing and holding costs. Arrow, et al. (1951) provides an early exposition of this idea. Such costs accurately reflect the risk and return of firms' decisions. One assumption is that firms make inventory decisions independent of the stock market, which is a source of financing and valuation information.

This study is motivated by the growing body of evidence that the stock market is *not* efficient, which has implications for financing and valuation. Inefficient markets could mis-value firms. The key ideas are that there are noise traders who hold beliefs ("sentiment") that cannot be rationally justified, the activities of these traders do not cancel out, and there are limits to arbitraging away the uncancelled sentiment. For this paper, I use the terms "inefficiency," "sentiment," and "mis-valuation" (over- or under-valuation) interchangeably. Theoretical models show that inefficient markets can hold even if transactions are costless. Shleifer (2000) provides an account of inefficient markets in finance, and Chen, et al. (2005) and Gaur, et al. (2005) suggest evidence of this in an operations context. The body of theory and empirical evidence naturally leads to the question of whether and how inefficient stock markets affect real operational decisions.

A hint of what is to come is that there is well-known empirical evidence at the macroeconomic level that the stock market explains changes in investments (e.g., Bosworth (1975), Blanchard, et al. (1990)). And the most volatile of investment changes is in inventories (e.g., Kashyap, et al. (1994)). Does the stock market also explain changes in inventories, and not just investments in general, and at the firm level, not just the macroeconomic level? If so, how? If the answers to these questions reveal that firms do time their inventories according to vagaries of the stock market, the resulting misallocation of resources over time is more severe than misallocation in a cross-section of firms. As pointed out by Morck, et al. (1990), misallocation in a cross-section could at least be mitigated by the fact that overall inventory levels are approximately unaffected. Too little inventory in one department store might be compensated by more at another.

However, misallocation over time is irrevocably more damaging to the economy at large.

Beyond this practical implication, the answers can also form the basis of a more empirically accurate model of how inventory decisions are made (e.g., Netessine and Roumiantsev (2005)). They help address the concern "often made [about inventory models, that] any resemblances between the models constructed and reality are purely coincidental" (Whitin (1952)).

I build up the answers by testing four hypotheses. The first is the baseline: the stock market is just a side-show, a term introduced by Morck, et al. (1990), who study the impact of the stock market on capital expenditures. Under this hypothesis, the market does not explain inventory decisions beyond the fundamental parameters. The earliest exposition of this idea is the Q theory expounded by Tobin (1969), where Q is a summary statistic for the stock market's information about the firm's fundamental investment opportunities. For this paper, I adhere to the more recent incarnation of "fundamentals" (e.g., Morck, et al. (1990), Polk and Sapienza (2004)), which consists of parameters that drive two decisions: (1) whether the costs justify the benefits of inventory (e.g., financing cost, increased sales) and (2) whether financial constraints (e.g., cash flow situation, availability of credit, potential to raise equity; as in Kashyap, et al. (1994)) force the inventory decision into a corner solution. Morck, et al. (1990) find that for the period 1959-87, "the market may not be a complete sideshow, but nor is it very central." This somewhat ambiguous conclusion, and the different time period and dependant variable (inventory instead of capital expenditures), motivate my study of the other three hypotheses.

In the second hypothesis, the stock market affects inventory decisions via a financing channel. The idea is that if the market is inefficient, firms could time their funding-raising when their valuations are overly high. The higher the valuation of a firm, the lower is its cost of capital (e.g., Brainard and Tobin (1968), Fischer and Merton (1984)). This lower cost of capital could come directly from the lower cost of equity issuance, or indirectly by lower cost of debt with expanded debt capacity or reduced overhang. Lower cost of capital leads to higher inventories. A further implication, which I leave for further research, is whether the higher inventory is efficient. This is a source of debate (e.g., Morck, et al. (1990)). Fischer and Merton (1984) suggest that the higher inventory is inefficient, because the irrationally low cost of capital leads firms to invest in marginally negative net present value projects (or hold too much inventory, in my case). However, Blanchard, et al. (1990) argue that higher inventory is neutral, since firms would have invested in zero net present value investments, such as liquid financial securities However, the world might not be Modigliani-Miller at the margin. If a firm is financially-constrained, the overly cheap financing available when it is irrationally over-valued would allow it to invest in *positive* net present value projects that it could not otherwise undertake (e.g., Fazzari, et al. (1988), Kaplan and Zingales (1997), and Baker, et al. (2003)).

The third hypothesis is that during periods of mis-valuation (either over- or under-valuation), firms might let inventories rise unnecessarily, dissipating value that might otherwise be captured with more efficient operations. This dissipation could arise because: (1) in the language of principal-agent models such as Baker (1992), keeping operations efficient with lower inventory requires costly effort that does not translate well into observable characteristics, (2) the observable characteristic, valuation, is being driven up or down unrelated to inventory, and (3) the principal's monitoring on efficient inventory levels is reduced, relative to other priorities that might drive firm value. This dissipation hypothesis is empirically indistinguishable from one part of the financing hypothesis, where overvaluation leads to easier financing, which in turn leads to more inventories. It is, however, distinguishable from the financing hypothesis in that dissipation is predicted to occur in both times of over-valuation and under-valuation, whereas the financing hypothesis predicts that inventories will be overly high during over-valuation and overly low during under-valuation. The dissipation hypothesis might seem to be related to the free cash-flow hypothesis of Jensen (1986), in which firms left with too much cash dissipate them with empire-building. However, the motivating factor there is that managers consciously choose to implement negative net present value projects, rather than not exert costly effort to keep inventories optimal. It is also important to clarify that the dissipation hypothesis does not suggest that there is no dissipation without mis-valuation. Instead, it predicts that dissipation is increased with mis-valuation. Under the dissipation hypothesis, and unlike the first two hypotheses, managers of the firms are assumed to have interests that diverge from those of shareholders. This is also an assumption in the fourth and last hypothesis.

The fourth hypothesis is that managers cater to the interest of the stock market, even if this catering is at the expense of long-term shareholder value. Managers cater because of short-term interests, as pointed out by Stein (1988). For example, their compensation might be a function of short-term stock price. They might also need to periodically sell off their shares in the firm, so they ensure that the firm's short-term is not undervalued. Or they might keep the firm's short-term value high to avoid being its being taken-over by buyout firms that might fire them. Or they might want to ensure that their reputation and worth in the executive market is high, as in the career-concerns models of Narayanan (1985) and Holmstrom (1999). While the financing and dissipation hypotheses depend on stock market mis-valuation in general, the catering hypothesis depends on a specific kind of mis-valuation based on inventory. When there is an "inventory discount," managers cater to the market by reducing their inventories. Conversely, when pthere is an inventory premium, managers increase inventories. The inventory discount/premium might arise because it is difficult to read what high inventory really means (e.g., Lai (2005)). It could mean operational incompetence, but it could also mean good prospective sales. Furthermore, at any one time, the beliefs of investors, especially noisy traders, tend to herd (e.g., Scharfstein and Stein (1990)). Therefore, we might see an inventory discount one time and a premium at another. Aghion and Stein (2005) provide a formal model of how something like this can happen.

The inventory discount/premium is analogous to similar phenomena studied in other areas of market inefficiency, such as the small firm premium (Roll (1983)), close-end mutual fund premium (Boudreaux (1973), Lee, et al. (1991)), or the dividend discount/premium (e.g., Baker and Wurgler (2004)). The catering hypothesis is also consistent with the signaling hypothesis of Lai (2005), which documents an inventory threshold for a separating equilibrium. In general, firms face an inventory discount. The graph of valuation against inventory level slopes down, until inventory (scaled by sales) is above 0.1, when it becomes flat – *i.e.,* inventory becomes a noisy signal. Therefore, to the extent that only competent firms can reduce their inventory levels to below 0.1, there will be a separating equilibrium.[2] Finally, as a concluding clarification: the catering hypothesis does not require that firms are smart enough to time the market. For example, managers in firms might simply be forced to cater to the inventory discount.

1.3. Empirical Strategy and Data

The key challenge is identification in the presence of endogeneity, since inventory and the right-hand-side variables can be simultaneously determined or there might be reverse causality. I address these in this section.

The data is extracted from COMPUSTAT-CRSP, ExecuComp, I/B/E/S, CDA, *The Wall Street Journal*, and a variety of other sources detailed below. I updated all COMPUSTAT-CRSP data with restated ones – e.g., for sales, assets, cost of goods sold. To be included in the dataset, I follow the practice in the literature (e.g., Morck, et al. (1990), Polk and Sapienza (2004), Gompers, et al. (2003), Baker, et al. (2003)): observations cannot be involved in acquisitions or mergers, the market-to-book and Q must be between 0.1 and 100, sales, assets, capital expenditures, income before earnings and interest, common dividends, common equity must all have non-negative values, and outliers are dealt with by winsorizing at the 1% and 99% percentiles. One of the usual problems with using COMPUSTAT-CRSP data is truncation bias, because some firms are not documented in the earlier years. To deal with this, I use a Heckman sample selection correction; an example is reported in the test of the "fundamentals only" hypothesis below. The bias (the inverse Mills ratio) is only significant at about 8%, so I do not report corrections in the rest of the tables. A possible reason that the bias is small is that the long period of coverage overwhelms the shorter period of truncation. There is also possible

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[2] For clarification, I should mention that the pioneering work by Chen, et al. (2005) speaks to the issue of changes in valuation (returns) rather than the inventory discount. Specifically, they find that high inventory firms face abnormal poor long-term returns, suggesting that inventory discount widens (or if the starting position is an inventory premium, then the premium decreases). However, the finding is agnostic about whether there is an inventory discount or premium, or whether this changes over time.

survivorship bias: the dataset might contain surviving firms that are different from those dropped. For this, I create a sub-sample that truncates five years out of the beginning and end of my dataset. Again, the result is qualitatively unchanged so I do not report this to save space.

1.3.1. The "Fundamentals Only" Hypothesis

I estimate the following model with fixed effects:

$$INVENTORY_t = \beta_0 + \beta_1.OVERVALUATION_{t-1} + \beta_2.FUNDAMENTALS_t + \text{firm effects} + \text{year indicators} + \varepsilon_t. \quad (1)$$

This is essentially differencing the standard *Q*-theoretic investment equation (e.g., Summers (1981)). *OVERVALUATION* is lagged while *FUNDAMENTALS* is contemporaneous because I am interested in whether the former affects *INVENTORY* beyond its ability to predict the latter. It is possible, however, that lagging *OVERVALUATION* might provide *FUNDAMENTALS* with an informational advantage. However, including contemporaneous measures of *OVERVALUATION* (unreported) do not change the results, a finding consistent with Poterba (1990). The non-fundamental *OVERVALUATION* channels are considered to be influential if an *F*-test on β_1 rejects the null, after partialling out the fundamentals effects.

In the baseline model, I measure *INVENTORY* using inventory value. For robustness, I also employ alternatives used in the literature, such as scaling by property, plant, and equipment, following Polk and Sapienza (2004), or using the adjusted inventory used in Gaur, et al. (2005).[3]

In the baseline model, I measure *OVERVALUATION* using abnormal stock returns. Following Morck, et al. (1990), I employ alphas under a CAPM (capital asset pricing model) model, using

[3] Gaur, et al. (2005) regress inventory turn (defined as cost of goods sold over inventory) on gross margin, capital intensity, and sales surprise. To facilitate comparison with other measures here, I use the inverse of inventory turn. Also, sales surprise is a market factor likely to be confounded with *OVERVALUATION*, so I drop it in the baseline regression. In any case, adding it does not qualitatively change the results.

annual market and risk-free returns from Professor French's website.[4] Using the CAPM alpha has the advantage that it could understate the effect of *OVERVALUATION* on *INVENTORY*, because if part of the CAPM alpha is really compensation for risks, that part is a fundamental parameter (being expected, not abnormal, return) that should not cause any change in *INVENTORY*. Nevertheless, overvaluation is a potentially contentious issue, so I employ other measures to maximize robustness. I do bear in mind, however, that the literature is still ambivalent about the source of sentiment (e.g., whether it reflects changing risk tolerance or growth expectations, Baker and Wurgler (2004)), so the object here is to measure sentiment rather than to achieve the more ambitious goal of studying it. First, I use the more recent model by Fama and French (1993) for abnormal returns, based on *SML* ("small minus large"), *HML* ("high book-to-market minus low"), and *UMD* ("up momentum versus down") factors, also obtained from the same website. Second, I use the close-end fund discount, which has the well-known characteristic that stock price often differs from net asset value in such funds, because unsophisticated investors hold different beliefs than others. This difference is generally regarded as a measure of market mis-valuation (e.g., Zweig (1973), Long, et al. (1990), Lee, et al. (1991)). Following Baker and Wurgler (2004), I obtain the value-weighted closed-end fund discount from Neal and Wheatley (1998) (for years 1962 through 1993), CDA (1994 through 1998), and *The Wall Street Journal* end-of-year issues (1999 through 2000). Third, following Polk and Sapienza (2004), I use discretionary accruals. Sloan (1996) and Teoh, et al. (1998) find that such accruals lead to lower stock returns, which can be interpreted as over-valuation. This argument relies on investors not being sophisticated enough to see through the manipulation of accruals, a fact well-documented by researchers such as Maines and Hand (1996). Discretionary accruals are measured as total accruals less normal accruals, following Jones (1991) and Teoh, et al. (1998). Total accruals are defined as:

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[4] The data is at http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html, for which I am grateful. Last accessed July 21, 2005.

$$ACCR_{i,t} = (\ \Delta[CurrentAssets_{i,t} + Cash_{i,t}] - \Delta[CurrentLiabilities_{i,t} - LongTermDebt_{i,t}]\ )\ /\ TotalAssets_{i,t-1}.$$

For each firm, I then derive its non-discretionary accruals by first running a cross-section regression using the firm's four-digit SIC code peers (i.e., all but itself):

$$ACCR_{i,t} = \theta_0 + \theta_1.(1/TotalAssets_{,t-1}) + \theta_2.(\Delta sales_{i,t}/TotalAssets_{,t-1}) + \theta_3.(PlantPropertyEqpt_{i,t}/\ TotalAssets_{,t-1}) + \varepsilon_{i,t}.$$

Using the predicted coefficients $\hat{\theta}$ from the regression, the firm's non-discretionary accruals are:

$$NONDIS\text{-}ACCR_{i,t} = \hat{\theta}_0 + \hat{\theta}_1.(1/TotalAssets_{,t-1}) + \hat{\theta}_2.(\Delta sales_{i,t} - \Delta accountsReceivable_{i,t})/TotalAssets_{,t-1} + \hat{\theta}_3.(PlantPropertyEqpt_{i,t}/TotalAssets_{,t-1}).$$

Discretionary accruals are then defined as the difference between total and non-discretionary accruals. One advantage of using discretionary accruals in this paper is that it could understate the effect of *OVERVALUATION*. This is because Chan, et al. (2001) documents that firms with high discretionary accruals tend to be followed by low cash flows (a fundamental parameter)), so that even if accruals might be correlated with *FUNDAMENTALS*, they are so only negatively.

The different measures of *OVERVALUATION* have two important properties. First, they work through different channels in mis-valuation. For example, the closed-end fund discount operates through differences in clientele segments while discretionary accruals work through information distortion. Second, they are all linked to cross-sectional patterns in returns that are not well-explained by standard asset pricing models.

I measure *FUNDAMENTALS* using net sales and cash flow, following Morck, et al. (1990). The first drives how much inventory is needed and the latter, how much a firm can afford. There are other possible drivers, such as the internal cost of capital and ordering costs, and these are absorbed into firm and year fixed effects. The *marginal* cost of external financing, however, is something I will consider explicitly, in the financing hypothesis. As a robustness check, I also measure *FUNDAMENTALS* using Q, following Polk and Sapienza (2004). This has the advantage that Q could capture parts of *OVERVALUATION* (e.g., Abel and Blanchard (1986)), so that the coefficient of *OVERVALUATION* is likely to understate its importance. My measure of average Q has another well-known theoretical problem, that it is a poor measure of marginal Q. However, this is generally resolved in the literature as not an important measurement problem empirically (see, for example, Abel and Blanchard (1986)).

There are some other empirical issues:

1. *Estimation method*. One method is to use a fixed effects model. Another is to undertake an OLS (ordinary least squares) estimation using changes in levels, so as to make comparisons with Morck, et al. (1990), a major paper in the field. Like them, I use industry dummies and find that the results (unreported) are qualitatively unchanged. Furthermore, I use year dummies (reported here), whose inclusion means a more stringent test because they understate the effect of *OVERVALUATION* if they pick up time variations of the aggregate stock market. One issue here is over what horizon should the changes be taken. Morck, et al. (1990) use a three-year period. This has the advantage of letting inventory decisions take their course, although unlike their capital expenditure regressions, inventories might be expected to take their course at a quicker pace. The disadvantage is that the longer the horizon, the more susceptible is the specification to endogeneity. For example, in Q-theory, the desired level of capital stock might not follow a deterministic trend over longer periods. In any case, I regress over shorter one- and three-year horizons and the results are qualitatively unchanged. I report only the one-year ones. As clarification, when estimating using fixed effects, the variables are at levels; when using OLS, they are changes.
2. *Discretized dependant variables.* One way to deal with measurement error of *INVENTORY* is to discretize it, using a dummy which is set to 1 if the change in inventory exceeds a threshold and 0 otherwise (e.g., Morck, et al. (1990)). Importantly, this also weakens the contending interpretation that small inventory changes are not the result of conscious firm policy, but involuntary changes.

3. *Lag structures*. Lags help minimize simultaneity issues. I use zero to four lags in the specifications. In this paper, I report results from estimations using no lags for OLS regressions and two lags for fixed effect regressions; other specifications give qualitatively similar results, unless otherwise stated.

4. *Reversed causality and simultaneity.* Reversed causality is handled by lagging *OVERVALUATION*. It is still possible that the measures of *FUNDAMENTALS* such as sales and cash flow are simultaneously determined with the stock returns used to measure *OVERVALUATION.* Suppose a good past return increases inventories because of lower costs of financing, but increased inventories improve sales because of better availability. Therefore, measuring *FUNDAMENTALS* with sales would pick up some effect of the influence of returns on inventories. First, this only understates the effect of *OVERVALUATION*. Second, it turns out that the data does not support this story, as I argue below in the "Results" section.

1.3.2. The Financing Hypothesis

I add variables measuring the volume of past equity and debt issuance:

$$INVENTORY_t = \beta_0 + \beta_1. FUNDAMENTALS_t + \beta_2.OVERVALUATION_{t-1} + \gamma_1.EQUITY_{t-1} + \gamma_2.DEBT_{t-1} + \text{firm effects} + \text{year indicators} + \varepsilon_t. \quad (2)$$

We should see that the γ coefficients are positively signed and β_2 drops in economic significance. I measure *EQUITY* using two methods, one following Morck, et al. (1990) that divides common equity by beginning-of-year market capitalization, and a more sophisticated way by Daniel and Titman (2003) that considers equity issuance, employee stock and pension plans, repurchases, and dividends. Specifically, the latter, which I will call DT equity, can be interpreted as the (log of the) number of shares one would have at time t for every share one owns at t-τ, had one reinvested all cash distributions back into the stock. It is defined as:

$$DT\ equity = \log (M_t/M_{t-\tau}) - r(t-\tau,t)\ .$$

M_t is the per share value at t and $r(t-\tau,t)$ is the log stock return from $t-\tau$ to t, in turn defined as:

$$r(t\text{-}\tau,t) = \sum_{s=t-\tau+1}^{t} log[(M_s.f_s + D_s)/M_{s\text{-}1}] ,$$

where f_s is the price adjustment factor from *s-1* to *s* that accounts for splits and rights issues, and D_s is the per-share cash distribution paid at time *s*.

I measure *DEBT* using book debt. *EQUITY* and *DEBT* are interpreted as specialized measures of *OVERVALUATION* that account for the financial channel which with *OVERVALUATION* might influence *INVENTORY*. For example, Daniel and Titman (2003) documents how their measure of equity issuance predicts subsequent low stock returns, suggesting current over-valuation.

Empirically, data on these are often inaccurate (often due to acquisitions), so Morck, et al. (1990) suggest using indicator variables, where *EQUITY* is 1 if the change in equity is over 5% and *DEBT* is 1 if the change in debt is over 10%. This provides a less stringent test. As will be seen, the financing hypothesis is not well supported, so using this method allows me to see if the hypothesis is indeed weak even when given benefit of the doubt.

The financing hypothesis makes another prediction that I can use as a still more robust test: financially-constrained (or small, as a proxy) firms should be even more susceptible to the effect of the stock market. To test this, I augment the specification in (2) to:

$$\begin{aligned} INVENTORY_t = \beta_0 + \ldots as\ before \ldots + \gamma_1.EQUITY_{t\text{-}1} + \gamma_2.DEBT_{t\text{-}1} + \\ \delta_1.EQUITY_{t\text{-}1} \times FINANCIALLY\text{-}CONSTRAINED_t + \\ \delta_2.DEBT_{t\text{-}1} \times FINANCIALLY\text{-}CONSTRAINED_t + \\ \text{firm effects} + \text{year indicators} + \varepsilon_t. \end{aligned} \quad (3)$$

Positively-signed δ coefficients would be consistent with the financing hypothesis.

A measure of *FINANCIALLY-CONSTRAINED* would include standard corporate finance parameters such as firm size, firm age, leverage, cash balance, cash flow, cash volatility, and investment opportunities. Kaplan and Zingales (1997) incorporate these in an index. The advantage of this KZ index is that it is transparent and, having been built from scratch for a different purpose, is unlikely to be biased for my purpose.

1.3.3. The Dissipation Hypothesis

The dissipation hypothesis predicts a quadratic relationship in *OVERVALUATION*:

$$INVENTORY_t = \beta_0 + \beta_1.\ FUNDAMENTALS_t + \beta_2.OVERVALUATION_{t-1} + \beta_3.OVERVALUATION^2_{t-1} + \text{firm effects} + \text{year indicators} + \varepsilon_t. \quad (4)$$

Unlike the financing hypothesis, the dissipation hypothesis is motivated by an agency problem between manager and shareholder. Therefore, it also predicts that in a cross section, firms with bigger agency problems have more dissipation. I test for this by modifying specification (1) as follows, where *G* is a governance index from I/B/E/S calculated by Gompers, et al. (2003):

$$INVENTORY_t = \beta_0 + \beta_1.\ FUNDAMENTALS_t + \beta_2.OVERVALUATION_{t-1} + \beta_3.OVERVALUATION^2_{t-1} + \zeta_1\ G_t + \zeta_2.OVERVALUATION^2_{t-1} \times G_t + \text{firm effects} + \text{year indicators} + \varepsilon_t. \quad (5)$$

A negatively signed ζ_2 is consistent with the dissipation hypothesis.

1.3.4. The Catering Hypothesis

The biggest empirical challenge to testing the catering hypothesis is in measuring the inventory discount. I use a number of measures to minimize measurement problems. Structurally, each measure divides the dataset into low- and high-inventory firm-year observations and the inventory discount is the difference by some measure (say the mean market-to-book ratio) between these two sub-samples. For the choice of dividing into low- and high-inventory observations, I use a variety of criteria: (1) inventory value *levels*, (2) inventory value *changes*, (3) inventory value divided by property-plant-equipment value, (4) inventory/PPE changes, (5) inventory/sales based on the adjusted-inventory-turn specification in Gaur, et al. (2005), and (6) inventory/sales changes. For the choice of measuring the difference between the low- and high- sub-samples, I use the log of the difference in the market-to-book (MTB) ratios and the *future* one-year, two-year, three-year, and cumulative three-year stock returns (please see Baker and Wurgler (2004) for a similar set-up for calculating the dividend premium). For each of these, I employ still finer variations, using means versus medians, and using equal-weighted versus market cap-weighted measures. The inventory discount is positive when the MTB for low-inventory firms exceed that for high-inventory firms. It is negative when measured using future returns, since future returns are low when current valuations (MTB) are too high and vice versa. We can also think of the difference in future returns as an inventory *premium*.

Figure 1 shows two measures of the inventory discount. It appears the discount is positive for most of the late 1970s and the 1980s, turns negative in the 1990s, and begins its journey back to neutrality in the early 2000s. Another striking figure of the picture is that the two measures are reassuringly correlated. Table 1 shows the correlation coefficients among a few of these measures. It also reports Dickey-Fuller tests for unit roots, with and without time trends and lags. These tests are valid because there are theoretical reasons for covariance stationarity. For example, the discount cannot grow indefinitely.

The catering hypothesis predicts that the coefficient on *INVENTORY-DISCOUNT* is negative. It also predicts that firms with shorter-term horizons are more sensitive to the discount. I use six pieces of executive-level information from I/B/E/S to consolidate into firm-level information that I interpret as shorter-term orientations: (1) more executives granted options or shares[5], (2) greater percent of options granted to employees, (3) higher value of unexercised exercisable options held by the average executive, (4) higher value realized from options for the average executive, exercised at t+1, (5) higher percentage of company stock held by employees, and (6) higher value of restricted stock holdings by the average executive. I then compare the inventory discount sensitivity in the top and bottom quartiles ranked by short-termism.

1.4. Results

The summary statistics are in Table 2.

Table 3 shows the baseline results, in models (1) through (4). Models (1) and (2) replicate the

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[5] In I/B/E/S, "executives" mean top management officers as defined by the firm, usually taken to mean vice president and above, while "employees" mean all staff, full-time or otherwise.

first two models in Morck, et al. (1990). They are OLS regression on changes. Apart from the dependant variable, one difference is that I use one-year horizons whereas Morck, et al. (1990) use three-year horizons, because I expect that inventories, unlike their capital expenditures, are adjustable much faster over time[6]. Because of this difference, I have three times more year indicators, and therefore expect a much higher R^2. As a starting point, I note from Model (1) that *OVERVALUATION* is an important driver of inventory decisions, with both a substantial R^2 and positive significant sign. Model (2) partials out the effects of *FUNDAMENTALS*, and the resulting coefficient on *OVERVALUATION* drops substantially, but is still very significant. For robustness, I undertake similar estimations using other measures of the variables. For example:

- Using a Fama-French alpha rather than the CAPM alpha for *OVERVALUATION* gives a *t*-statistic of 5.9 for *OVERVALUATION* even after partialling over *FUNDAMENTALS*
- Using a three-year horizon gives a *t*-statistic of 1.8.
- Using a two-period lag structure gives a *t*-statistic of 2.5.

Model (3) continues the robustness check, using fixed effects estimation on inventory scaled by property-plant and equipment, and with *OVERVALUATION* measured by discretionary accruals. The fixed effects estimation significantly reduces the R^2, but *OVERVALUATION* is once again significantly positive. The low R^2 may be an artifact of measurement error in discretionary accruals, so Model (4) uses a more established measure of sentiment, the closed-end fund discount. The R^2 is significant, and *OVERVALUATION* is once again significant and positive. In Model (5), I use all the measures as instrument variables for the Fama-French alpha measure, in a two-stage least squares estimation. The result is qualitatively unchanged.

Model (6) shows the result of a logistic regression using a discrete version of *INVENTORY*, in which the dummy is 1 if Δinventory is more than 1.2 and 0 otherwise. The results are qualitative unchanged, as are those (unreported) using different thresholds for creating the dummy variable.

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[6] These estimations are done with heteroskedastic-robust standard errors and clustered around firms to minimize serial correlation, although it is unclear whether Morck, et al. (1990) do the same.

Model (7) shows a Heckman correction for possible truncation bias, because the dataset appears to be more complete for later years. The first-stage correction model is:

$$SELECTED = f\,(MKTCAP,\ S\&P500,\ ASSETS)\ ,$$

where *MKTCAP* is market capitalization, *S&P500* is whether the firm is ever in the S&P 500, and *ASSETS* is total assets. The results are qualitatively the same, and the inverse Mill's ratio is marginally significant at 7.9%. To simplify the exposition here, I present results without the Heckman correction, after checking that the corrected results are qualitatively unchanged.

One concern I explain earlier is the possibility of simultaneity, in that *INVENTORY* might influence sales, which in turn influence the stock market. This seems unlikely from model (2), which shows that doubling sales would increase inventory by 49.3%. The mean sales-to-inventory ratio is 27.7 and the median is even lower, at 6.6. Therefore, most of the sales increase does not come from inventory increase.

The economic significance varies. In the closed-end fund discount measure of *OVERVALUATION*, a one standard deviation change in *OVERVALUATION* leads to a 10% standard deviation change in *INVENTORY*, while the CAPM alpha measure produces only a 2% standard deviation change in *INVENTORY.* This compares well with the economic significance of the *FUNDAMENTALS* measured. A standard deviation change in cash flow growth correlates with a 28% standard deviation change in *INVENTORY*. For sales growth, it is 43% and for lagged Q, it is 6%. Overall, it is significant that market sentiment, *OVERVALUATION*, contributes changes to *INVENTORY* on the same order of magnitude as *FUNDAMENTALS*.

Table 4 shows the test for the financing hypothesis. Model (1) is a baseline to follow the specification in Morck, et al. (1990). All the coefficients are positively signed as predicted, and are significant. Firms that issue 1% more new debt show 3.3% to 6.6% more inventory growth, on average and controlling for fundamentals. This is higher but of the same order of magnitude as the 1.75% Morck, et al. (1990) obtain for growth in capital expenditures. Similarly, firms that increase their shares by 1% show 2.5% to 3.4% more inventory growth. Again, this is comparable to the 1.6% obtained by Morck, et al. (1990). Comparing this model (1) with model

(1) in Table 3, we can see that *FINANCING* reduces the impact of *OVERVALUATION*, although the latter is still significant. I interpret this as weak support for the financing hypothesis. Model (2) shows the same, using discretized versions of Δdebt and Δequity following Morck, et al. (1990), in which they set the debt dummy to 1 if the change is more than 20% and the equity dummy to 1 if more than 10%. The results are qualitatively unchanged.

Model (3) shows the delineation of the financing effect by the degree of financial constraint. As expected, constrained firms (high KZ index) have lower inventory levels. More interesting, the interaction of the financing channel in overvaluation (as measured by changes in debt and equity issues, after partialling out *FUNDAMENTALS*) with the KZ index is positive and significant. This again supports the financing hypothesis: the more constrained a firm, the more it leverages misevaluation to obtain easier financing for inventory. Unreported robustness checks with other measures of *OVERVALUATION* such as Fama-French alphas and accruals produce the same result, although the effect of *FINANCIALLY-CONSTRAINED* is much reduced with accruals. I interpret this as accruals picking up financial-constraints, so using accruals is less interesting as a measure of *OVERVALUATION* here.

Model (4) uses the closed-end fund discount as a measure of *OVERVALUATION* and DT equity. It produces negative coefficients for the *FINANCING* variables. These are the opposite of what is predicted, although their low economic significance (e.g., one standard deviation change in DT equity produces only 0.6% standard deviation change in *INVENTORY*) might best be interpreted as negligible impact. When I regress using interactions with the KZ index in Model (5), I obtain the predicted positive signs on the interaction terms. The economic significance is low.

It is possible that firms have different financing technologies. For example, if *INVENTORY* is concave in *EQUITY* or *DEBT*, and financially-constrained firms tend to also have low *EQUITY* or *DEBT*, then I would observe that these firms have a higher inventory sensitivity to finance. To take care of this, I use quadratic formulations of *EQUITY* and *DEBT*, and it turns out (in unreported regressions) that this is not a concern. Overall, I conclude that I cannot reject the financing hypothesis, although the evidence for it is rather weak.

In Table 5, I report the results of testing the dissipation hypothesis. In Model (1), I report a predicted quadratic relationship between *INVENTORY* and *OVERVALUATION*, which is statistically and economically significant. In Model (2), I conduct a further test to see if the quadratic relationship is ameliorated with stronger governance. Unfortunately, the small number of observations with a G index does not produce a statistically valid estimation. Nevertheless, the G index is negatively signed and significant, consistent with the view that stronger governance reduces inventory, controlling for other effects. In Model 3, I estimate with a fixed-effects specification using the closed-end fund discount measure of *OVERVALUATION*. The dissipation effect is not evident, as the only significant coefficient on *OVERVALUATION* is on the linear term. Model (4) attempts to use the G index, and again, due to the small sample size, I could not arrive at a reasonable estimation. Overall, it appears that the dissipation effect is only very weakly supported, if at all.

In Table 6, I report the test for the catering hypothesis. Panel (a) shows the influence of *INVENTORY-DISCOUNT* and panel (b) shows how this influence is different for firms with more short-term orientation (S) versus others (L, for long-term orientation), measured in various ways. In panel (a), the first five models are estimated using inventory growth as the measure of *INVENTORY* and five different measures of *INVENTORY-DISCOUNT* (other measures described earlier are unreported but achieve the same qualitative result). As predicted, the measures using differences in future returns (which can be thought of as inventory premium) are positively signed, while the last using the difference in market-to-book between high- and low-inventory firms shows the predicted negative sign. All coefficients are significant. For robustness, I show the next five models based on inventory/PPE as a measure of *INVENTORY*. The result is qualitatively similar. Panel (b) shows just the coefficients for *INVENTORY-DISCOUNT*, from estimations done with specifications like those of models (9) and (10) in panel (a). Each of the six sub-panels is for some measure of short-term orientation of the management. For example, sub-panel (1) classifies firm-years by the number of executives in that firm-year that hold options on the firm's stock. The top quartile of these firm-years is considered short-term and the bottom quartile long-term. As predicted, coefficients on *INVENTORY-DISCOUNT* is almost always more sensitive for short-term oriented firm-years, while they are mostly lower or statistically indistinguishable from zero for long-term oriented firm-years.

In table 7, I report results with all hypotheses together. The financing hypothesis seems to have the most economic significance in model (1), but its reversal of signs in model (2) makes me worry about concluding that it is the most important. The dissipation hypothesis lack statistical significance in both models. The catering hypothesis seems to be more robust, even if its economic significance is only roughly half that of the financing hypothesis.

Given the preponderance of evidence consistent with the catering hypothesis, it appears the hardest to reject among all the ones tested.

1.5. Alternative Interpretations

The weight of the evidence appears to support the view that the stock market does influence inventory decisions. Among the channels with which the market could affect these decisions, the catering hypothesis seems to be the one most favored by the data. I cannot reject the financing and dissipation hypotheses, but the evidence seems comparatively weak.

Might there be alternative interpretations of the same data? First, I emphasize that the financing, dissipation, and catering hypotheses are neither exhaustive nor exclusive. For example, Morck, et al. (1990) describe another hypothesis, that the stock market impacts capital expenditures via an information channel. Under this hypothesis, the stock market affects expenditures because it provides investment information useful to firms. However, even Morck, et al. (1990) dismiss this hypothesis as a lame strawman that does not need testing, because it is difficult to imagine that the stock market has better information than insiders in firms do.

Another alternative interpretation that is also easily ruled out is that the catering hypothesis could arise from a rational clientele effect, as is the case argued by Black and Scholes (1974) for dividend clienteles, rather than inefficient markets. Since clientele effects rely on differences in investor preferences that come from tax effects, transaction costs, or institutional investment constraints, it is hard to see how any of these could be applicable to the inventory discount.

A more intriguing critique of the set of hypotheses is that it could be that markets are efficient and it is firms and managers who are irrational. Originally developed by Roll (1986) in the context of takeovers, the idea is that managers, even if acting in the interest of shareholders, genuinely believe (inaccurately) that their firms are undervalued. Such overconfident managers might load up on too much inventory (thinking that sales will come) or too little (thinking that they can handle the same amount of sales with less inventory). I do not test this hypothesis for several reasons. First, managers' overconfidence is much less observable (but see Malmeindier and Tate (2002)). Second, while the psychological basis of some aspects of investor sentiment (e.g., herding) has time variations and is widely documented (e.g., Baker, et al. (2004), Barberis, et al. (1998)), it is harder to think of the psychological basis of overconfidence having the same time variation. Third, the investor sentiment paradigm is comparatively more studied and accepted. Finally, the overconfidence interpretation and the market inefficiency interpretation can be discriminated by examining the impact of future returns. If markets were efficient and managers overconfident, future returns would not be especially low because of current over-valuation. In the results section, I report tests that use future returns as measures of *OVERVALUATION*. The result is consistent only with a market inefficiency paradigm. Nevertheless, it is possible that both the overconfidence and market inefficiency paradigms simultaneously hold, and this is a promising avenue for future research.

Finally, I have to consider if changes in inventory, unlike changes in capital expenditures studied in macroeconomics and finance, might actually not be the result of policy decisions by firms. Instead, they could be involuntary changes that are outcomes of changes to say, sales prospects. What this means is that the relationship between dependant and independent variables might be hardwired. Two arguments count against this interpretation. First, I measure inventory changes at yearly frequencies. While it is plausible, even likely, that inventory changes might not be policy decisions at shorter frequencies, it is much harder to say that firms do not review their inventory levels at yearly intervals when, for example, they and their auditors review financial statements. Even no action could be viewed as a policy decision at these times. The second counter-argument is that in the data, the volatility of inventory is high. For example, a ratio of standard deviation to mean can be computed for inventory change for each firm. This ratio has a mean of 34%. Similarly, a ratio of standard deviation to mean can be computed for inventory/PPE. This has a mean of 51%. Such high ratios suggest that it is unlikely that firms do not have an active hand in their inventory policy.

1.6. Conclusion

I find that the stock market does influence inventory decisions and provide evidence that this influence is likely to have taken effect via a catering channel, and perhaps also by financing and dissipation channels. The theoretical implication is that inventory models might have been more accurate taking into account such empirical parameters (e.g., Netessine and Roumiantsev (2005)). The practical implication is that inventory levels might have been optimized with a short-term view, rather than for the long-term interest of the firm. One nature line of future work is to further confirm this empirically, for example, by investigating long-term returns within a Fama and Macbeth (1973) framework. Another line of future research is to investigate the source of mis-valuation in general, and the inventory discount in particular. For example, it is possible that investors sometimes treat high inventory as a signal of operational incompetence but at other times, treat high inventory as a signal of expected growth. In a broader sense, it might be profitable to investigate more closely the interface between finance and operations management.

References

Abel, A. and O. Blanchard. "The Present Value of Profits and Cyclical Movements in Investment," *Econometrica*, 54(1986), 249-274.

Aghion, P. and J. C. Stein. *Growth Vs. Margins: Destabilizing Consequences of Giving the Stock Market What It Wants*, *Economics Department Working Paper*. Cambridge, MA: Harvard University, 2005

Arrow, K. J., T. Harris and J. Marschak. "Optimal Inventory Policy," *Econometrica*, 19(1951), 250-272.

Baker, G. P. "Incentive Contracts and Performance Measurement," *Journal of Political Economy*, 100(1992), 598-614.

Baker, M., J. C. Stein and J. Wurgler. "When Does the Market Matter? Stock Prices and the

Investment of Equity-Dependent Firms," *The Quarterly Journal of Economics*, 118(2003), 969-1005.

Baker, M., R. S. Ruback and J. Wurgler, "Behavioral Corporate Finance: A Survey," in Eckbo, B. E. (Ed.), *Handbooks in Corporate Finance: Empirical Corporate Finance*, 2004

Baker, M. and J. Wurgler. "A Catering Theory of Dividends," *Journal of Finance*, LIX(2004).

Barberis, N., A. Shleifer and R. Vishny. "A Model of Investor Sentiment," *Journal of Financial Economics*, 49(1998), 307-343.

Black, F. and M. S. Scholes. "The Effects of Dividend Yield and Dividend Policy on Common Stock Prices and Returns," *Journal of Financial Economics*, 1(1974), 1-22.

Blanchard, O., C. Rhee and L. H. Summers. *The Stock Market, Profit, and Investment*, *NBER Working Paper 3370*. Cambridge, MA: National Bureau of Economic Analysis, 1990

Bosworth, B. "The Stock Market and the Economy," *Brookings Papers on Economic Activity*, 2(1975), 267-290.

Boudreaux, K. J. "Discounts and Premiums on Closed-End Mutual Funds: A Study in Valuation," *Journal of Finance*, 28(1973), 515-522.

Brainard, W. C. and J. Tobin. "Pitfalls in Financial Model Building," *American Economic Review Papers and Proceedings*, 56(1968), 99-122.

Chan, K., L. K. C. Chan, N. Jegadeesh and J. Lakonishok. *Earnings Quality and Stock Returns*, *NBER Working Paper 8308*. Cambridge, MA: NBER, 2001

Chen, H., M. Z. Frank and O. Q. Wu. "What Actually Happened to the Inventories of American Companies between 1981 and 2000?," *Management Science*, Forthcoming(2005).

Daniel, K. and S. Titman. "Market Reactions to Tangible and Intangible Information," *National Bureau of Economic Research, Inc, NBER Working Papers: 9743.*(2003).

Fama, E. F. and J. D. MacBeth. "Risk, Return, and Equilibrium: Empirical Tests," *Journal of Political Economy*, 81(1973), 607-636.

Fama, E. F. and K. R. French. "Common Risk Factors in the Returns on Stock and Bonds," *Journal of Financial Economics*, 33(1993), 3-56.

Fazzari, S. M., R. G. Hubbard and B. C. Petersen. "Financing Constraints and Corporate Investment," *Brookings Papers on Economic Activity*, 1(1988), 141-195.

Fischer, S. and R. C. Merton. "Macroeconomics and Finance: The Role of the Stock Market," *Carnegie-Rochester Conference Series on Public Policy*, 21(1984), 57-108.

Gaur, V., M. Fisher and A. Raman. "An Econometric Analysis of Inventory Turnover Performance in Retail Services," *Management Science*, 51(2005), 181–194.

Gompers, P., J. Ishii and A. Metrick. "Corporate Governance and Equity Prices," *The Quarterly Journal of Economics*, 118(2003), 107-155.

Hendricks, K. B. and V. R. Singhal. "Association between Supply Chain Glitches and Operating Performance," *Management Science*, 51(2005), 695–711.

Holmstrom, B. "Managerial Incentive Problems--a Dynamic Perspective," *Review of Economic Studies*, 66(1999), 169-182.

Jensen, M. "Agency Costs of Free Cash Flow, Corporate Finance, and Takeovers," *American Economic Review*, 76(1986), 323-329.

Jones, J. "Earnings Management During Import Relief Investigation," *Journal of Accounting Research*, 29(1991), 193-228.

Kaplan, S. N. and L. Zingales. "Do Investment-Cash Flow Sensitivities Provide Useful Measures of Financing Constraints," *The Quarterly Journal of Economics*, 112(1997), 169-215.

Kashyap, A., O. Lamont and J. C. Stein. "Credit Conditions and the Cyclical Behavior of Inventories," *Quarterly Journal of Economics*, 109(1994), 565-592.

Lai, R. *Inventory Signals*, *Harvard NOM Working Paper*. Boston, MA, 2005

Lee, C. M. C., A. Shleifer and R. H. Thaler. "Investor Sentiment and the Closed-End Fund Puzzle," *Journal of Finance*, 46(1991), 75-109.

Long, J. B. D., A. Shleifer, L. H. Summers and R. J. Waldmann. "Noise Trader Risk in Financial Markets," *Journal of Political Economy*, 98(1990), 703-738.

Maines, L. and J. Hand. "Individuals' Perceptions and Misperceptions of the Time Series Properties of Quarterly Earnings," *Accounting Review*, 71(1996), 317-339.

Malmeindier, U. and G. Tate. *Ceo Overconfidence and Corporate Investment*, *Economics Department Working Paper*. Cambridge, MA: Harvard University, 2002

Morck, R., A. Shleifer and R. Vishny. "The Stock Market and Investment: Is the Market a Sideshow?," *Brookings Papers on Economic Activity*, 2(1990), 157-215.

Narayanan, M. P. "Managerial Incentives for Short-Term Results," *Journal of Finance*, 40(1985), 1469-1484.

Neal, R. and S. M. Wheatley. "Do Measures of Investor Sentiment Predict Returns?," *Journal of Financial & Quantitative Analysis*, 33(1998), 523-547.

Netessine, S. and S. Roumiantsev. *Empirical Testing of Classical Inventory Management Models: Evidence from Us Public Companies*. Paper presented at the POMS OM Frontiers: Winds of Change, Chicago, 2005.

Polk, C. and P. Sapienza. *The Real Effects of Investor Sentiment*: Northwestern University, 2004

Poterba, J. "The Stock Market and Investment: Is the Market a Sideshow? Discussion," *Brookings Papers on Economic Activity*, 2(1990), 208-212.

Roll, R. "On Computing Mean Returns and the Small Firm Premium," *Journal of Financial Economics*, 12(1983), 371-386.

---. "The Hubris Hypothesis of Corporate Takeovers," *Journal of Business*, 59(1986), 197-216.

Scharfstein, D. S. and J. C. Stein. "Herd Behavior and Investment," *American Economic Review*, 80(1990), 465-479.

Shleifer, A. *Inefficient Markets*. Oxford, Oxford University Press, 2000

Sloan, R. "Do Stock Prices Reflect Information in Accruals and Cash Flows About Future Earnings?," *Accounting Review*, 71(1996), 289-315.

Stein, J. C. "Takeover Threats and Managerial Myopia," *Journal of Political Economy*, 96(1988), 61-80.

---. "Rational Capital Budgeting in an Irrational World," *Journal of Business*, 1996(1996), 429-455.

Summers, L. H. "Taxation and Corporate Investment: A Q-Theory Approach," *Brookings Papers on Economic Activity*, 1(1981), 67-127.

Teoh, S. H., I. Welch and T. J. Wong. "Earnings Management and the Long-Run Market Performance of Initial Public Offerings," *Journal of Finance*, 53(1998), 1935-1974.

Tobin, J. "A General Equilibrium Approach to Monetary Theory," *Journal of Money Credit and Banking*, 1(1969), 15-29.

Whitin, T. M. "Inventory Control in Theory and Practice," *Quarterly Journal of Economics*, 66(1952), 502-521.

Zweig, M. E. "An Investor Expectations Stock Price Predictive Model Using Closed-End Fund Premiums," *Journal of Finance*, 28(1973), 67-87.

Figure 1 – The Inventory Discount.

The vertical axis is a normalized scale obtained by subtracting the raw discount by the mean over the entire time series, and dividing that by the standard deviation of the time series. The lighter line is the discount calculated as the difference in mean market-to-book value between the lowest- and highest-inventory quartiles classified by inventory value. The darker line shows the negative of the discount calculated as the mean future three-year stock return of the lowest- and highest-inventory quartiles, also classified by inventory value.

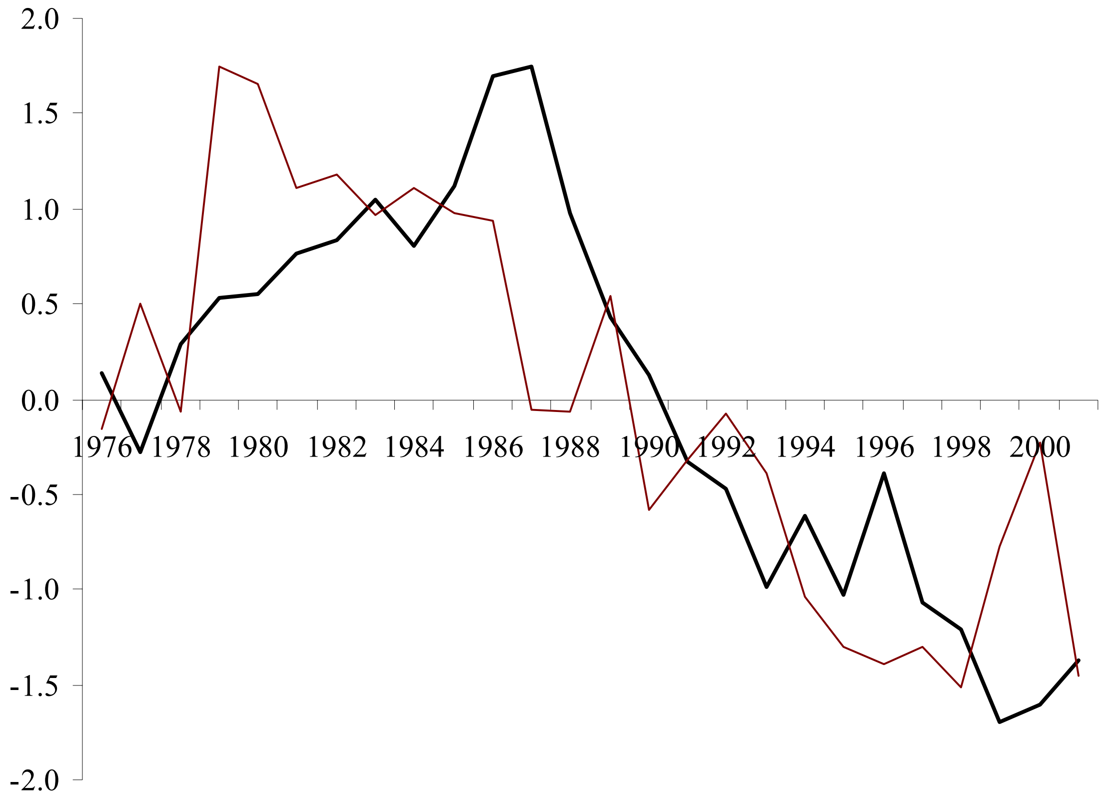

Table 1 – Statistics for Some Measures of Inventory Discount

The measures of inventory discount are based on the difference in the second column (e.g., future return at time *t*+3, or market to book, MTB) of the low vs. high quartiles of firm-year observations, sorted by the criteria in the third column. The data is from COMPUSTAT-CRSP.

			Dickey-Fuller test of unit roots		Correlation coefficients						
		Low vs. high criteria	No lag, no trend	5 lags, trend	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(1)	$Return_{t+3}$	Inventory	-3.12 (.025)	-2.58 (.289)	1.00						
(2)	$Return_{t+2}$	Inventory	-3.20 (.020)	-1.57 (.804)	0.41	1.00					
(3)	$Return_{t+1 \text{ to } 3}$	Inventory	-0.56 (.880)	-2.60 (.279)	0.81	0.76	1.00				
(4)	$Return_{t+1}$	ΔInventory/ PPE	-4.83 (.000)	-2.20 (.493)	-0.14	0.16	0.15	1.00			
(5)	$Return_{t+1 \text{ to } 3}$	ΔInventory/ PPE	-2.80 (.059)	-2.68 (.244)	0.23	0.33	0.32	0.45	1.00		
(6)	MTB	Inventory	-1.43 (.565)	-2.45 (.356)	-0.64	-0.66	-0.72	-0.15	-0.38	1.00	
(7)	MTB	Δinventory	-2.13 (.234)	-2.47 (.341)	-0.15	-0.30	-0.28	-0.15	-0.29	0.59	1.00

Table 2 - Summary Statistics

The data is from COMPUSTAT-CRSP, I/B/E/S, and ExecuComp, winsorized at 1% and 99%. Observations cannot be involved in acquisitions or mergers, the market-to-book and Q must be between 0.1 and 100, sales, assets, capital expenditures, income before earnings and interest, common dividends, common equity must all be non-negative.

	N	Mean	SD	Min.	Max
Year	97,934	1989.7	8.5	1962	2003
Market cap	97,922	885.8	6,629.9	0.0	508,329
Book equity	97,811	406.1	2,388.1	-4,174.0	186,066
Market-to-book ratio	97,922	3.0	5.9	0.0	99.4
Return (%)	71,061	3.2	29.1	0.0	4,474.1
Δcash flow	97,922	4.4	5.9	-12.2	12.9
Δsales	97,922	1.7	1.1	0.2	3.3
Δinventory	97,922	2.1	1.2	0.0	3.4
Alpha CAPM	71,061	1.8	29.0	-2.4	4,471.8
Alpha Fama French	71,061	1.7	29.0	-4.6	4,469.3
$Inventory_t$ / PPE_{t-1}	97,922	8.7	10.9	0.0	24.1
Discretionary accruals	4,514	-40.5	2,807.4	-188,518	5,081
Δdebt	97,934	3.7	4.2	-1.0	8.6
Δequity	97,934	1.2	1.8	-0.8	4.0
KZ index	97,934	-1.3	15.7	-137.4	6.3
Q	97,922	1.7	2.3	0.0	85.4
G index	3,435	8.8	2.8	1.0	17.0
Restricted stock holdings by average executive ($)	8,913	411.3	7,434.3	0.0	655,968
Unexercised exercisable options held by average executive ($)	8,913	2,113.0	9,078.4	-21.7	556,283
$ realized from options for average executive, exercised	8,913	623.6	2,891.3	-7.1	121,427
% company stock held by employees	5,520	5.6	8.6	0.0	64.2
% options granted to employees	10,011	19.5	20.7	0.0	342.5
Number of executives granted options or shares	10,011	5.5	2.0	1.0	12.0

Table 3 – Testing the "Fundamentals Only" Hypothesis

INVENTORY, OVERVALUATION, and *FUNDAMENTALS* are measured using a variety of variables in the models below. The specification is of the form:

$$INVENTORY_t = \beta_0 + \beta_1.OVERVALUATION_{t-1} + \beta_2.FUNDAMENTALS_t + \textit{firm effects} + \textit{year indicators} + \varepsilon_t.$$

Models (1) and (2) use OLS on changes, (3) and (4) use firm fixed effects, (5) uses two-stage least squares with instrumental variables, (6) logistic, and (7) a Heckman correction. Accruals are discretionary ones, obtained by subtracting from total accruals the discretionary portion. Totals are:

$$ACCR_{i,t} = (\,\Delta[CurrentAssets_{i,t} + Cash_{i,t}] - \Delta[CurrentLiabilities_{i,t} - LongTermDebt_{i,t}]\,)\ /\ TotalAssets_{i,t-1}\,.$$

The discretionary portion is:

$$NONDIS\text{-}ACCR_{i,t} = \hat{\theta}_0 + \hat{\theta}_1.(1/TotalAssets_{,t-1}) + \hat{\theta}_2.(\Delta sales_{i,t} - \Delta accountsReceivable_{i,t})/TotalAssets_{,t-1} + \hat{\theta}_3.(PlantPropertyEqpt_{i,t}/TotalAssets_{,t-1})\ ,$$

where the $\hat{\theta}$'s are obtained from firm-by-firm regressions using all four-digit SIC code peers (i.e., all but itself):

$$ACCR_{i,t} = \theta_0 + \theta_1.(1/TotalAssets_{,t-1}) + \theta_2.(\Delta sales_{i,t}/TotalAssets_{,t-1}) + \theta_3.(PlantPropertyEqpt_{i,t}/\,TotalAssets_{,t-1}) + \varepsilon_{i,t}.$$

Most data is from COMPUSTAT-CRSP and I/B/E/S, winsorized at 1% and 99%. The closed-end fund discount is from Neal and Wheatley (1998) (for years 1962 through 1993), CDA (1994 through 1998), and *The Wall Street Journal* end-of-year issues (1999 through 2000). Fama-French factors are SML, HML, and MOM, from Professor French's website. The Heckman correction in model (7) uses the following selection model:

$$SELECTED = f\,(MKTCAP,\ S\&P500,\ ASSETS)\ ,$$

where *MKTCAP* is market capitalization, *S&P500* is whether the firm is ever in the S&P 500, and *ASSETS* is total assets. Observations cannot be involved in acquisitions or mergers, the market-to-book and Q must be between 0.1 and 100, sales, assets, capital expenditures, income before earnings and interest, common dividends, common equity must all have non-negative values. Estimations are done with heteroskedastic-robust standard errors (in brackets below) and clustered around firms to minimize serial correlation.

INVENTORY	(1) Δinventory	(2) Δinventory	(3) Inventory/PPE	(4) Inventory/PPE	(5) Δinventory	(6) Inventory dummy	(7) Δinventory
OVERVALUATION							
CAPM $alpha_{t-1}$	.035 (.000)	.002 (.000)				.0075 (.0007)	.004 (.000)
$Accruals_{t-1}$			.018 (.006)				
Closed-end fund $discount_{t-1}$				.012 (.002)			
Fama-French $alpha_{t-1}$ instrumented using all three above					.0013 (.0004)		
FUNDAMENTALS							
ΔCash flow		.058 (.002)			.046 (.003)	.110 (.004)	.049 (.005)
ΔSales		.493 (.010)			.404 (.012)	1.380 (.027)	.715 (.028)
Q_{t-1}			.034 (.007)	.031 (.008)			
Inverse Mill's ratio							-.543 (.309)
Firm fixed effects			Yes	Yes			
Year indicators	Yes	Yes			Yes	Yes	Yes
R^2	.245	.513	.003	.126	.082	.294	41257 (Wald)
N	97,922	97,922	71,391	66,203	66,203	95,326	97,922

Table 4 – Testing the Financing Hypothesis

Models (1) through (3) use OLS on changes and (4) and (5), firm fixed effects. The data is from COMPUSTAT-CRSP and I/B/E/S, winsorized at 1% and 99%. The closed-end fund discount is from Neal and Wheatley (1998) (1962 through 1993), CDA (1994 through 1998), and *The Wall Street Journal* (1999 through 2000). The discretized versions of Δdebt is set to 1 if Δdebt is more than 20%; likewise for equity if more than 10%. The measure of DT equity is $log\ (M_t/M_{t-\tau}) - r(t\text{-}\tau,t)$, where M_t is the per share value at t and $r(t\text{-}\tau,t)$ is the log stock return from $t\text{-}\tau$ to t, in turn defined as $r(t\text{-}\tau,t) = \sum_{s=t-\tau+1}^{t} log[(M_s{\cdot}f_s + D_s)/M_{s-1}]$, where f_s is the price adjustment factor from $s\text{-}1$ to s that accounts for splits and rights issues, and D_s is the per-share cash distribution paid at time s. The KZ index is -1.001909*[(Income before extraordinary items + Depreciation & amortization)/PPE] + 0.2826389*[(Assets + Market capitalization – Common equity – Deferred taxes) / Assets] + 3.139193*[(Long-term debt + Debt in current liabilities) / (Long-term debt + Debt in current liabilities + Stockholders' equity)] -39.3678*[(Common dividends + Preferred dividends) / PPE]-1.314759*[Cash & short-term investments / PPE]. Observations cannot be involved in acquisitions or mergers, the market-to-book and Q must be between 0.1 and 100, sales, assets, capital expenditures, income before earnings and interest, common dividends, common equity must be non-negative. Estimations are with heteroskedastic-robust standard errors (in brackets) and clustered around firms to minimize serial correlation.

INVENTORY	(1) Δinventory	(2) Δinventory	(3) Δinventory	(4) Inventory/PPE	(5) Inventory/PPE
OVERVALUATION					
CAPM alpha$_{t-1}$	.002	.002	.001		
	(.000)	(.000)	(.000)		
Closed-end fund discount$_{t-1}$				.014	.012
				(.002)	(.002)
FUNDAMENTALS					
ΔCash flow	.048	.055	.024		
	(.002)	(.002)	(.002)		
ΔSales	.332	.404	.297		
	(.011)	(.010)	(.000)		
Q$_{t-1}$				.030	.022
				(.008)	(.008)
FINANCING					
Δdebt	.066		.033		
	(003)		(.003)		
Δequity	.025		.034		
	(.006)		(.006)		
Δdebt dummy		.417			
		(.014)			
Δequity dummy		.018			
		(.008)			
Debt				-.00004	-.00006
				(.00002)	(.00002)
Daniel-Titman (DT) equity				-.007	-.042
				(.001)	(.003)
Kaplan-Zingales (KZ) index			-.007		-.017
			(.001)		(.003)
Δdebt × KZ index			.011		
			(.001)		
Δequity × KZ index			.022		
			(.001)		
Debt × KZ index					.0004
					(.0000)
DT equity × KZ index					.0027
					(.0002)
Firm fixed effects				Yes	Yes
Year indicators	Yes	Yes	Yes		
R^2	.542	.534	.559	.135	.213
N	97,922	97,922	97,922	66,203	66,203

Table 5 – Testing the Dissipation Hypothesis

The specification for models (1) and (3) is:

$$INVENTORY_t = \beta_0 + \beta_1. FUNDAMENTALS_t + \beta_2.OVERVALUATION_{t-1} + \beta_3.OVERVALUATION^2_{t-1} + \varepsilon_t.$$

That for models (2) and (4) is:

$$INVENTORY_t = \beta_0 + \beta_1. FUNDAMENTALS_t + \beta_2.OVERVALUATION_{t-1} + \beta_3.OVERVALUATION^2_{t-1} + \zeta_1 G_t + \zeta_2.OVERVALUATION^2_{t-1} \times G_t + \varepsilon_t.$$

Models (1) and (2) use OLS on changes and (3) and (5), firm fixed effects. Most data is from COMPUSTAT-CRSP and I/B/E/S, winsorized at 1% and 99%. The closed-end fund discount is from Neal and Wheatley (1998) (for years 1962 through 1993), CDA (1994 through 1998), and *The Wall Street Journal* end-of-year issues (1999 through 2000). The governance index G is from Gompers, et al. (2003), obtained from I/B/E/S. Observations cannot be involved in acquisitions or mergers, the market-to-book and Q must be between 0.1 and 100, sales, assets, capital expenditures, income before earnings and interest, common dividends, common equity must all have non-negative values. Estimations are done with heteroskedastic-robust standard errors (in brackets below) and clustered around firms to minimize serial correlation.

INVENTORY	(1) Δinventory	(2) Δinventory	(3) Inventory/PPE	(4) Inventory/PPE
OVERVALUATION				
CAPM alpha$_{t-1}$	-.035	.045		
	(.004)	(.067)		
CAPM alpha$^2_{t-1}$	.0012	-.001		
	(.0001)	(.002)		
Closed-end fund discount$_{t-1}$			.017	.15
			(.006)	(.19)
Closed-end fund discount$^2_{t-1}$			-.0002	-.021
			(.0002)	(.014)
FUNDAMENTALS				
ΔCash flow	.058	.043		
	(.002)	(.009)		
ΔSales	.490	.642		
	(.010)	(.048)		
Q$_{t-1}$			.030	-.13
			(.008)	(.07)
GOVERNANCE				
G index		-.020		-.012
		(.009)		(.090)
G index × *OVERVALUATION*		-.006		-.022
		(.007)		(.020)
G index × *OVERVALUATION*^{2}		.0002		.003
		(.0002)		(.002)
Firm fixed effects			Yes	Yes
Year indicators	Yes	Yes		
R^2	.515	.584	.128	.038
N	97,922	3,435	66,203	1,920

Table 6 – Testing the Catering Hypothesis

Panel (a) shows a regression of *INVENTORY* on various measures of *OVERVALUATION, FUNDAMENTALS*, and *INVENTORY-DISCOUNT*. The measures of inventory discount are based on the difference (such as the future return at time t+3 or market to book, MTB) of the low vs. high quartiles of firm-year observations, sorted by certain criteria (such as inventory, or Δinventory/PPE). Panel (b) shows just the coefficients for *INVENTORY-DISCOUNT*, from estimations done with specifications like those of models (9) and (10) in panel (a). Each of the six sub-panels is for some measure of short-term orientation of the management. For example, sub-panel (1) classifies firm-years by the number of executives in that firm-year that hold options on the firm's stock. The top quartile of these firm-years is considered short-term and the bottom quartile long-term. Most data is from COMPUSTAT-CRSP and I/B/E/S, winsorized at 1% and 99%. The closed-end fund discount is from Neal and Wheatley (1998) (for years 1962 through 1993), CDA (1994 through 1998), and *The Wall Street Journal* end-of-year issues (1999 through 2000). Fama-French factors are SML, HML, and MOM, from Professor French's website. The Heckman correction in model (7) uses the following selection model:

SELECTED = f (MKTCAP, S&P500, ASSETS) ,

where *MKTCAP* is market capitalization, *S&P500* is whether the firm is ever in the S&P 500, and *ASSETS* is total assets. Observations cannot be involved in acquisitions or mergers, the market-to-book and Q must be between 0.1 and 100, sales, assets, capital expenditures, income before earnings and interest, common dividends, common equity must all have non-negative values. Estimations are done with heteroskedastic-robust standard errors (in brackets below) and clustered around firms to minimize serial correlation.

Panel (a)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
INVENTORY			Δinventory					Inventory/PPE		
OVERVALUATION										
CAPM $alpha_{t-1}$	.002	.002	.002	.002	.002					
	(.000)	(.000)	(.000)	(.000)	(.000)					
Closed-end fund $discount_{t-1}$						.011	.011	.009	.018	.012
						(.002)	(.001)	(.002)	(.002)	(.002)
FUNDAMENTALS										
ΔCash flow	.058	.058	.058	.058	.057					
	(.002)	(.002)	(.002)	(.002)	(.002)					
ΔSales	.500	.500	.500	.495	.495					
	(.010)	(.010)	(.010)	(.010)	(.010)					
Q_{t-1}						.031	.030	.031	.027	.031
						(.008)	(.008)	(.008)	(.008)	(.008)
INVENTORY-DISCOUNT based on										
• t+3 return differences of by inventory quartiles	.045					.118				
	(.012)					(.031)				
• t+2 return differences of by inventory quartiles		.072					.232			
		(.013)					(.030)			
• t+1 to t+3 return differences of by inventory quartiles			.034					.136		
			(.006)					(.015)		

• t+1 to t+3 return differences of Δinventory/PPE quartiles				.024 (.006)					.060 (.012)	
• MTB differences of inventory quartiles					-.192 (.014)					-.094 (.029)
Firm fixed effects						Yes	Yes	Yes	Yes	Yes
Year indicators	Yes	Yes	Yes	Yes	Yes					
R^2	.507	.507	.507	.502	.513	.128	.131	.131	.154	.126
N	88,727	88,727	88,727	85,937	97,922	66,203	66,203	66,203	63,949	66,203

Panel (b)

	(1) Number of executives granted options or shares				(2) % options granted to employees				(3) Unexercised exercisable options held by average executive ($)			
Orientation	Short	Long	Short	Long	Short	Long	Short	Long	Short	Long	Short	Long
INVENTORY-DISCOUNT based on												
• t+1 to t+3 return differences of Δinventory/PPE quartiles			.061 (.013)	.055 (.044)			.064 (.013)	.042 (.048)			.064 (.013)	.013 (.069)
• MTB differences of inventory quartiles	-.108 (.031)	.012 (.153)			-.120 (.031)	-.024 (.190)			-.118 (.031)	.165 (.228)		

	(4) $ realized from options for average executive, exercised at t+1				(5) % Company stock held by employees				(6) Restricted stock holdings by average executive ($)			
Orientation	Short	Long	Short	Long	Short	Long	Short	Long	Short	Long	Short	Long
INVENTORY-DISCOUNT based on												
• t+1 to t+3 return differences of Δinventory/PPE quartiles			.064 (.013)	-.072 (.061)			.059 (.013)	.005 (.060)			.064 (.013)	.065 (.040)
• MTB differences of inventory quartiles	-.109 (.031)	.313 (.206)			-.097 (.030)	-.145 (.175)			-.122 (.031)	.069 (.128)		

Table 7 – Comparison of All Hypotheses

The cells show the percent change in the standard deviation of *INVENTORY* for one standard deviation change in the explanatory variable, where the specification is:

$$INVENTORY_t = \beta_0 + \beta_1.\ FUNDAMENTALS_t + \gamma_1.EQUITY_{t-1} + \gamma_2.DEBT_{t-1} + \beta_2.OVERVALUATION_{t-1} + \beta_3.OVERVALUATION^2{}_{t-1} + \zeta_1\ G_t + \zeta_2.OVERVALUATION^2{}_{t-1} \times G_t + \eta.INVENTORY\text{-}DISCOUNT_t + \varepsilon_t.$$

Model (1) uses OLS on changes and (2), firm fixed effects. Most data is from COMPUSTAT-CRSP, I/B/E/S, and ExecuComp, winsorized at 1% and 99%. The measure of DT equity is $log\ (M_t/M_{t-\tau}) - r(t\text{-}\tau,t)$, where M_t is the per share value at t and $r(t\text{-}\tau,t)$ is the log stock return from $t\text{-}\tau$ to t, in turn defined as $r(t\text{-}\tau,t) = \sum_{s=t-\tau+1}^{t} log[(M_s.f_s + D_s)/M_{s-1}]$, where f_s is the price adjustment factor from $s\text{-}1$ to s that accounts for splits and rights issues, and D_s is the per-share cash distribution paid at time s. The governance index G is from Gompers, et al. (2003), obtained from I/B/E/S. Observations cannot be involved in acquisitions or mergers, the market-to-book and Q must be between 0.1 and 100, sales, assets, capital expenditures, income before earnings and interest, common dividends, common equity must all have non-negative values. Estimations are done with heteroskedastic-robust standard errors and clustered around firms to minimize serial correlation.

INVENTORY	(1) Δinventory	(2) Inventory/PPE
FINANCING		
• Δdebt	.104***	
• Δequity	.084*	
• Debt		-.043
• Daniel-Titman (DT) equity		-.016
DISSIPATION		
• G index × *OVERVALUATION*	-.796	-.147
• G index × *OVERVALUATION*^{2}	-.770	-.128
CATERING – inventory discount based on:		
• t+1 to t+3 return differences of low vs. high inventory quartiles	.045***	
• t+1 to t+3 return differences of low vs. high Δinventory/PPE quartiles		.018
Firm fixed effects		Yes
Year indicators	Yes	
R^2	.636	.0085
N	2,550	1,920