Inventory Write-downs in the Semiconductor Industry*

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Abstract

We examine the discretionary nature of inventory write-downs in the semiconductor industry. The semiconductor industry, with consistent price declines and rapid obsolescence, provides an ideal setting to examine inventory write-down decisions of managers. Based on historical data, we first build an expectation model of ending inventory levels for firms in the industry. We then identify "excess" inventory as the difference between actual inventory levels and out of sample fitted values from the model and find that our empirical estimate of excess inventory is highly correlated with actual write-downs. We also find that inventory write-downs are associated with other economic as well as opportunistic factors identified in prior research. Our results are consistent with managers strategically taking write-downs consistent with 'big bath' incentives. We also examine the relation between abnormal levels of write-downs and subsequent operating performance. Consistent with managerial-discretion-induced accounting reversals, we find that abnormally high (low) write-downs in year t are followed by improvements (deterioration) in accounting measures of operating performance in year t+1. Neither analysts, nor investors seem to fully appreciate the future implications of write-down activity with respect to predictable subsequent performance.

1. Introduction

Under Generally Accepted Accounting Principles (GAAP), firms are required to write down inventory if its market value at the end of the fiscal year falls below historical cost.[1] To implement this lower-of-cost-or-market (LCM) rule, firms consider multiple, potentially subjective factors that are relevant to the market value of inventories. Examples of such factors include the estimate of the hypothetical replacement cost of the inventory, forecast demand for the firm's products, and expected costs of disposal. Typically, write-downs are non-routine accounting events. However, firms that experience significant and frequent declines in inventory values often maintain inventory reserves - offsets to the balance in the inventory account (similar to the provision for doubtful accounts offset to accounts receivable). Inventory reserves are subjective estimates of the expected decline in inventory values and are increased or decreased at the discretion of the management.

We study three issues related to subjectivity in inventory valuation. First, following prior research on asset write-downs, we hypothesize and test whether firms exploit the subjectivity in inventory valuation to manipulate the magnitude and timing of write-downs consistent with several proxies for opportunism. In conducting these tests, we recognize that write-downs also reflect legitimate consideration of economic factors and attempt to control for these factors. Second, we argue that because of the reversing nature of accruals, there are predictable consequences for subsequent operating performance when firms over- or under-accrue inventory-related charges in a given period. More specifically, we use an inventory write-down expectation model from prior literature to provide a proxy of 'abnormal write-downs' and test

[1] Accounting Research Bulletin 43 (1953) defines 'market' as current replacement cost, but that amount extends over the following range: the maximum is expected selling price less costs of completion and disposal (also known as net realizable value), the minimum is net realizable value less the mark-up to sales price.

whether there is a positive relation between excess write-down activity and subsequent operating performance. Finally, having established a link between 'abnormal' write-down behavior and subsequent operating performance, we examine whether market participants appear to appreciate the predictable reversing nature of excess inventory accruals. To this end we test whether subsequent analyst forecast errors and abnormal returns are correlated with 'abnormal' inventory write-downs.

We conduct our tests using a panel of firm years from the semiconductor manufacturing industry. The semiconductor industry is characterized by rapid innovation with new generations of more powerful semiconductors (chips) continually entering the market place. Existing chips tend to be priced downward to be competitive with the performance level and pricing of new chips. Consequently, the economic magnitude and frequency of inventory write-downs in this industry are larger than most other industries.[2] The second distinguishing characteristic of the semiconductor industry is its pronounced cyclicality. Cyclicality causes earnings to be unusually volatile which in turn increases incentives to manage or smooth earnings. Thus, the semiconductor industry provides an excellent setting within which to examine inventory write-down decisions.

Our design and methodological approach consists of the following choices. Our sample consists of an unbalanced panel of semiconductor firms for the period 1993-2007. We read all the 10-Ks / annual reports for our sample firms for these years and obtain data on whether or not a write-down was recorded and, if so, its dollar amount. We use a two-stage approach to model write-downs. In the first stage, we use a pooled time-series and cross-sectional regression to estimate "required" inventory levels based on company-specific, as well as industry-wide factors.

[2] Of all the industries in the U.S., the semiconductor industry experienced the largest decline in its producer price index over the last two decades.

Specifically, for each year, we use the preceding ten years of available information to year t-1 relative to the sample year to estimate the industry-level coefficients of our inventory prediction model. In the second stage, using the estimated model coefficients and the related independent variables, we predict the "required" inventory level for each firm in year t. We deem the difference between the predicted and actual inventory level as excess inventory that will potentially be written off in year t. We conduct our first set of tests on regressions of inventory write-downs on our excess inventory variable, various proxies of managerial opportunism, and other economic determinants. This enables us to revisit the issue of whether inventory write-downs appear to be managed, a finding not established by prior research.

We then compare our excess inventory measure to the actual write-down and label the difference as the 'abnormal' write-down in year t. We argue that abnormally high write-downs in year t are more likely to reverse, leading to improvements in future operating performance. Similarly, abnormally low write-downs are more likely reflective of manager' income-increasing accounting choices in the current year that typically lead to future performance declines. Our post-write-down performance tests correlate abnormal write-downs with subsequent operating performance measured by gross margin and return on assets.

Several important findings emerge from our research. First, we find that our estimates of excess inventory are highly correlated with actual inventory write-downs, validating our model of "required" inventory levels. Specifically, inclusion of the excess inventory variable increases the explanatory power of our inventory write-down regression from 10 percent to 42 percent. Second, we find evidence consistent with bath-taking incentives driving write-down decisions. Third, we find that abnormal inventory write-downs are significantly related to subsequent changes in operating performance (as measured by both gross margin and return on assets).

Specifically, firms that have abnormally high (low) inventory write-downs in year t perform better (worse) in year t+1. Fourth and finally, we find that neither analysts, nor investors seem to understand the implications of 'abnormal' write-downs for future performance in that current 'abnormal' write-downs are correlated with both subsequent analyst forecast errors and subsequent stock returns. These findings are consistent with a setting wherein managers take excess (smaller) write-downs in a given period, resulting in higher (lower) subsequent profitability, ceteris paribus, and market participants that are unable to anticipate the write-down-related profitability changes.

Prior research on managerial discretion underlying inventory write-downs is surprisingly limited. Francis, Hanna, and Vincent (1996) (FHV, henceforth) study inventory write-downs as part of overall asset write-off decisions but fail to find evidence consistent with managerial incentives influencing inventory write-downs. FHV conclude that inventory write-offs are not driven by incentives arguing that market values are readily available and that the LCM rule provides guidance which diminishes the role for judgment. There are at least two reasons that could potentially reconcile the difference between FHV's findings and ours. FHV's analysis is based on a sample drawn from different industries; in contrast to our focus on the semiconductor industry, and the magnitude and frequency of inventory write-downs in their sample are smaller. Moreover, unlike our study, FHV do not control for excess inventory in their model of inventory write-downs.

Our study extends prior research on asset write-downs. This sizable literature includes Strong and Meyer (1987), Elliot and Shaw (1988), Zucca and Campbell (1992), FHV, Rees, Gill, and Gore (1996), Riedl (2004), Beatty and Weber (2005), and Ramanna and Watts (2009). FHV use a broad sample of firms to investigate inventory write-offs among other asset write-offs.

They find opportunistic write-off behavior for other assets, but not for inventory. Beatty and Weber (2005) provide an analysis on the determinants of goodwill write-offs and find support for managerial incentives behind these decisions. Riedl (2003) compares firms' write-off behavior before and after SFAS 121 and finds more opportunistic reporting and decreased reporting quality after the implementation of that standard related to impairment of long-lived assets. Ramanna and Watts (2009) use a sample of firms that are more likely to experience impairment in examining the effect of SFAS 142 on goodwill impairments. Ramanna and Watts (2009) indentify managerial discretion, rather than true economic impairment in value, as driving goodwill impairment decisions.

We make a few contributions to this literature. Our study extends the literature on asset write-downs by providing some evidence that inventory write-downs can be ascribed in part to opportunistic motives. This is more difficult to establish with inventory because of the LCM rule which provides a floor and ceiling on 'market' values as opposed to non-current asset write-downs which are made with reference to fair value. We also contribute to the earnings management literature by developing an 'abnormal' inventory write-down proxy that manifests a reversal property – it is negatively correlated with future profitability. Our study complements and extends a rich accounting literature on earnings management in specific industries. Healy and Wahlen (1999) argue that evidence related to specific forms of earnings management can provide more information to standard setters. Beaver (1996) also notes that context-based research can address specific accounting issues that are more relevant to some firms (or industries) than others.[3] By focusing on a single industry and single account, we reap the

[3] Many prior studies have adopted this approach and focused on a single industry or single account for this purpose (e.g., Moyer (1990); Petroni (1992); Beatty, Chamberlain, and Magliolo (1995); Collins, Shackelford, and Wahlen (1995); Beaver and Engel (1996), Key (1997); Miller and Skinner (1998); Ayers (1998); Schrand and Wong

advantage that flows from the ability to more carefully model managerial discretion and consequently reduce noise in our regressions.

We also contribute to recent evidence on market efficiency with respect to the inventory accruals. Thomas and Zhang (2002) and Chan, Chan, Jegadeesh, and Lakonishok (2006) document that inventory changes are the primary cause of the negative relation between accruals and future abnormal returns. We find that, in the semiconductor industry, the inventory write-down component of inventory changes is misinterpreted by analysts and mispriced by the market.

The paper is organized as follows. Section 2 discusses the semiconductor industry. Section 3 describes our sample. Inventory and write-down models are motivated and described at length in section 4. We discuss determinants of inventory write-downs in section 5 and report related results in section 6. Section 7 relates write-downs to subsequent performance and section 8 concludes.

2. Semiconductor Industry

The semiconductor industry is among the largest manufacturing industries in the United States. In the past twenty-five years, semiconductor devices have found applications in a diverse set of products that range from digital watches, computers, and cellular phones to medical equipment, automobiles, and weapon systems. The manufacture and sale of semiconductors is so important to the U.S. economy that the Congress holds hearings on the industry to discuss its impact on national policy. Scalise (2004), in his Congressional Testimony, summarizes the

(2003)). Similar to Beaver and Engel (1996), who focus on loan loss reserves in banks, we investigate a sample of firms where the accrual choice is likely to be important in a sample of firms with relatively similar characteristics.

importance of the semiconductor industry to the U.S. economy.[4] He states that, "[s]emiconductors are, in effect, the brains and nerve center for almost all electronic products today and are thus at the heart of the entire IT sector, enabling everything from advanced computers to medical equipment to weapons systems and contributing $75 billion annually to U.S. GDP, more than another other single manufacturing technology."

From its inception in 1958, when the first integrated circuit was developed, the semiconductor industry has been cyclical with periods of alternating rapid and slow growth. Despite these periods of slow growth, during the years 1975-2000, the industry recorded an impressive 16.1 percent compound annual growth rate (SIA (2004)). However, following this, the industry recorded its worst collapse in 2001, when, after achieving more than $200 billion in worldwide sales in 2000, it witnessed an abrupt decline in sales of over thirty percent. A sharp fall in the sales of personal computers, cellular phones, and networking and communications equipment in that year negatively affected the demand for semiconductors.

As a response to the lowering market demand, in 2001 the semiconductor industry took arguably the biggest collective write-down decision in history. Semiconductor firms, among other technology firms, took sizable inventory write-offs (e.g., Lucent Technologies took a $563 million write-off, Conexant Systems took a $149 million write-off, and Xilinx took a $32 million write-off). In fact, the write-downs were so big that they were considered as overly aggressive by investors and the SEC "was closely watching."[5]

Semiconductor firms are highly capital intensive – their operation requires substantial investments in capital equipment. Because firms need to recover the high cost of their equipment, they tend to produce at capacity even in periods of low demand. This tendency leads

[4] George Scalise was the President of the U.S. Semiconductor Industry Association (SIA), at the time of this testimony.
[5] Pender (2001).

to build-up of inventories during periods of low demand. The second striking characteristic of the industry is the high levels of research and development activity and the consequent rapid rate of technological obsolescence. The famous prediction by Gordon Moore, Intel Corp's co-founder, in 1965, informally known as Moore's law, has been fairly accurate – the number of transistors on a chip tends to double every eighteen to twenty-four months.[6] New generations of faster and more powerful chips enter the market very frequently, rendering the prior generation obsolete. This provides the second reason for high incidence of inventory build-ups and more frequent write-downs in this industry.

The third important characteristic of the semiconductor industry is that chip selling prices decline continually. Aizcorbe (2002) documents that, for the years 1993-1999, these declines are primarily attributable to technological innovations rather than lower manufacturing costs. In addition, she finds that some of these price declines are related to the pricing strategy of Intel Corporation, the dominant player in the semiconductor industry: Intel reduced its mark-ups over costs during the 1990s. Because selling prices could fall below costs, semiconductor firms, more than firms in most other industries, are likely to take frequent inventory write-downs.

To provide evidence on declining prices, we obtain Producer Price Index (PPI) data for the semiconductor industry from the website of the Bureau of Labor Statistics, www.bls.gov. PPI is a family of indexes that measures the average selling prices received by producers of goods and services in the United States. The Bureau computes these indexes from data obtained from over 25,000 establishments that provide approximately 100,000 price quotations per month. In Figure 1, we report the monthly values of the PPI for the semiconductor industry for the years 1990-2008. Consistent with Aizcorbe (2002), semiconductor prices have declined considerably,

[6] For example, in 1971, the Intel 4004 microprocessor contained 2,300 transistors; in 1998, the Pentium II contained 7.5 million transistors.

with the PPI falling from 153.4 points in the beginning of 1990 to 51.4 points at the end of 2008. The downward trend is steady, with price declines occurring in 168 of the 228 months over the sample period, or nearly seventy-four percent of the time. The mean January–to–January annual percentage decline in the index is 5.5 percent with the largest decline in prices occurring in 2008 (20 percent). Importantly, in untabulated analysis, we find that among all the industries in the U.S., the semiconductor industry has recorded the largest price declines over this period. Producer price indices for other industries generally increase (e.g., for electronic capacitors the series is more variable, but has increased by slightly over 1% over the same time period).

In sum, the semiconductor industry is characterized by high capital costs, rapid technological change, and continual price declines. These industry characteristics result in high risks of excess capacity and technological obsolescence and thus increase the likelihood of excess inventories and write-downs. Thus, the semiconductor industry provides an excellent setting to study the causes and consequences of inventory write-downs.

3. Sample

The semiconductor industry can be broadly divided into three sectors: firms that are primarily in the business of manufacturing and selling semiconductors, vertically integrated firms that produce semiconductors as inputs for products that they manufacture (e.g., IBM and Sun Microsystems), and firms that do not manufacture semiconductors but which focus on research and design of semiconductors (known as fabless firms, in industry parlance). To arrive at our sample, we examine the CorpTech Directory of Technology Companies for each of the years 1992-2007. This annual directory provides a comprehensive listing of all firms in the semiconductor industry. Our initial sample consists of 220 firms that appeared in at least one of the annual editions for the years 1992-2007, were domiciled in the U.S., were publicly traded,

and were not subsidiaries. From this initial sample, we exclude fifty-eight vertically integrated firms or firms that were not semiconductor manufacturers (based on our reading of their 10-Ks), thirteen fabless firms, fourteen firms that are not listed on the Center for Research in Security Prices (CRSP) database, and eight firms for which financial data was missing throughout our sample period on COMPUSTAT. We exclude vertically integrated firms to achieve a sample of firms with fairly homogenous production functions and fabless firms because they do not carry inventories. This yields a sample of 127 firms.

Our sample period is over the 15 years 1993-2007. The final sample consists of 1,070 firm-year observations for which we are unambiguously able to determine the inventory write-down amounts from firms' form 10-Ks or annual reports and for which other requisite data are available on CRSP and COMPUSTAT. Details of how we arrive at the final sample are presented in Panel A of Table 1.[7] The sample is an unbalanced panel, with the number of observations per firm ranging from one to fifteen.

Table 1 provides descriptive statistics related to our sample. The mean (median) firm-year level of sales in our sample is 980.24 (180.75) million dollars. The mean (median) total assets is 1,434.88 (261.50) million dollars and the mean (median) market capitalization is 3,745.30 (466.77) million dollars. Reported end-of-year inventory across firm years has a mean (median) value of 113.78 (23.55) million dollars and the mean (median) value of inventory as a percentage of sales is 16.25% (12.68%). The mean (median) firm-year write-down amount is 9.66 (0.00) million dollars. The zero median write-down value indicates that less than half the firm-years in our sample experience income-decreasing inventory write-downs. Using only the 517 observations that take positive inventory write-downs in our sample, the mean (median) inventory write-down is 62.96% (14.74%) of the absolute value of reported earnings before

[7] In the next section, we discuss how we collect data on write-downs from the 10-Ks or annual reports

extraordinary items (numbers not reported in Table 1). Thus, inventory write-downs are reasonably large relative to reported earnings and could potentially be used to manage earnings.[8]

4. Measuring Inventory Write-downs

Our sample consists of firm-years with non-zero inventory write-downs as well as firm-years with no write-downs. Within the set of firms with write-down amounts, most are positive (income decreasing), though a smaller set are negative (income increasing). The income-increasing write-down observations result from firms' adjustments to provision levels or sales of fully-written down inventory as discussed next.

Among the firms that record write-downs, there are two general types. First, we have firms that record write-downs through an inventory reserve account in anticipation of future declines, increasing expense by increasing the reserve in the current period ('reserve approach'). Second, we have firms that record 'unexpected' write-downs in the years in which the market value of inventories fall below the cost ('direct write-down approach'). As we discuss below, either approach can result in income-increasing impacts.[9]

Under the reserve approach, firms maintain an inventory reserve account that is increased as a write-down is recorded and is decreased subsequently when inventories for which the reserve was created are sold (or otherwise disposed). The initial increase in the inventory reserve represents the forecast or expected decline in the value of inventories and, like allowances for uncollectible receivables, these are subjective estimates open to manipulation. While the initial increase in the reserve reduces profitability, the subsequent reduction in reserve at the time of the inventory sale or disposal is a transfer from the reserve account to the inventory account. In the

[8] Seventy firm-year observations (about 6.5% of our sample) report income-increasing "negative" write-downs. These are typically reversals of a prior year write-down.
[9] The two approaches are not mutually exclusive: a given firm may switch approaches across years and some firms employ both approaches in the same year.

case of disposal, the transfer does not directly affect profitability. If the inventory is disposed of through sale to a third party, then income is impacted via the difference between the selling price and the cost basis (i.e., carrying value in inventory less the reserved amount). Because the corresponding cost of sale is lower than what it would have been absent a write-down, gross margins improve in the year the reserved inventory is sold (assuming the write-down and sale are in different periods). By increasing the inventory reserve in excess of what is warranted by economic circumstances in the current period, firms can use reserves as a tool to improve profits in future years.[10]

Under the direct write-down approach, firms do not maintain a regular reserve account; rather they record a write-down expense (typically to cost of goods sold) when it is assessed that inventory values have declined below cost (or become obsolete in the limit). This approach would be analogous to the 'direct write-off' or tax approach for uncollectible accounts receivable. In this case the offset is directly to inventory. As such, the same income shifting is possible using this mechanism to the extent that the inventory is subsequently sold with a lower cost basis than would be the case absent the write-down.

We collect write-down information from SEC Filings Library of the LexisNexis database or the Securities and Exchange Commission's web site, www.sec.gov. Write-down data reflecting the reserve approach described above is gathered from "Valuation and Qualifying Accounts" alternatively reported on Schedule II, VII, or VIII, typically at the end of the 10-K. The beginning balance, new charges, inventory write-offs, amounts charged to other accounts, and ending balance in the inventory reserve (contra asset) account is reported in the schedules.

[10] Guidry, Leone, and Rock (1999) also use the inventory reserve account to generate an accrual-specific earnings management measure in their study of bonus-plan induced earnings management by business unit managers. However, their model is substantially different from ours in that they focus on the *level* of the account balance, whereas our approach is similar to McNichols and Wilson (1988) who study earnings management related to the allowance for uncollectible accounts.

We use the *initially reported* new charges as the write-down amount. Schedules are sometimes inconsistent from year to year because of acquisitions, divestitures, and perhaps restatements. Appendix A displays an example of the 'inventory reserve' approach – LSI Logic's 2001 $189M inventory reserve. For the direct write-down approach (taking write-downs directly versus using a reserve account), we search the 10-Ks and annual reports for the phrases "write" or "charge" or "adjust" with any suffix within fifteen words of "inventor"; the latter effectively captures potential variations of the word "inventory." This form of write-down tends to be included in cost of goods sold, or selling, general, and administrative expenses with amounts reported in a footnote. However, in other cases write-downs are reported directly as a line item on the income statement, as an adjustment to net income on the operating section of the statement of cash flows, or in the management discussion and analysis section. Appendix B displays an example of the 'direct write-down' approach – Maxim Integrated Products' $36.5M inventory write-down for the fiscal year ended in June, 2007.

5. Determinants of Inventory Write-downs

To better understand the determinants of inventory write-downs we corresponded with a few semiconductor manufacturers. In general, our interviews suggest that write-down decisions are based on current inventory levels and assessments of market demand for firms' products. Firms record write-downs when there is a buildup of excess inventories and market demand for their products is expected to decline in the following year.

To estimate excess inventory (i.e., the potential inventory write-down), we use a two-stage procedure. For every year t, we first estimate coefficients from rolling pooled, cross-sectional time-series regressions of inventory levels on its determinants using previous ten years of data (t-10 to t-1) for firms in the semiconductor industry. Using the coefficients from the

estimated regression and the actual values of independent variables from year t, we predict the "required" inventory level for year t. The difference between the actual inventory level prior to the write-down and the predicted inventory from above is our estimate of "excess" inventories or, alternatively, the predicted write-down. In the second stage, we model inventory write-downs as a function of predicted write-downs, our measure of economic impairment, and other economic and incentive-related variables (e.g., managerial incentives) shown in prior research to affect asset write-offs, impairments, and restructuring charges.

5.1 Predicting inventory levels and estimating excess inventory

We estimate "required" inventory levels based on the expectations model for inventory proposed by Bernard and Noel (1994, BN henceforth). BN use quarterly data in their study; we use the same variables but estimate the model annually because almost all write-down disclosures are only provided in 10-Ks / annual reports. BN use a simple inventory model where current inventory as a percentage of current sales is determined by the lagged value of the same variable, sales growth, lagged values of sales growth, and changes in inventory levels in the prior period. We assume that reported inventory in years prior to year t reflect the "required" level of inventory for those firm-years. It is possible that managerial discretion over write-off decisions in the estimation period may induce noise in reported inventory levels for some firms. However, noise in individual firms' inventory levels may not have a significant effect on the coefficient estimates when we pool across firms and years. Because inventory reserves and write-downs are typically not delineated by type of inventory (i.e., raw materials, work-in-process, and finished goods), we focus our study on total inventory.

We also supplement the variables in BN with the change in the Producer Price Index (PPI) for semiconductors from the end of the previous fiscal year to the end of the current fiscal

year as an additional variable in the inventory estimation model. The semiconductor industry experienced rapid declines in the producer price index during our sample period. We expect changes in PPI in the current year to be positively related to reported inventory levels for two reasons. First, decreases (increases) in PPI will decrease (increase) the cost of inventory. Second, decreases (increases) in PPI will make it more (less) likely that the replacement cost of inventory will fall below (exceed) the carrying cost, and therefore make it more (less) likely that the firm will write-down inventory. Hence our model for the expected level of inventory is:

$$\frac{I_t}{S_t} = a_0 + b_1 \left[\frac{1}{S_t}\right] + b_2 \frac{I_{t-1}}{S_{t-1}} + b_3 \Delta\left[\frac{I_{t-1}}{S_{t-1}}\right] + b_4 SG_t + b_5 SG_{t-1} + b_6 \Delta PPI_t + e_t \quad (1)$$

where firm subscripts are omitted for brevity, and :

I_t is reported inventory in year t;

S_t is sales revenue for year t;

$\Delta\left[\frac{I_{t-1}}{S_{t-1}}\right] = \left[\frac{I_{t-1}}{S_{t-1}}\right] - \left[\frac{I_{t-2}}{S_{t-2}}\right]$ is the change in scaled inventory from year t-2 to t-1;

$SG_t = \frac{S_t - S_{t-1}}{S_{t-1}}$ is the percentage growth in sales from year t-1 to t;

$SG_{t-1} = \frac{S_{t-1} - S_{t-2}}{S_{t-2}}$ is the percentage growth in sales from year t-2 to t-1;

ΔPPI_t is the percentage change in the semiconductor industry producer price index from year t-1 to t.

Table 2 presents results of the equation (1) regressions. We report the average of the coefficients from the 10-year rolling estimates and report t-statistics based on the distribution of the yearly coefficients (Fama and MacBeth, 1973). The sign of the coefficients are consistent with results reported in Bernard and Noel (1991) and all coefficients are significant at less than the 1% level. Not surprisingly, the prior year's inventory-to-sales ratio is the most significant determinant of current year's inventory-to-sales ratio. Consistent with BN, we also find that current year's inventory-to-sales ratio is negatively related to current year's sales growth,

suggesting that inventory adjustment to sales is not instantaneous. As expected, the change in the PPI for the semi-conductor industry is positively related to inventory levels. The average adjusted R^2 from the regressions is 68.92% indicating that the model reasonably captures variation in inventory levels.

Next, we take the estimated coefficients from equation (1) and predict the expected inventory level for year t. For example, to predict the inventory level $\frac{I_t}{S_t}$ for firm i in 1996 (t=1996), we use data for all available firm-years from 1986 to 1995 and estimate the coefficients in equation (1). We then use the estimated coefficients and predict $E\left[\frac{I_{1996}}{S_{1996}}\right]$ for firm i as follows:

$$E\left[\frac{I_{1996}}{S_{1996}}\right] = \widehat{a_0} + \widehat{b_1}\left[\frac{1}{S_{1996}}\right] + \widehat{b_2}\,\frac{I_{1995}}{S_{1995}} + \widehat{b_3}\Delta\left[\frac{I_{1995}}{S_{1995}}\right] + \widehat{b_4}\,SG_{1996} + \widehat{b_5}\,SG_{1995} + \widehat{b_6}\,\Delta\,PPI_{1996}$$

We use the predicted value of inventory to sales $E\left[\frac{I_t}{S_t}\right]$ described above and compute excess inventory as $\frac{I_t}{S_t}$ (-)$E\left[\frac{I_t}{S_t}\right]$ where I_t is the reported inventory for year t plus the inventory write-down for year t (i.e., I_t is the pre-write-down inventory). If the inventory expectation model provides reasonable estimates of "required" inventory and firms' write-down decisions are related to holding excess inventory, then the empirically estimated excess inventory, or predicted write-down (*PREDWD* = $\frac{I_t}{S_t}$ (-)$E\left[\frac{I_t}{S_t}\right]$), will be positively related to the 'actual' write-down amount.

5.2. Other factors related to inventory write-downs

FHV study more general asset write-offs and consider impairments and incentives / manipulation as factors resulting in write-offs. We intend our *PREDWD* proxy to better capture

impairment causes of inventory write-downs as it is motivated and developed for the specific purpose of modeling excess inventory (as opposed to a disparate set of assets across many industries, as in FHV). In addition to including the predicted write-down from our two-step model to proxy for impairment-related (or non-discretionary) inventory write-downs, we include most variables that FHV consider in their study of discretionary asset write-offs. FHV identify industry and firm-specific variables to explain cross-sectional variation in write-downs. Because our sample consists of only one industry, we cannot use inter-industry variation to explain write-downs.

5.2.1 Other economic factors

Stock prices are generally seen as leading indicators of firm performance. Firms with poor stock price performance in the current year are more likely to experience diminished sales and margins in the future. Such firms are more likely to have impaired assets including overvalued inventory and therefore are more likely to write-down inventory in the current year. Accordingly, we expect size-adjusted returns for the fiscal year (*FYRET*) to be negatively related to the amount of the write-down.[11]

A related measure of potentially overvalued assets relative to market value is the firm's book-to-market ratio. Firms with high book-to-market ratios are more likely to have inventory with market prices below cost. We therefore expect a firm's book-to-market ratio (*BTM*) to be positively related to inventory write-downs. We add back the tax-adjusted write-down amount to reported stockholders' equity to measure *BTM* prior to the write-down decision. To capture the effect of relative declines in market value, we also include the change in *BTM* (*ΔBTM*) from the

[11] Including a similar variable for the prior five years (like FHV) would result in a substantially reduced sample size.

prior year to the current year as an additional explanatory variable and expect *ΔBTM* to be positively related to inventory write-downs.[12]

Declining profitability is also an indicator of falling asset values. We expect firms with declining profitability to be more likely to write-down inventory. We use a firm's change in return on assets (*ΔROA*) from the prior year to the current year as our measure of change in profitability and expect *ΔROA* to be negatively related to inventory write-downs.

Finally, we also include the natural log of firm's sales (*LNSALES*) as an additional factor that is potentially related to firms' write-down decisions. Larger firms are more likely to possess products that are less prone to obsolescence and may also be able to withstand temporary downturns in demand. We expect *LNSALES* to be negatively related to inventory write-downs.

5.2.2 Managerial Incentives

FHV consider different incentives that motivate managers to take discretionary write-downs (see also Strong and Meyer, 1987). Consistent with FHV, we include a variable that reflects whether there was a change in any of the top three executive positions (chairman of the board, chief executive officer, or president) in the year of, or the year prior to, the write-down (*ΔMGMT*). In our setting, it seems reasonable that new management would benefit by writing down inventory and attributing the charge to prior management. If the cost of the inventory sold during the new management regime were artificially reduced based on a generous write-down, higher profits will be reported when the chips are sold under current management, ceteris paribus. We expect *ΔMGMT* to be positively related to inventory write-downs.

[12] Since we confine our study to the semiconductor industry, unlike FHV, we do not industry-adjust our book-to-market measures. Also, FHV use the mean change in *BTM* over the past five years, but due to the rapid change in our industry (e.g., incidence of arriving and departing firms), we use only the contemporaneous change in *BTM* to avoid decrease in sample size.

Firms that are considering public issues of debt or equity may have an incentive to withhold bad news to obtain favorable prices on stock issuances or favorable credit terms on debt. We obtain new issue data from the SDC database and include the variable*FNNCNG*, equal to the sum of the proceeds of debt and equity issuances during the year divided by total assets. We expect *FNNCNG* to be negatively related to inventory write-downs. We also test whether firms appear to time inventory write-downs across years so as to avoid violating debt covenants. We proxy for proximity to debt covenant violation using long-term debt divided by total assets (*LTDDTA*).[13]

FHV also argue that operating performance in the write-down year can be related to the propensity to take write-downs. Specifically, if income is already low and managers are implicitly or explicitly rewarded based on the level of earnings, managers have incentive to "take a bath" (accelerate write-down recognition) to increase the probability of enjoying rewards in the future.[14] Alternatively, if semiconductor firms are more concerned about reporting a smooth earnings stream (a difficult task in a cyclical industry), we expect a positive relation between pre-write-down earnings and write-downs. Like FHV, we attempt to distinguish between bath taking and smoothing explanations by including two variables, *POOR* and *GOOD,* in the model.[15] We use a random walk expectation to model earnings and define *UE* as the pre-write-down operating income after depreciation in year t, less the reported operating income after depreciation in year t-1, divided by total assets at the end of year t-1.[16] *POOR* is set equal to *UE* if $UE < 0$, and 0

[13] We considered using the debt-to-equity ratio, but a non-trivial number of our firm-year observations have negative stockholders' equity.
[14] The vast majority of our inventory charges are included in cost of goods sold, so concerns about whether managers are compensated based on income before or after charges classified as non-recurring are less relevant.
[15] In their two-period model Kirschenheiter and Melumad (2002) show that managers tend to under-report to the maximum possible extent when earnings news is sufficiently bad and smooth earnings when earnings news is good.
[16] We use pre-write-down earnings in the current year because the write-down decision is made prior to the write-down itself. We do not adjust the prior year earnings for any write-downs because managers are more likely to view

otherwise. Similarly, *GOOD* is set equal to *UE* in year t if greater than zero, and 0 otherwise. If firms take earnings baths via inventory write-downs, then *POOR* will be negatively-related to *WD*. If smoothing is a more dominant motivating factor, then the signs of the coefficients on both *POOR* and *GOOD* should be positive.

Finally, following FHV we also include an indicator variable, *NEGSPEC* set equal to one if the company has other income-decreasing special items (charges) in year t. We expect *NEGSPEC* to be positively related to inventory write-downs consistent with write-downs motivated as part of a broader "big bath" decision.[17]

6. Determinants of Inventory Write-downs – Results

6.1 Univariate Analysis

Our sample consists of 519 firm-year observations with positive inventory charges against income (positive inventory charge subsample), 70 firm-year observations with negative inventory charges (negative inventory charge subsample), and 481 firm-year observations with zero write-downs (non-write down subsample). We present comparisons of the differences in values of factors affecting inventory write-downs across the two inventory charge subsamples relative to the non-write-down subsample in Panel A of Table 3. Both actual (*ACTWD*) and predicted write-downs (*PREDWD*) as a percentage of sales are different in the expected directions from non-write down observations for the two inventory charge subsamples. Having non-zero *ACTWD* is the basis of separating the sample and the corresponding levels of *PREDWD*

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reported earnings in the previous year as the benchmark for the current year, rather than earnings adjusted for operating items such as write-downs.

[17] We also note support for this argument in the popular press. Pender (2001) suggests that "[i]f a company announces a big inventory write-off along with restructuring charges, it can probably persuade analysts to disregard the inventory write-off, too."

reflect the predictive ability of the model (i.e., predicted positive inventory charges are positive and predicted negative inventory charges are negative).

The other economic predictors of write-downs differ in the expected manner between the positive inventory charge subsample and the non-write-down subsample. For example, we expect *FYRET* (size-adjusted fiscal year returns) to be negatively correlated with the direction of inventory charges and both *BTM* (lagged book-to-market), and the change therein, to be positively correlated with the direction of inventory charges. We find corresponding support for positive inventory charge firm-year observations relative to the non-write-down firm-year observations, but not for negative inventory charge observations.

In terms of incentive-related factors, the differences in *POOR* across subsamples provide preliminary evidence that semiconductor firms take write-downs when performance is already bad. The differences in *NEGSPEC* (an indicator variable signifying that a negative special item was recognized during the year) suggest that firms that take charges in either direction are more apt to have a concurrent negative special item charge. In contrast to our expectation, both the magnitude of equity and debt issuance (*FNNCNG*) and *LTDDTA* are higher for firms taking income-decreasing inventory write-. These univariate results are suggestive at best and our multivariate analyses reported below are intended to control for non-strategic (i.e., economic) causes of write-downs when considering more carefully strategic motivations.

6.2 Multivariate Analyses

We report results from four models intended to capture the determinants of inventory write-downs in Panel B of Table 3. In all cases the dependent variable is the actual inventory write-down scaled by sales revenues (*ACTWD*). In the first three models, we exclude the predicted write-down (*PREDWD*) and examine the effect of other economic factors, effect of

managerial incentives, and their combined effect, respectively. In Model 4, we include *PREDWD* and report results of the full model.

Results in Model 1 are generally consistent with prior research on the effect of economic factors on write-offs. Firms with high book-to-market ratios are more likely to take larger write-downs consistent with these firms having more overvalued assets. Size, as measured by log of sales revenues, is negatively related to actual write-downs, suggesting that larger firms are less likely to have impaired inventory. Though the coefficient on size-adjusted returns for the fiscal year is negative, it is not significantly different from zero. Similarly, neither the change in *BTM*, nor the change in *ROA* appears to have a discernable impact on actual inventory write-down amounts. The explanatory power of the model is modest with an adjusted R^2 of 6.84%, consistent with the omission of other explanatory variables.

Model 2 reports results from separately examining the effect of managerial incentives on the inventory write-down decision, absent economic factors. Consistent with the intuition in FHV, we find that poorer firm performance is related to larger inventory write-downs, suggesting a "big bath" approach to timing inventory write-downs. Better firm performance *(GOOD)* is also related to larger write-downs consistent with a smoothing explanation, however because the coefficient on *POOR* manifests a negative sign, on balance the results are consistent with "big bath" incentives driving behavior. In line with our expectations, firms with negative special items are more likely to also write-down inventory which again is consistent with "big bath" incentives. Controlling for other factors, we do not find support for management changes, stock/debt issuance, or debt covenant violation avoidance driving inventory write-down decisions of firms. The adjusted R^2 is lower than Model 1 at 4.40%, suggesting a potentially

weaker role for managerial incentives, as considered here, in explaining firms' inventory write-down decisions relative to economic explanations.

In Model 3, we examine the combined effect of the above two specifications. Variables that are statistically significant in the separate specifications in Models 1 and 2 continue to be significant in the combined specification. Not surprisingly, the adjusted R^2 of 10.26% is much higher than either of the previous two models.

Finally, in Model 4 we introduce the predicted write-down (*PREDWD*) as an additional explanatory variable. If our empirical estimate of the write-down amount captures the potential overvaluation in pre-write-down inventory, *PREDWD* should be positively related to the actual write-down amount. We find that *PREDWD* is positively related to *ACTWD* and is highly significant. In fact, the explanatory power of Model 4 jumps to 42.05%, a substantial improvement from the 10.26% reported for Model 3. Firms' inventory write-off decisions seem best predicted by empirical estimates of "excess" inventory levels, at least in the semiconductor industry. In terms of other economic factors, fiscal year size-adjusted returns are negatively related to inventory write-downs as expected and larger firms are less likely to experience income-decreasing inventory charges. We continue to find support for 'big bath' incentives playing a role in write-down decisions as the coefficient on *POOR* is negative and significant and the coefficient on *NEGSPEC* is positive and significant.

7. Consequences of inventory write-downs for subsequent performance

The evidence in Table 3 suggests that while inventory write-downs are associated with economic factors, they are also partially discretionary. In this section, we examine two issues associated with inventory write-downs. First, we consider the relation between current year write-downs and subsequent operating performance. The results in Table 3 suggest that

managers intentionally over-reserve for inventory when performance is poor. As such, we expect a measure of the extent to which managers over-reserve in one year to be predictably and positively associated with subsequent operating performance as inventory with reduced basis is sold at prices not fully reflective of the prior write-down amounts. The effect is exaggerated because the excess write-downs are indicative of larger 'bath-taking' events which are also likely to reverse. The second issue we consider is whether market participants appear able to untangle over- and under-reserving in the current period. We use analyst forecasts and market returns to discern the market's appreciation of the impact of current period excessive or deficient write-downs on subsequent performance.

To conduct this analysis, we require a proxy for 'abnormal' inventory write-downs. We measure an 'abnormal' write-down (*ABWD*) in any year as the difference between the actual write-down in the year (*ACTWD*) and the predicted write-down (*PREDWD*). The predicted write-down is our estimate of excess inventory computed as the difference between the reported inventory-to-sales ratio and the predicted inventory-to-sales ratio (see section 4). We hypothesize that inventory write-downs in the current year in excess of (*HIGHWD*, $ABWD > 0$) or below (*LOWWD*, $ABWD < 0$) "required" amounts have predictable performance consequences in the subsequent year.[18]

With regard to subsequent period operating impacts, we first expect current year's *ABWD* to be negatively related to the actual inventory write-down for the next year. Firms that take larger (smaller) write-downs in the current year will compensate by writing down less (more) in the next year. Second, we expect current year's *ABWD* to be positively related to future profitability. Larger than required write-downs of inventory (*HIGHWD*) as part of a "big bath"

[18] We do not use the data from Table 3 to more finely separate a measure of 'abnormal' write-down into economic and opportunistic elements because to do so involves using in-sample estimation (i.e., we do not have a long time series of those determinants available for out of sample estimation).

will reduce the carrying cost of unsold inventory, which will increase (reported) margins and profits if the inventory is subsequently sold. On the other hand, if firms postpone inventory write-downs (*LOWWD*) to report higher profits in the current year, subsequent (reported) profits will be lower when the "overpriced" inventory is sold.

Our results associated with the operating performance analysis are captured on Table 5. We examine the effect of *ABWD* on the subsequent year's: actual inventory write-down ($ACTWD_{t+1}$), change in gross margin (ΔGM_{t+1}), and change in return on assets (ΔROA_{t+1}). We expect *ABWD* to be negatively related to $ACTWD_{t+1}$ and positively related to changes in gross margin and return on assets.

7.1 Univariate Results

We report univariate comparisons of the dependent and control variables between firms that have positive (*HIGHWD*) and negative (*LOWWD*) values of *ABWD* in Panel A of Table 4. The total sample size of 920 firm years is smaller than in previous tables because we lose firm-years from the final year in our sample – we require write-down information for two consecutive years for this analysis. Of the 920 firm-year observations, a majority of the firm year observations (526) have larger write-downs than predicted (*HIGHWD*) in year t, whereas 394 firm-year observations reflect smaller than expected write-downs (*LOWWD*). As expected, both the mean and median actual write-down in the subsequent year ($ACTWD_{t+1}$) are significantly higher for *LOWWD*, consistent with a "catch-up" effect in the subsequent year. Both mean and median reported change in profitability, measured as ΔGM_{t+1} or ΔROA_{t+1}, is higher for the *HIGHWD* group, consistent with the argument that firms over (under) reserve for inventory charges resulting in predictable increases (decreases) in operating performance.

The *HIGHWD* and *LOWWD* groups also differ significantly on other dimensions in the current year (t). Specifically, changes in *ROA* (ΔROA_t) are higher, and book-to-market ratios (BTM_t) are lower for the *HIGHWD* group compared to those for the *LOWWD* group. Panel A results compare distributions of performance measures based on the sign of *ABWD*, but ignore the magnitude of the abnormal write-down amount. To provide a more powerful test of the relation between abnormal write-downs and subsequent operating and market performance and to ensure that the effect of *ABWD* is incremental the impact of these other dimensions, we include $FYRET_t$, ΔROA_t and BTM_t as control variables in the multivariate analyses, which we discuss next.

7.2 Multivariate Analyses

In Panel B of Table 4 we present results from multivariate regression of *ABWD* and control variables on the subsequent year's measures of operating and market performance. As expected, we find that *ABWD* is significantly negatively related to the next year's inventory write-down amount. Firms that take higher (lower) write-downs than expected in the previous year have lower (higher) write-downs in the next year, consistent with a "catch-up" effect for discretionary write-downs. We find no significant relation between firms' past performance (as measured by the three control variables) and future write-downs.

As discussed above, if firms with lower (higher) than expected inventory write-downs in year t compensate with higher (lower) write-downs in year t+1, then subsequent reported profits will be lower (higher). Consistent with this argument, we find that *ABWD* is significantly positively related to next year's changes in gross margin (column 2) and return on assets (column 3). Consistent with prior research (Fairfield and Yohn (2001)), we also find that profitability changes in t are negatively related to profitability changes in t+1. Overall, we find that our

predictions of excess inventory are related to contemporaneous inventory write-downs, and our estimates of abnormal write-downs have predictive power for future write-downs, and firm profitability. Based on these results we next consider whether market participants seem to be able to unravel the predictable relation between current excess (or deficient) write-downs and subsequent accounting performance.

7.3 Abnormal write-downs and subsequent returns and forecast errors

In an efficient market, the unexpected inventory write-down (*ABWD*) will be priced immediately and subsequent stock prices will be unaffected by the predictable accounting effects of these write-downs. However, if the market fails to correctly process the implications of these unexpected write-downs, future returns will be systematically related to them. Specifically, firms that write down inventory more than required (*HIGHWD*) in the current year will have higher returns in the future when they report higher profits. Similarly, firms with smaller inventory write-downs than required (*LOWWD*) in the current year will have lower returns in the future when they report lower profits.

Prior research provides evidence that analysts ignore publicly-available information in forming earnings forecasts (e.g., Bradshaw et al. (2001) and Ikenberry and Ramnath (2002)). If analysts process accounting information efficiently, there should be no discernable relation between 'abnormal' inventory write downs and subsequent forecast errors. On the other hand, if analysts fail to appreciate the future earnings implications of current period write downs, then we will observe be a positive relation between the abnormal portion of current period write downs and subsequent forecast errors. In the previous section we found that excess write downs lead to predictably higher performance. If analysts do not incorporate this pattern into their forecasts of

future earnings, then the subsequent forecast error will be positively related to the current period abnormal write-down.

We provide univariate and multivariate tests of market and analyst efficiency with respect to information in inventory write downs. These tests require proxies for both subsequent returns and forecast errors. We use size-adjusted returns from month +4 to +15 relative to year end t ($SZARET_{t+1}$). The cumulation period starts at the beginning of the fourth month after the end of fiscal year t to ensure that investors are aware of, and have already reacted to, the write-down decisions of firms for year t. If the market is unable to anticipate the pricing implications of over- or under-reserving for future inventory charges, then *ABWD* will be positively correlated with subsequent returns.

In a similar fashion, we construct consensus forecasts of earnings per share (EPS) for year t+1 from forecasts made within 60 days of the beginning of month +4 relative to year end t. Our intent is to allow analysts to have information about year t inventory write downs. We use forecasts and actual EPS measures from IBES and scale the actual less mean forecast by price per share, also from IBES, to obtain our forecast error measure (AFE_{t+1}). Because prior research indicates that forecast errors are serially correlated (Abarbanell and Bernard, 1992), we control for forecast errors of a comparable horizon for year t (AFE_t). We also control for the forecast horizon ($FLAG_{t+1}$) – the number of days between the mean of the forecast dates comprising the consensus and the earnings announcement date per IBES – based on prior research indicating that analysts are more optimistic from a temporal distance (e.g., Richardson et al (2004) and Lim (2001)). We additionally control for the number of forecasts comprising the consensus ($NFCST_{t+1}$) and firm size ($LNSALES_t$, as above).

7.4 Univariate Results

We group the samples into HIGHWD and LOWWD based on whether the write-down amount exceeds or is less than the expected write down for year t. Table 5, Panel A indicates that mean size-adjusted returns do not appear to differ significantly across the excess write-down groups. Because we require analyst forecasts from IBES within a sixty day interval, as well as actual EPS, price data, and prior scaled analyst forecast errors, by necessity we have fewer observations on Table 5 than on Table 4 (615 versus 920). Table 5, Panel A indicates that forecast errors are lower for LOWWD observations than for HIGHWD observations, consistent with our conjecture. This is the case using parametric and non-parametric tests. In terms of prior forecast errors, the mean forecast error for HIGHWD is somewhat surprisingly higher than for the LOWWD group. This may be due to the exclusion of inventory write-downs from the IBES actuals depending upon how the write-downs are reported.

7.5 Multivariate Results

In the last column of Table 4 Panel B, we report results related to future returns. We find that *ABWD* is significantly positively related to returns in the subsequent year, consistent with the market failing to see through abnormal inventory write-downs in the previous year. Consistent with performance of 'value' stocks (e.g., Lakonishok, Shleifer, and Vishny (1994)), *BTM* is positively related to returns (or consistent with *BTM* as an additional risk factor in the three-factor model). Our results are consistent with Thomas and Zhang (2002) who examine the consequences of inventory changes and conclude that those changes are the primary cause of the negative relation between accruals and future abnormal returns.

In Table 5, Panel B, we regress year t+1 forecast errors (AFE_{t+1}) on our abnormal write-down proxy, $ABWD_t$, AFE_t, $FLAG_{t+1}$, $NFCST_{t+1}$, and $LNSALES_t$. We find that $ABWD_t$ is

positively and significantly related to subsequent forecast errors (t = 3.94), controlling for these other factors.[19] The implication is that analysts ignore information available in abnormal inventory write downs which would improve their forecasts.

8. Conclusions

We investigate the causes and consequences of inventory write-downs in the semiconductor industry. The semiconductor industry is particularly interesting for study because of the substantial fixed investment necessary to compete and corresponding tendency to produce at capacity, its cyclical nature, and because unit values of inventory generally decrease over time, making inventory write-downs more prevalent relative to most other industries. In contrast to FHV, we find that inventory write-downs are related to both impairments (as proxied by our unexpected inventory measure) and incentives to increase reported income in the future. Our proxy for abnormal inventory write-downs is related to increases in future operating performance and future market performance. Overall, the results are consistent with managers over-accruing inventory charges, resulting in increased profits in the future (resulting from under-valued inventory charged to cost of goods sold). We provide evidence that neither analysts, nor the market are able to see through this behavior.

[19] We conduct rank regressions and find very similar results.

References

Abarbanell, J. and V. Bernard. (1992). Tests of analysts' overreaction/underreaction to earnings information as an explanation for anomalous stock price behavior. *Journal of Finance*, 47: 1181-1207.

Accounting Research Bulletin 43. Restatement and Revision of Accounting Research Bulletins. 1953. Committee on Accounting Procedure.

Aizcorbe, A. 2002. Why are semiconductor prices falling so fast? Industry estimates and implications for productivity measurement. FEDS Discussion Paper No. 2002-20.

Ayers, B. 1998. Deferred tax accounting under SFAS No. 109: An empirical investigation of its incremental value-relevance relative to APC No. 11. *The Accounting Review* 73 (2): 195-212.

Beaver, W. 1996. Directions in accounting research: NEAR and FAR. *Accounting Horizons* 10: 113-124.

Beaver, W. and E. Engel. 1996. Discretionary behavior with respect to allowances for loan losses and the behavior of security prices. *Journal of Accounting and Economics* 22: 177-206.

Beatty, A., S. Chamberlain, and J. Magliolo. 1995. Managing financial reports of commercial banks: The influence of taxes, regulatory capital and earnings. *Journal of Accounting Research* 33 (2) 231-261.

Beatty, A., and J. Weber. 2006. Accounting discretion in fair value estimates: An examination of SFAS 142 goodwill impairments. *Journal of Accounting Research* 44(2): 257-288.

Bernard, V. 1995. The Feltham-Ohlson Framework: Implications for Empiricists. *Contemporary Accounting Research* 11: 733-747.

Bernard, V. and J. Noel. 1991. Do inventory disclosures predict sales and earnings? *Journal of Accounting Auditing and Finance* 6: 145-181.

Bradshaw, M.T., S.A. Richardson & R.G. Sloan. (2001). Do analysts and auditors use information in accruals? *Journal of Accounting Research,* 39: 45-74.

Chan, K., L. Chan, N. Jegadeesh, and J. Lakonishok. 2006. Earnings quality and stock returns. Journal of Business 79: 1041-1082.

Collins, J., D. Shackelford, and J. Wahlen. 1995. Bank differences in the coordination of regulatory capital, earnings and taxes. *Journal of Accounting Research* 33 (2): 263-291.

Elliot, J., and W. Shaw. 1988. Write-offs as accounting procedures to manage perceptions. *Journal of Accounting Research* 26 Supplement: 91-119.

Fairfield, P. and T. Yohn. 2001. Using asset turnover and profit margin to forecast changes in profitability. *Review of Accounting Studies* 6: 371-385.

Fama, E. and J. MacBeth. 1973. Risk, return, and equilibrium: Empirical tests. *Journal of Political Economy* 81: 607-636.

Francis, J., J. Hanna, and L. Vincent. 1996. Causes and effects of discretionary asset write-offs. *Journal of Accounting Research* 34: 117-169.

Guidry, F., A. Leone, and S. Rock. 1999. Earnings-based bonus plans and earnings management by business-unit managers. *Journal of Accounting and Economics* 26: 113-142.

Healy, P. and J. Wahlen. 1999. Commentary: A review of the earnings management literature and its implication for standard setting. *Accounting Horizons* (13-4):365-383

Ikenberry, D.L and S. Ramnath (2002). Underreaction to self-selected news events: The case of stock splits. *The Review of Financial Studies*, 15: 489-526.

Key, K. 1997. Political cost incentives for earnings management in the cable television industry. *Journal of Accounting and Economics* (23-3): 309-337.

Kirschenehiter, M., and N. Melumad. 2002. Can "big bath" and earnings smoothing co-exist as equilibrium financial reporting strategies? *Journal of Accounting Research* 40(3): 761-796.

Lakonishok, J., A. Shleifer, and R. Vishny. 1994. Contrarian investment, extrapolation, and risk. *The Journal of Finance* (49): 1541-1578.

Lim, T. (2001). Rationality and analysts' forecast bias. *Journal of Finance* 56(1): 369-385.

McNichols, M. and G. Wilson. 1988. Evidence of earnings management from the provision for bad debts. *Journal of Accounting Research* 26: 1-31.

Miller, G. and D. Skinner. 1998. Determinants of the valuation allowances for deferred tax assets under SFAS No. 109. *The Accounting Review* 73 (2): 213-233.

Moyer, S. 1990. Capital adequacy ratio regulations and accounting choices in commercial banks. *Journal of Accounting and Economics* 12: 123-154.

Pender, K. 2001. "Write-offs remove excess inventory from books -- not shelves / Accounting move can often distort firms' financial data." *The San Francisco Chronicle* (May 8).

Petroni, K. 1992. Optimistic reporting in the property casualty insurance industry. *Journal of Accounting and Economics* 15: 485-508.

Rees, L., S. Gill, and R. Gore. 1996. An investigation of asset write-downs and concurrent abnormal accruals. *Journal of Accounting Research* 34: 157-170.

Riedl, Edward J. 2004. An examination of long-lived asset impairments. *The Accounting Review* (79- 3): 823-852.

Ramanna, K., and R. Watts. 2009. Evidence on the effects of unverifiable fair-value accounting, *Working paper, Massachusetts Institute of Technology*.

Richardson, S., S. Teoh and P. Wysocki. (2004). The walk-down to beatable analyst forecasts: The role of equity issuance and insider trading incentives. *Contemporary Accounting Research* 21(4): 885-924.

Scalise, G. 2004. Statement before the Committee on Financial Services, Subcommittee on Capital Markets, Insurance and Government Sponsored Enterprises, U.S. Congress. Washington D.C. April 21 2004.

Schrand, C., and F. Wong. 2003. Earnings management using the valuation allowance for deferred tax assets under SFAS No. 109. *Contemporary Accounting Research* (20-3):579-611

Schipper, K. 1989. Commentary: Earnings management. *Accounting Horizons* (December): 91-102.

Semiconductor Industry Association (SIA). 2004. Annual Report. www.sia-online.org. San Jose, CA.

Strong, J. and J. Meyer. 1987. Asset writedowns: Managerial incentives and security returns. *Journal of Finance* 42:643-61.

Thomas, J., and H. Zhang. 2002. Inventory changes and future returns. *Review of Accounting Studies* 7 (2-3): 163-187.

Wahlen, J. 1994. The nature of information in commercial bank loan loss disclosures. *The Accounting Review* (July): 455-478.

Zucca, L., and D. Campbell. 1992. A closer look at discretionary writedowns of impaired assets. *Accounting Horizons* 6: 30-41.

Appendix A

Example of 'Reserve Approach' for Inventory Write-downs (from LSI Logic's 10-K, 12/31/2001):

SCHEDULE II VALUATION AND QUALIFYING ACCOUNTS(IN MILLIONS)

COLUMN A DESCRIPTION	COLUMN B BALANCE AT BEGINNING OF PERIOD	COLUMN C ADDITIONS CHARGED TO COSTS, EXPENSES OR OTHER ACCOUNTS	COLUMN D DEDUCTIONS	COLUMN E BALANCE AT END OF PERIOD
2001				
Allowance for doubtful accounts.....	$ 8	$ 15	$ (3)	$ 20
Inventory reserves.....	87	189	(117)	159
Valuation allowance for deferred tax assets.....	20	130	--	150
2000				
Allowance for doubtful accounts.....	$11	$ 4	$ (7)	$ 8
Inventory reserves.....	61	53	(27)	87
Valuation allowance for deferred tax assets.....	23	--	(3)	20
1999				
Allowance for doubtful accounts.....	$ 4	$ 9	$ (2)	$ 11
Inventory reserves.....	83	22	(44)	61
Valuation allowance for deferred tax assets.....	58	--	(35)	23

Appendix B

Example of 'Direct Write-Down' Approach for Inventory Write-downs (Maxim Integrated Products' 10K, 6/30/2007, from Management Discussion and Analysis):

During fiscal years 2007, 2006 and 2005, we had inventory write downs of $35.6 million, $9.0 million and $19.9 million, respectively, due primarily to inventory in excess of forecasted demand.

Figure 1

US Monthly Semiconductor Producer Price Index (PPI) for the years 1990-2008

Monthly Producer Price Index (PPI) data for the semiconductor industry are from the website of the Bureau of Labor Statistics, www.bls.gov. Base is December 1998.

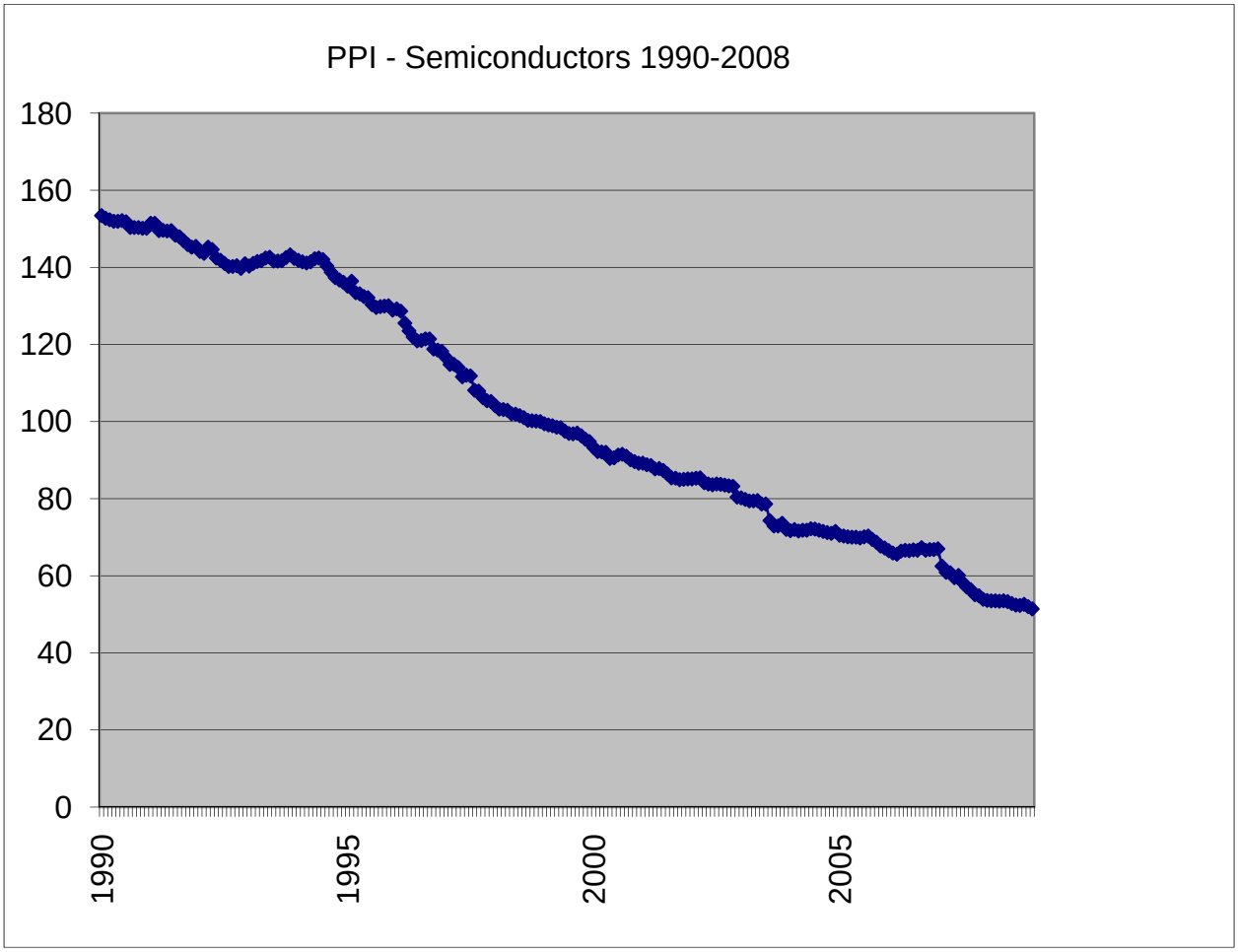

Table 1
Sample Selection and Descriptive Statistics

Panel A: Sample Selection

Firm-years for which form 10-K available on EDGAR from 1993-2007	1,702
Less: Firm-years with no clear write-down information or amount	(322)
Less: Firm-years with insufficient data on CRSP and COMPUSTAT	(310)
Final Sample (firm-year observations)	1,070
Number of unique firms in sample	127

Panel B: Sample Descriptive Statistics

Variable	Mean	Std. Deviation	25th percentile	Median	75th percentile
Inventory ($ millions)	113.78	442.92	8.23	23.55	68.38
Sales Revenues ($ millions)	980.24	3,514	61.68	180.75	537.21
Total Assets ($ millions)	1,434.88	4,625	77.62	261.50	932.83
Market Value ($ millions)	3,745.30	164.93	117.20	466.77	1,793.54
Inventory Write-down ($ millions)	9.66	84.84	0.00	0.00	2.60
Inventory as a % of Sales Revenues	16.25%	15.07%	8.58%	12.68%	18.81%

Table 2
Estimation of Ending Inventory Levels

$$\frac{I_t}{S_t} = b_0 + b_1 \left[\frac{1}{S_t}\right] + b_2 \frac{I_{t-1}}{S_{t-1}} + b_3 \Delta\left[\frac{I_{t-1}}{S_{t-1}}\right] + b_4 SG_t + b_5 SG_{t-1} + b_6 \Delta PPI_t + e_t \quad (1)$$

	Expected Sign	Coefficient	t-statistic
b_0	?	0.0281***	7.40
b_1	?	0.1079***	6.61
b_2	+	0.8347***	204.30
b_3	?	-0.1125***	-4.34
b_4	-	-0.0353***	-5.58
b_5	+	0.0135***	4.65
b_6	+	0.0674	0.86
Adjusted R^2		68.92%	

For every year from 1993 to 2007, regression (1) is estimated using firm-year observations from the previous ten years. Reported coefficients are the mean of the 15 yearly estimates. T-statistics are computed based on the distribution of the 15 yearly coefficients (Fama-MacBeth (1973)). The adjusted R^2 is the mean of the 15 yearly adjusted R^2s. The minimum (maximum) number of observations used in the estimation is 398 (931) firm-years and the mean (median) is 718 (755).

$I_{i,t}$ is reported inventory for firm *i* in year *t*; $S_{i,t}$ is sales revenue for firm *i* in year *t*;
$\Delta\left[\frac{I_{t-1}}{S_{t-1}}\right] = \left[\frac{I_{t-1}}{S_{t-1}}\right] - \left[\frac{I_{t-2}}{S_{t-2}}\right]$ is the change in scaled inventory from t-2 to t-1;
$SG_t = \frac{S_t - S_{t-1}}{S_{t-1}}$ is the percentage growth in sales from t-1 to t;
$SG_{t-1} = \frac{S_{t-1} - S_{t-2}}{S_{t-2}}$ is the percentage growth in sales from t-2 to t-1;
ΔPPI_t is the percentage change in the semiconductor industry producer price index over the 12-month period from the end of fiscal year t-1 to end of fiscal year t.

Table 3

Determinants of Inventory Write-downs

Panel A: Univariate Comparisons

	Positive inventory charge firm-years (N=519)		Negative inventory charge firm-years (N=70)		Non-write-down firm-years (N=481)	
	Mean	Median	Mean	Median	Mean	Median
ACTWD (% of Revenues)	4.241***	1.840***	-2.067$^{###}$	-0.970$^{###}$	0.000	0.000
PREDWD (% of Revenues)	4.860***	2.096***	-3.190$^{###}$	-2.190$^{###}$	-0.332	-0.724
FYRET (%)	12.170***	-14.464***	1.255$^{#}$	-1.053	34.169	-0.718
BTM	0.536***	0.448***	0.490	0.410	0.445	0.355
Δ BTM	0.062***	0.046***	-0.073	-0.008	-0.006	-0.010
Δ ROA	0.000	0.009	0.022	0.013	0.003	0.007
Δ MGMT	0.333	0.000	0.037	0.000	0.318	0.000
LNSALES	5.138***	5.149*	4.965$^{##}$	4.846$^{##}$	5.369	5.299
FNNCNG (% of Assets)	3.700***	0.000***	0.732	0.000$^{#}$	1.845	0.000
LTDDTA	0.109***	0.034***	0.092	0.000$^{##}$	0.081	0.009
POOR	-0.039***	0.000**	-0.015$^{##}$	0.000$^{##}$	-0.026	0.000
GOOD	0.070	0.028	0.067	0.032	0.065	0.030
NEGSPEC	0.576***	1.000***	0.557$^{##}$	1.000$^{##}$	0.412	0.000

***, **, * indicates that the value for positive inventory charge observations is significantly different from the value for the non-write-down firm-year observations at the 0.01, 0.05, or 0.10 level, respectively

$^{###, ##, #}$ indicates that the value for negative inventory charge observations is significantly different from the value for the non-write-down firm-year observations at the 0.01, 0.05, or 0.10 level, respectively

Table 3, continued

Panel B: Multivariate Analysis of Factors Associated with Inventory Write-downs

Variable	Predicted Sign	Model 1	Model 2	Model 3	Model 4
Intercept	?	0.0390***	0.0082***	0.0227***	0.0136**
		(6.59)	(2.75)	(3.40)	(2.54)
PREDWD	+				0.3736***
					(24.12)
Other Economic Factors					
FYRET	-	-0.0020		-0.0020	-0.0030**
		(-1.26)		(-1.22)	(-2.35)
BTM	+	0.0159***		0.0177***	0.0059
		(3.32)		(3.63)	(1.49)
Δ BTM	+	0.0075		0.0053	-0.0021
		(1.45)		(1.01)	(-0.48)
Δ ROA	-	-0.0068		0.0420	0.0208
		(-0.66)		(1.63)	(1.01)
LNSALES	?	-0.0052***		-0.0047***	-0.0026***
		(-5.78)		(-4.99)	(-3.46)
Incentive Related Factors					
Δ MGMT	+		-0.0003	-0.0000	0.0018
			(-0.11)	(-0.01)	(0.71)
FNNCNG	-		-0.0190	-0.0094	-0.0063
			(-1.27)	(-0.62)	(-0.52)
LTDDTA	-		-0.0101	0.0054	0.0008
			(-0.94)	(0.50)	(0.09)
POOR	-		-0.1579***	-0.1661***	-0.0646**
			(-6.47)	(-4.85)	(-2.32)
GOOD	+		0.0481***	0.0343	0.0338*
			(2.92)	(1.44)	(1.77)
NEGSPEC	+		0.0088***	0.0095***	0.0096***
			(2.86)	(3.11)	(3.92)
Adjusted R^2		6.84%	4.40%	10.26%	42.05%

The sample includes 1,070 firm-year observations of which positive inventory write-downs occur in 519 firm-years, negative inventory write-downs occur in 70 firm-years, and 481 firm-years have zero inventory write-downs. T-statistics are reported below parameter estimates.

ACTWD is the actual inventory write-down for the year scaled by revenues for the year; PREDWD is the predicted write-down scaled by sales obtained using the coefficient estimates from Table 2; FYRET is the size-adjusted return for the fiscal year; BTM is the ratio of book equity value (after adding back the after-tax effect of the write-down) to the market value of equity at the end of the fiscal year; Δ BTM is the change in BTM from the previous year (using reported book values) to the current year; Δ ROA is the change in ROA from the previous year to the current year; ROA is defined as operating income after depreciation (OIADP), prior to inventory write-downs for the current year, divided by average total assets; LNSALES is the natural log of sales revenues for the current year.; Δ MGMT is an indicator variable set equal to one if any of the three top officers of the company changed in the current or previous year, zero otherwise; FNNCNG is the proceeds of debt and equity offerings during year t divided by total

assets; LTDDTA is long term debt divided by total assets; POOR is set equal to UE, if UE < 0, zero otherwise; UE is defined as current year's operating income after depreciation (prior to inventory write-downs) less previous year's operating income, divided by prior year's total assets; GOOD is set equal to UE if UE > 0, zero otherwise; and NEGSPEC is an indicator variable set equal to one if the firm has negative special items in the current year, zero otherwise. All non-indicator variables are winsorized at 1% and 99%.

Table 4
Abnormal Write-downs and Subsequent Write-downs and Performance

Panel A: Univariate Comparisons

	HIGHWD ($ABWD_t > 0$) (N=526)		LOWWD ($ABWD_t < 0$) (N=394)		Difference	
	Mean	Median	Mean	Median	α-Levels	
$ABWD_t$ (% of Revenues)	3.394	2.456	-4.611	-2.728	**0.00**	**0.00**
$ACTWD_{t+1}$ (% of Revenues)	1.439	0.000	2.728	0.0052	**0.00**	**0.00**
ΔGM_{t+1}	0.0177	0.0100	-0.0139	-0.0081	**0.00**	**0.00**
ΔROA_{t+1}	0.0029	0.0062	-0.0207	-0.0086	**0.00**	**0.00**
$SZARET_{t+1}$ (%)	26.879	-7.851	21.602	-12.695	0.64	0.32
$FYRET_t$ (%)	28.449	-3.320	23.007	-11.956	0.68	**0.00**
BTM_t	0.4436	0.3650	0.5125	0.4325	**0.00**	**0.00**
ΔROA_t	0.0002	0.0097	-0.0184	-0.0016	**0.02**	**0.02**

Panel B: Multivariate Analysis of Abnormal Write-downs and Future Performance

	DEPENDENT VARIABLE			
	$ACTWD_{t+1}$	**ΔGM_{t+1}**	**ΔROA_{t+1}**	**$SZARET_{t+1}$**
Intercept	0.0174***	-0.0035	-0.0183**	0.0429
	(5.60)	(-0.58)	(-2.59)	(0.57)
$ABWD_t$	-0.2138***	0.2929***	0.1933***	1.5546**
	(-7.32)	(5.19)	(2.91)	(2.19)
$FYRET_t$	0.0001	0.0044	0.0075**	-0.0845**
	(0.09)	(1.42)	(2.07)	(-2.18)
BTM_t	0.0051	0.0121	0.0175	0.4837***
	(0.99)	(1.21)	(1.49)	(3.84)
ΔROA_t	-0.0008	-0.1178***	-0.1181***	0.3799
	(-0.05)	(-4.13)	(-3.52)	(1.06)
Adjusted R^2	5.66%	3.84%	1.81%	2.90%

$ABWD_t$ is the "abnormal" write-down of inventory in year t, defined as the actual write-down in year t less the predicted write-down (see Table 3); HIGHWD (LOWWD) are firm-years for which the write-down was higher (lower) than the predicted values in year t; $ACTWD_{t+1}$ is the actual write-down of inventory in year t+1; $SZARET_{t+1}$ is the size-adjusted cumulative abnormal return for the firm cumulated from the fourth month of fiscal year t+1 to three months after the end of the fiscal year; ΔGM_{t+1} is the change in gross margin (as a percentage of sales) from year t to year t+1; ΔROA_{t+1} is the change in ROA from year t to year t+1. See Table 3 for other variable definitions.

All variable values are winsorized at 1% and 99%. ***, ** indicate statistical significance at the 1% and 5% levels, respectively.

Table 5
Abnormal Write-downs and Subsequent Forecast Errors

Panel A: Univariate Comparisons

	HIGHWD ($ABWD_t > 0$) (N=368)		LOWWD ($ABWD_t < 0$) (N=247)		Difference	
	Mean	Median	Mean	Median	α-Levels*	
$ABWD_t$ (% of Revenues)	3.034	2.084	-4.169	-2.271	**0.00**	**0.00**
AFE_{t+1} (% of Price)	-0.223	-0.001	-1.129	-0.337	**0.00**	**0.00**
AFE_t (% of Price)	-0.250	0.056	-0.940	-0.302	**0.01**	**0.00**
$FLAG_{t+1}$	280	277	281	277	0.89	0.98
$NFCST_{t+1}$	11.946	9	11.644	9	0.71	0.92
$LNSALES_t$	5.787	5.605	5.881	5.719	0.44	0.39

*Significance levels are based on t-tests for means and Wilcoxon tests for medians.

Panel B: Multivariate Analysis of Abnormal Write-downs and Subsequent Forecast Errors (n=615)

	Predicted Sign	AFE_{t+1}
Intercept		0.0373
		(1.48)
$ABWD_t$	+	0.1036***
		(3.94)
AFE_t	+	0.0603
		(1.41)
$FLAG_{t+1}$	-	-0.001
		(-1.48)
$NFCST_{t+1}$	?	0.003
		(1.48)
$LNSALES_t$	?	-0.0021
		(-1.46)
Adjusted R^2		2.93%

$ABWD_t$ is the "abnormal" write-down of inventory in year t, defined as the actual write-down in year t less the predicted write-down (see Table 3); HIGHWD (LOWWD) are firm-years for which the write-down was higher (lower) than the predicted values in year t; $ACTWD_{t+1}$ is the actual write-down of inventory in year t+1; AFE_{t+1} is the price-deflated EPS forecast error for year t+1 using the mean forecast (from IBES) of EPS made within 60 days of the required 10-K filing date for year t. AFE_t is the forecast error for the year t horizon constructed in the same manner. $FLAG_{t+1}$ is the mean forecast lag (calendar days between the forecast date and earnings announcement date) of forecasts comprising the consensus

for year t+1. $NFCST_{t+1}$ is the number of forecasts used to construct the mean forecast for year t+1 earnings. $LNSALES_t$ is the natural log of sales in year t.

All variable values are winsorized at one percent and ninety-nine percent. ***, ** indicate statistical significance at the one percent and five percent levels, respectively.