Are Inventories Accretive? Lessons from Inventory and Earnings Relationship in the U.S. Capital Goods Sector

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Abstract

This paper presents results documenting the effects of inventories (considered as *current assets*) on corporate earnings in the US capital goods industry. The results reveal that inventories may have a negative impact on corporate earnings. Therefore, shareholder wealth may be negatively impacted by carrying inventories in the US capital goods sector. Carrying inventories may be crowding out non-inventory assets. Interestingly, higher inventories may lead to depressed overall sales. Depressed overall sales may contribute to further reduction in non-inventory assets. This reduction in non-inventory assets may further result in lower corporate earnings. These results strengthen the need for optimal inventory management and also call for a more nuanced treatment of inventories in the standard accounting literature. These results also strengthen the popular rationale for lean supply chain management. This paper contributes to the literature on the close relationship between operational efficiency and corporate financial outcomes.

Keywords: Inventory Management, Optimal Inventory, Financial Accounting, Operational Efficiency

JEL Classification: G31, G32, L6, L1, L23, L25

1. Introduction

The decision to carry inventories is one of the most critical decisions made by managers in their day to day operations. These decisions have critical implications for production, distribution, marketing, sales, warehousing, transportation and logistics, and overall financial health of the firm. Hence, inventory carrying decisions are also consequential for the shareholders since such decision *affect their overall equities in the firm*.

Carrying inventories also affect the *balance sheet* of the firm. *Generally Accepted Accounting Practices* of the United States (US-GAAP) treats inventories as *current assets*. It is customary to view assets (hence, *current assets* like inventories) as economic resources that are *financially beneficial* to the firm. Assets can be sold to serve customers during sudden demand spikes. It is possible to raise money for investment by selling assets. Assets can also be used to pay off liabilities. Also, assets like inventories may be used to fend off competition by using the inventory stockpile as strategic entry deterrence. Current assets may also be used to buy other lucrative business interests and generate future cash flows.

Given the preceding discussion, it may be conjectured that *holding inventories (or current assets tied up in inventories) also adds financial benefits to the firm and its shareholders. In other words, it may be hypothesized that inventories are accretive to the firms*. This paper rigorously tests that prime conjecture. Especially, it is tested if the earnings of a firm are increasing in the amounts of inventories that it holds. It is also investigated if inventories crowd out other forms of assets that may be beneficial to the firm and thus dilute the financial position of the firm.

While we can easily understand the benefits of carrying inventories, we do not pay nearly as much attention to its potential pitfalls (i.e. *costs associated with inventory holding*). By tying up significant amounts of current assets in inventories of finished goods, work in progress and raw materials, firms may incur expensive *opportunity costs* that may negatively impact their residual income (Fry and Steele 1995, Wang 2002, Gaur, Fisher et al. 2005, Cachon and Olivares 2010). This effect might work against the shareholder wealth/equity maximization (Wang 2002, Meade, Kumar et al. 2006, Fullerton, Kennedy et al. 2013, Steinker and Hoberg 2013). Furthermore, resources tied up in inventories may make it difficult for firms to acquire other assets, or maintain cash balances that may be used to gain a *competitive advantage* in the market. It may be entirely possible that the *adverse effects* of inventory holding may be significant enough to outweigh the benefits accrued by holding inventories.

It is important to note that these *opportunity costs* may also partially stem from the inability of an inventory-rich firm to take advantage of alternate investment opportunities. For example, instead of tying up resources in unsold inventories of finished goods or, blocking current assets in work in progress for potentially non-existing demand, a firm may decide to invest its slack resources in buying high-quality bonds. Buying such high-quality bonds might help the firm to earn interests on its loanable funds adding to its existing cash flows. Alternatively, the firm may decide to reduce its liabilities thereby saving future interest payments and improving its attractiveness in the corporate bond market. A lower *debt-equity ratio* may help the firm to secure investment on more favorable terms and hence, may end up reducing future cost of borrowing.

Higher non-inventory related assets (like ownership of high yielding good quality bonds) might also help a firm to offer more competitive deals to its customers as cash flow may be less of a binding constraint. Also, the same liquidity-heavy financial position might offer the firm the ability to extract better deals from its suppliers as the suppliers may have more confidence about getting paid from a company that has a larger non-inventory related asset base and higher cash balances. On a related note, higher inventory on the balance sheets may signal poor quality of demand for the products of the firm and might make potential investors nervous about investing in the firm. This feeling might negatively impact overall investor confidence in the firm.

Besides the opportunity cost-based arguments, there are *technological factors* that might make holding inventories an unattractive proposition. Holding inventories may be unwelcome where the technology changes at a relatively fast pace making earlier products obsolete fairly quickly. The fast pace of obsolescence may require frequent *fire sales* or large *inventory write-offs* which might adversely affect the balance sheet of the firm. For example, in the semiconductor industry, fast technological progress (Moore's Law) frequently obsoletes inventories of chips, device memories, hard drives, motherboards, etc. (Wu 2013). Such write-off may require optimal inventory modeling especially in the presence of fixed and proportional transaction costs (Wang, Yiu et al. 2013).

The possibility of quick obsolescence is theoretically akin to a faster *physical depreciation*. A mathematically limiting case of faster depreciation is one of the complete *write-offs*. However, in this case, physical depreciation of technology goods is different from the depreciation of buildings. While older device memories may be useless in future because of rapid technological change and lack of incomplete backward compatibility, buildings and the land on which the buildings stand may still retain their intrinsic values. This value may go up as population increases, and economic development spreads more rapidly thereby placing more demand on inelastically supplied capital like land.

Given both the positives and negatives effects associated with inventory carrying decisions, it is important to ask if inventories *contribute to* shareholder wealth. In other words, we may ask if higher levels of inventories increase firm's earnings as earnings are more closely related to *shareholder equity*.

Inventory carrying behavior of capital goods sector in the U.S.A. is analyzed in this paper. The focus on a single sector ensures close matching of the firms in the sample. These companies face very similar demand conditions, face similar markets for inputs, and operate on largely comparable technological factors. Also, they are very similar regarding the accounting treatments and hence, are much easier to benchmark against one another.

Firms in the U.S. capital goods sector are a significant segment of the US economy. Between 2009 and 2012, representative capital goods producing firm had a total asset of about \$4.6 billion, generated annual EBITDA (*Earnings before Interest, Taxes, Depreciation, and Amortization*) of about \$477 million on an average sales volume exceeding \$3.8 billion. That representative firm also spent over \$2.8 billion in COGS (*Cost of Goods Sold*). Also, the representative firm carried over \$236 million of inventories of finished goods, \$157 million of inventories of raw materials and \$166 million of inventories of work in progress. This high volume of inventories represented a significant fraction (over 18%) of the total assets of that average firm. This average firm also maintained an average of 63.7 days of inventories at hand effectively "turning over" its inventories completely about 5.73 times a year. (Note 1)

In simple regression frameworks, it is found that inventories *positively affect* corporate earnings in that *higher inventories lead to higher earnings*. This simple observation points to the possibility that inventories are *accretive*.

However, simple regressions also generate different results for various industries within the capital goods sector. In some industries, inventories positively affect earnings while in other industries, inventories are either *non-accretive* or, actually lead to diminished earnings. These differences point to one of two problems; either, the simple regression framework is not the right approach (*misspecification error*) or, inventories are not accretive (*modeling erro*r). It also leads to the confusion if inventories have (*directionally*) different impact on earnings in various industries.

A system of structural equations is estimated to mitigate these confusions and account for the complex sets of relationships between earnings, assets, inventories, sales, the cost of goods sold, etc. It is found that inventories, by themselves, do not have any *statistically significant* impact on corporate earnings. However, when the interactions between inventories and other assets (that are not inventory related) are accounted for, it is found that inventories may have a *negative* impact on corporate earnings.

Higher inventories may lead to crowding out of non-inventory related assets and that might lead to lower sales and may further prompt declining asset creation which in turn may depress corporate earnings. In other words, *inventories may not be accretive* and higher inventories may be resulting in lower corporate earnings in the U.S. capital goods sector. This result provides a strong justification for prudent inventory management as it might provide higher earnings.

It should also be noted that the choice of firms in the capital goods producing sector is not the main focus of the paper. As mentioned earlier, U.S. capital goods producing sector is chosen merely for convenience and because of the rich data that is already available for that sector. High volumes of inventories also characterize capital goods sector. This phenomenon facilitates analyzes presented in the paper. It is entirely possible that the results presented in this article may be replicated quite easily for other areas without changing the central messages presented here.

EBITDA is used as the main dependent variable in this article. EBITDA one of the most widely used measures of earnings in standard finance and accounting literature. Since EBITDA is essentially a flow concept, it is proper to treat it as a *measure of change rather than a stock of shareholder equity*. EBITDA may be easily found by subtracting expenses (*excluding* taxes, interest, depreciation and amortization) from the gross revenues of the firm earned during any given accounting period. In other words, EBITDA is essentially the *net income* of the firm with the addition of taxes, interests, depreciation and amortization paid/allocated by the firm during the same accounting window.

EBITDA is a convenient summary measure that allows analysts to compare companies and industries without concerns about individual financing and accounting decisions that are too unique to that company or the industry/sector that the enterprise belongs to and thereby provide a common platform for analyzing industries in both related and unrelated sectors.

Controlling for a host of relevant factors, a positive effect of inventories on EBITDA would imply that shareholder equity may be increasing in inventories or, inventories are accretive while a negative impact would imply that carrying inventory may not be financially beneficial for the shareholders or, inventories are not accretive.

1.1 Summary of the Main Results

As indicated above, simple regressions point to a positive impact of inventories on corporate earnings. Specifically, an additional dollar of inventory is found to increase EBITDA by about 21.7 cents (95% Confidence Interval: 2.8 to 40.7 cents). However, this result is *not very strong*. It is statistically significant only at 10% level that points to the *potential weakness* of the effect of inventories on shareholder wealth.

Simple regression results performed at the individual industrial levels indicate that industries widely differ regarding the impact of inventories on EBITDA. It is found that carrying inventories decreases earnings in aerospace, defense, engineering and construction and metal fabrication industries. While each dollar of inventory contributes to about 14.7 cents of additional earnings in the specialized manufacturing industry, the same additional dollar reduces earning by 18.1 cents in the metal fabricating industry. Every dollar of inventory reduces EBITDA by about 7.6 cents in the Aerospace and Defense industry and by about 10.7 cents in Engineering and Construction industry.

Simple calculations reveal that an average firm in the Aerospace and Defense industry loses about $64 millions of earnings annually because of their inventories. The corresponding numbers are $72 million and $81 million in Engineering and Construction and Metal Fabrication industries respectively. (Note 2)

The differences in the full sample and industry-specific results raise the possibility that the inventories may have a more complex relationship with corporate earnings. To evaluate this possibility, a system of structural equations is estimated where earnings, inventories, sales and assets other than inventories are treated to be endogenous variables and industry types, and cost of goods sold are taken as exogenous variables. It is assumed that the firms are price-takers in the input market, and those input prices are largest contributors to the cost of goods sold.

It is found that inventories have no statistically significant impact on corporate earnings. In other words, the statistically significant positive effect of inventories on corporate earnings (as found in simple linear regressions) *completely disappears* after complex interactions between various exogenous and endogenous variables are carefully modeled.

From the system of structural equations, it is found that higher sales lead to higher inventories *possibly because faster selling firms also like to hold to larger quantities of inventories*. It is also found that assets that are not inventory related, have a positive impact on firm's sales while higher sales help firms to rake up more non-inventory assets and higher earnings.

Surprisingly, larger volumes of inventories are found to be drivers towards lower sales. This is a very interesting result that is quite possibly associated with the *signaling value of inventories*. While non-inventory assets signal to the market about the superior strength of the firm and help the firm to spend more in marketing efforts, higher volumes of inventories may inadvertently signal lower market attractiveness of its products and might depress its sales.

After accounting for the negative impact of inventories on sales and the positive impacts of sales on non-inventory assets and the positive impact of non-inventory assets on EBITDA, it is found that an additional dollar of inventories may be reducing EBITDA by as much as 1.61 cents. Out that 1.61 cents of reduction, 1.47 cents of the reduction comes from sales inventory interaction and 0.14 cents comes from adverse asset substitution effect. (Note 3)

The rest of paper discusses the theoretical background, data, methods, a discussion of the results and some concluding thoughts.

2. Theoretical Background

Capital goods are vital ingredients in the economic lives of nations. They are usually embodied in *durable assets* like machines, tools, buildings, information technology investments in computers, cables, fiber optic networks, etc. Capital goods require substantial investments to acquire and once acquired, usually render economically valuable services over extended periods of time while depreciating (potentially unevenly) during that period.

The rate of depreciation of different types of capital goods may differ from one industry to another and from one type of capital goods to another. For example, some of these capital goods last only for a small period (like computers, networking equipment, cables, office supplies, etc.) while others last for much longer periods of time (like office buildings, warehouses, physical plants, vehicles, etc.) The ones that last for a shorter period are typically characterized by a faster rate of physical depreciation while a longer usable life span may be associated with a lower rate of physical depreciation. (Note 4)

Besides labor, capitals goods are considered fundamental resources of production in the standard neoclassical economics framework. Interestingly, capital goods are also very capital intensive in nature and need a substantial investment of initial capital to set up. While businesses purchase capital goods to produces final products and services, they also procure capital goods to produce their capital goods. For example, semiconductors (which are capital goods by themselves) are vital building blocks of computers and computer companies routinely buy semiconductors to manufacture computers. In other words, capital goods are not only used to produce finals products and services, but they are also used as intermediate inputs while producing other capital goods.

Being very capital intensive in nature, capital goods are relatively difficult to produce and require long production cycle times besides requiring a substantial lead time and fixed cost for set up. They are also difficult to carry, install and turned into operational assets immediately following their production. Hence, it is very hard to produce capital goods on an on-demand basis over a short period. This feature makes them quite different from short cycle goods like the fast food industry (burgers, fries, chicken nuggets, etc.) Therefore, producers of capital goods are very likely to carry substantial amounts of inventories to make sure that demand spikes may be accommodated more easily, and sales may be smoothed over a longer time frame. I discuss these and other rationales for carrying inventory in detail below.

The primary purpose of carrying inventories is to make sure that the firms can meet demand as it arrives. Demand (especially in the long term) may be tough to predict accurately. It is important to ensure that potential customers find the product they are looking for when they arrive at the store. Otherwise, they might leave for competitors' stores taking their businesses with them. Loss of a customer due to non-availability of products on the shelves constitutes a lost business opportunity and potentially creates a negative reputation for the firm. That may affect future sales as unhappy customers may discourage potential future customers from visiting the stores from where they left empty handed. (Kothari 2001, Gaur, Fisher et al. 2005, Cachon and Olivares 2010, Agrawal and Smith 2013)

Carrying healthy amounts of inventories also protects firms against a sudden rise in demand. This is especially true if there is a long lead time between order placement and finished product availability (like in the *semiconductor industry* discussed in (Wu 2013)). Inventories on hand offer a cushion that allows firms to keep serving the increased demand by drawing down their inventory levels while new products take the time to get manufactured. This might offer a relatively well-stocked firm an advantage in a competitive marketplace especially during the times of rising demand. In this regard, carrying inventories almost works as a hedge against sudden demand shock and offers firms some degree of strategic advantage in an uncertain market characterized by demand uncertainties (Caglayan, Maioli et al. 2012, Agrawal and Smith 2013, Fullerton, Kennedy et al. 2013, Jones and Tuzel 2013, Wu 2013).

Competition has another way of influencing the choice of the levels of inventories for competitive firms. In the presence of economies of scale in production, the average cost may be lower with higher levels of output. This is because average cost is computed by dividing the total cost of production by the total volume of production. The lower average cost of production may also be attained by placing volume (bulk) purchase orders for large volumes of production. Volume purchase of raw materials often saves firms significant sums of money through quantity discounts from the suppliers of the inputs. Other things remaining constant, the lower unit cost of production helps a firm to attain increased gross margin which in turn may help the managers to earn higher bonuses.

A lower average cost of production over a large volume of output may be realized if the fixed cost is very high like that in the high technology sector (Wu 2013) since fixed costs do not change with the level of production. With a fixed numerator, a larger production reduces average fixed cost per unit. A lower average fixed cost may, in turn, increase the gross margin thereby increasing the attractiveness of higher inventory maintenance (Rumyantsev and Netessine 2007, Li, Min et al. 2008, Kesavan, Gaur et al. 2010, Kesavan and Mani 2013, Li, Lundholm et al. 2013).

There is a suspicion that perverse managerial incentives may prompt managers to shore up the levels of their inventories even when demand conditions do not fully justify that (Fry and Steele 1995, Kothari 2001). This perverse incentive may stem from the pressure of the managers to reduce the unit cost of production and improve gross margin especially in the context of cash-constrained firms in highly competitive situations (Kothari 2001, Wang 2002, Kesavan, Gaur et al. 2010, Li, Lundholm et al. 2013).

The reduction in average cost of production may help the operations managers to signal to the management about their superior production efficiencies (even if there is no additional spike in demand to mop up this excess inventory). Interestingly, from a production manager's perspective, lack of sales rarely matters as far as day to day demands of her job is concerned. Slowing sales may be viewed more as a marketing problem than an industrial engineering problem. This may allow production managers and industrial engineers to tout high levels of efficiencies while the firm as a whole suffers because of rising inventories and lack of sales. (Note 5)

There may be a strategic reason that might dictate the choice of larger inventory size because it may be beneficial for a firm from a strategic standpoint in a competitive marketplace that places a premium on market leadership. Inventory choice may be used as a coordination device in a mixed duopoly (Ohnishi 2011). It is shown that in a dynamic repeated game framework, firms carrying larger inventories in earlier periods may act as Stackelberg leaders in subsequent periods by either by limiting the output choices of the competitors or by thwarting potential competitors joining the marketplace. This leadership advantage benefits the leader firm by enabling it to harness larger profits.

Given the tremendous importance of inventory in firms' competitive and financial lives, a lively literature has emerged through the careful analysis of inventory management and financial performance (Fry and Steele 1995, Gaur, Fisher et al. 2005, Capkun, Hameri et al. 2009, Kesavan, Gaur et al. 2010, Eroglu and Hofer 2011, Caglayan, Maioli et al. 2012, Hofer, Eroglu et al. 2012, Jones and Tuzel 2013, Kesavan and Mani 2013, Kroes and Manikas 2014). Despite the varied nature of the results found over time, a relatively robust consensus seems to be emerging that prudent inventory management does indeed contribute to better financial performance (Gaur, Fisher et al. 2005, Modi and Mishra 2011, Hourmes, Dickins et al. 2012, Jones and Tuzel 2013, Kesavan and Mani 2013, Wang, Yiu et al. 2013, Alan, Gao et al. 2014, Basu and Nair 2014, Kroes and Manikas 2014).

There is an important way that this paper is related to the lean supply chain management literature. It is posited that efficient supply chain management leads to the need for lower levels of inventories as much of the production may be fine-tuned with expected demand arrivals or sifted to *just in time* production methods. *If holding inventories affect firm earnings negatively then a reduction in the levels of inventories (through efficient inventory management) may* *lead to higher earnings. Hence, efficient inventory management and better financial performance are entirely consistent with one another.*

It may be noted that there is a significant difference between the existing literature and this paper. The focus of the existing literature is mostly on efficient inventory management (as in lean supply chain management) and the effect of the same on firm's financial performance. That is not the main aspect of this paper. While lean supply chain management indeed reduces firm's inventory at hand, it is hard to say that it is the driving force behind an increase in EBITDA. It is conceivable that many of the firms studied in this paper do follow lean supply chain management and their inventory levels are already very close to the optimum levels. Instead, this paper shows that there is virtually little or no impact of inventory on shareholder wealth as measured by earnings. Also, when the asset crowding effects are included in the analysis, inventories are found to affect corporate earnings negatively. A simple theoretical framework might be instructive here.

Let us assume that the total assets of the firm can be expressed as a sum of inventories and other assets that are not inventories. More formally, $AT = INVT + NAT$ where AT is the total amount of assets, INVT is the total amount of inventories and NAT is all other assets that are not inventory related. Rearranging the individual terms we obtain $NAT = AT - INVT$. Other things remaining constant, NAT and INVT move in the opposite direction since higher INVT leads to lower NAT. We may assume that higher NAT helps firms financially from a competition point of view. It helps firms to secure favorable financing, spend money in advertisement, buy more inventories and secure favorable deals from the suppliers, etc.

Let the cost of inventories are given by C_n and the benefits by B_n. Non-inventory related assets also deliver benefits to the firm and let us denote them as B_t. It is easy to see that the total assets of the firm, expressed as the sum of the inventory and non-inventory related assets is given by $(B_n + B_t) \geq 0$. To make things simple, let us assume that assets that non-inventories do not have a cost attached to them. Therefore, the total (net) benefit to the firm is given by $(B_n + B_t - C_n)$. Note that $C_n = f(INVT)$ such that $f' > 0$. Furthermore, $B_t = \varphi(INVT)$ such that $\varphi' < 0$. It is easy to conceptualize that $B_t - C_n = \varphi(INVT) - f(INVT) = \phi(INVT)$ such that $\phi' < 0$. Since $B_t - C_n$ is decreasing in inventories and B_n is increasing inventories the final change in $(B_n + B_t - C_n)$ as inventories change will depend ultimately on the relative magnitude of B_n vis-à-vis $B_t - C_n$. This is because benefits accrued from other assets are not assumed independent of the cost of carrying inventories.

Rising inventories certainly increase inventory related benefits. Furthermore, it not only increases inventory carrying associated costs it also crowds out assets, not including inventories and reduces their potential benefits. These twin negative impacts may be significant enough to outweigh the positive effects of inventories. In other words, if the cost (including opportunity cost) of holding inventories is sufficiently large to outweigh its potential benefits then inventories may not be accretive.

3. Data, Methods, and Results

3.1 Data Source and Selection

The data used in the paper comes from the full COMPUSTAT database. Four years' of data spanning over 2009-2012 are chosen for analysis in the paper. A complete set of variables collected and generated are presented in Table 1. Only firms in the capital goods sector (S&P Economic Sector code 925) are considered. All observations with missing values are *excluded* from the analysis. All firms with zero inventories on their books are also excluded from this analysis. Following all the exclusions, firms from the Waste Management (S&P Industrial Sector Code 405) sector remained in the dataset with but had only four observations. Since statistically meaningful observations are hard to derive from such a small sample size of firms in a particular sector, this industrial classification is also excluded from the analysis.

Table 1. Variable and Data Description

Data is collected from the full database of the COMPUSTAT spanning the years of 2009-2012. Only capital goods sector firms (S&P Economic Sector Code 925) are considered for this study. Firms with missing observations for the relevant variables are excluded from the study. Because of a very small sample size Waste Management (S&P Industrial Sector Code 405) is also excluded from the analysis.

Panel A: Directly Collected Variables

Variable Name	Variable Description (Names same as in COMPUSTAT)
AT	Total Assets; Measured in millions of U.S. Dollars
EBITDA	Earnings Before Interest, Taxes, Depreciation and Amortization; Measured in millions of U.S. Dollars
COGS	Cost of Goods Sold; Measured in millions of U.S. Dollars
SALE	Sales; Measured in millions of U.S. Dollars
INVT	Inventory; Measured in millions of U.S. Dollars
INVRM	Inventory of Raw Materials; Measured in millions of U.S. Dollars
INVFG	Inventory of Finished Goods; Measured in millions of U.S. Dollars
INVWIP	Inventory of Work in Progress; Measured in millions of U.S. Dollars

Panel B: Summary of the Key Variables

Variable Name	Mean (Standard Error)	95% Confidence Interval
EBITDA	477.26 (34.70)	[409.20, 545.33]
COGS	2820.53 (217.65)	[2393.54, 3247.51]
SALE	3856.48 (285.03)	[3297.30, 4415.67]
AT	4559.88 (380.89)	[3812.63, 5307.14]

Panel C: Inventories to Total Asset Ratio across S&P Sectors in US Capital Goods Industry (Figures in Percentages, Ascending in the Asset Inventory Ratio)

	Inventory-Asset Ratio	95% Confidence Interval
Engineering and Construction	0.1133	[0.0833, 0.1434]
Containers (Metal and Glass)	0.1284	[0.1064, 0.1506]
Manufacturing (Diversified)	0.1334	[0.1231, 0.1437]
Manufacturing (Specialized)	0.1707	[0 .1521, 0.1893]
Office Equipment and Supplies	0.1707	[0 .1424, 0.1990]
Total for all industries	0.1817	[0 .1752, 0.1881]
Machinery (Diversified)	0.1872	[0 .1728, 0.2017]
Metal Fabricators	0.1996	[0.1722, 0.2269]
Electrical Equipment	0.2029	[0.1908, 0.2149]
Trucks and Parts	0.2357	[0.2063, 0.2655]
Aerospace/Defense	0.2432	[0.2052, 0.2812]

Panel D: Inventories of Capital Goods across S&P Industry Sectors

(Millions of U.S. Dollars, Ascending in Total Inventories)

	Inventories of Finished Goods	Inventories of Raw Materials	Inventories of Work in Progress	Total Inventory
Office Equipment and Supplies	39.77	25.03	6.37	68.15
Trucks and Parts	175.15	181.56	48.89	386.12
Electrical Equipment	209	137.82	90.75	434.64
Metal Fabricators	195.85	137.78	128	446.18
Manufacturing (Specialized)	258.89	128.35	104.68	487.54
Total for all industries	236.97	157.63	166.08	554.76
Machinery (Diversified)	365.75	203.24	128.57	666.43
Engineering and Construction	25.08	72.75	581.38	677.04
Manufacturing (Diversified)	282.05	192.71	225.98	705.1
Containers (Metal and Glass)	455.27	277.55	59.69	775.38
Aerospace/Defense	**126.9**	**187.62**	**513.25**	**847.2**

Panel E: Days of Inventory Held across S&P Industry Sectors (Ascending in the Mean)

First a variable to named TURN is defined where TURN=(SALE/INVT) and then the days of inventory held is defined to be DAYS=365/TURN. TURN measures the number of times inventory is turned (sold) over an accounting year.

Variable	Mean	Std. Errors	[95% Conf.	Interval]
Engineering and Construction	29.7	4.4	[20.9,	38.5]
Office Equipment and Supplies	43.3	3.9	[35.5,	51.1]
Containers (Metal and Glass)	46.2	2	[42.0,	50.4]
Manufacturing (Diversified)	49.4	1.4	[46.8,	52.1]
Trucks and Parts	50.4	2	[46.4,	54.5]
Manufacturing (Specialized)	61.3	3	[55.4,	67.2]
Total for all industries	63.71	1.37	[61.02	66.40]
Electrical Equipment	67.1	2.1	[62.9,	71.2]
Metal Fabricators	70.8	6.1	[58.6,	83.0]
Machinery (Diversified)	75.3	4.9	[65.7,	84.9]
Aerospace/Defense	98.5	9.4	[79.9,	117.1]

Following all the exclusions mentioned above, the final data contained 1265 valid firm-year observations distributed over ten industrial categories:

Aerospace/Defense (S&P Industrial Sector Code 110)

Trucks and Parts (S&P Industrial Sector Code 135)

Metal and Glass Containers (S&P Industrial Sector Code 205)

Electrical Equipment (S&P Industrial Sector Code 220)

Engineering and Construction (S&P Industrial Sector Code 240)

Diversified Machinery (S&P Industrial Sector Code 345)

Diversified Manufacturing (S&P Industrial Sector Code 355)

Specialized Manufacturing (S&P Industrial Sector Code 357)

Metal Fabricators (S&P Industrial Sector Code 358)

Office Equipment and Supplies (S&P Industrial Sector Code 358).

3.2 Summary of the Key Variables and Ratios

Average amounts of total assets, EBITDA, the cost of goods sold and sales for the firms in the final dataset are calculated. These numbers, along with their corresponding standard errors and 95% confidence intervals are presented in the Panel B Table 1.

Different industries have different inventory to total assets ratio. It may be noted that inventories are categorized as current assets. However, inventories constitute only a subset of current assets. Therefore, the ratio of inventories to total assets is not equal to the quick ratio (defined as the ratio of current assets to total assets). On an average, this inventory to total asset ratio is about 18% in the capital goods sector.

To capture intra-sector, inter-industry differentials in the inventory to total assets ratio, the ratio for each industry is calculated and presented along with the corresponding 95% confidence intervals, in Panel C of Table 1.

Firms carry inventory in many different ways. They include inventories of finished goods, inventories in the form of raw materials and inventories in the form of work in progress. Therefore, total inventory can be defined as the sum of inventories in these subcategories. However, the distribution of inventories in these three subcategories may be different for different firms and can also vary from one sector to another. Average of each of these numbers and total inventory for a representative firm in the capital goods sector and also for each of the constituent industries in the capital goods sector are calculated. I present these figures in Panel D of Table 1.

To capture the differences in turnover across industrial classification within the capital goods sector, a variable named TURN is computed by taking the *ratio of sales to inventories*. TURN measures the number of times a firm runs through the whole supply of inventories in a given year. A higher number implies a faster rate of sale (possibly through cheaper pricing or higher demand or a combination of both of these factors). The inverse of the TURN is multiplied by 365 to measure the number of days it takes a firm to sell its batch of inventories. We can call this variable DAYS and define it as

$$DAYS = (365 / TURN) = \frac{365}{(SALE / INVT)} = \frac{365(INVT)}{SALE}.$$

We are working with the data obtained from the annual reports. Multiple years of data on the same firm may not be available for the same firm. Hence, these calculations are slightly different from the standard accounting definitions where TURN is usually defined by dividing SALE by the average of beginning and ending inventory. Therefore, the numbers are close approximations of the standard accounting numbers.

For the detailed presentation purposes, mean, standard errors and 95% Confidence Interval of the DAYS variable for each industrial classification within the capital goods sector are computed. I present these results in Panel E of Table 1.

3.3 Regression Models: Full Sample and Industry Specific

Table 2 presents the first key regression result of the paper. I estimate a linear equation with inventory as the independent variable and EBITDA as the dependent variable to model the effects of inventory on shareholder wealth. I include relevant control variables in the regression models to ensure that the coefficient of inventory on EBITDA is theoretically meaningful and intuitively clear. In particular, overall sizes of the firms are controlled by including asset size, the cost of goods sold and total sales volumes. Industry specific dummy variables are also included in the regression model to account for the inherent differences between different industries in the capital goods industry. The estimated regression equation is given by

$$EBITDA = \beta_0 + \beta_1(INVT) + \beta_2(AT) + \beta_3(COGS) + \beta_4(SALE) + \sum_{i=1}^{10} \gamma_i INDi + \varepsilon_1 \qquad (1)$$

Where

IND1: Dummy for Aerospace/Defense

IND2: Dummy for Trucks and Parts

IND3: Dummy for Containers (Metal and Glass)

IND4: Dummy for Electrical Equipment

IND5: Dummy for Engineering and Construction

IND6: Dummy for Machinery (Diversified)

IND7: Dummy for Manufacturing (Diversified)

IND8: Dummy for Manufacturing (Specialized)

IND9: Dummy for Metal Fabricators

IND 10: Dummy for Office Equipment and Supplies

IND2 is dropped from estimated regressions to avoid multicollinearity.

To distinguish the aggregate results presented in Panel A of Table 2 from the industry-specific results, regressions of EBITDA in each industrial classification is performed on inventories, total assets, sales and costs of goods sold (excluding industry specific dummies) and present results for different industries individually. Formally, these regressions may be expressed as

$$EBITDA = \beta_0 + \beta_1(INVT) + \beta_2(AT) + \beta_3(COGS) + \beta_4(SALE) + \varepsilon_2 \qquad (2)$$

The coefficient of inventory along with its standard error and the R-squared of the regression are presented in Panel B in Table 2. The last column of Panel B in Table 2 indicates if the coefficient of inventory is statistically significant.

Table 2. Effect of Inventory on Firm Earnings

Panel A: Full Sample Results

The following dummies have been used in this table: IND1: Dummy for Aerospace/Defense, IND2: Dummy for Trucks and Parts, IND3: Dummy for Containers (Metal and Glass), IND4: Dummy for Electrical Equipment, IND5: Dummy for Engineering and Construction, IND6: Dummy for Machinery (Diversified), IND7: Dummy for Manufacturing (Diversified), IND8: Dummy for Manufacturing (Specialized), IND9: Dummy for Metal Fabricators and IND 10: Dummy for Office Equipment and Supplies. IND2 is dropped from the regression to avoid multicollinearity. Overall R-squared for the model is 0.895 based on 1265 valid observations. 95% confidence interval values are included to facilitate interpretation of the results. Technically, the regression equation presented in the table if given by $EBITDA = \beta_0 + \beta_1(INVT) + \beta_2(AT) + \beta_3(COGS) + \beta_4(SALE) + \sum_{i=1}^{10} \gamma_i INDi$.

The equation was estimated using standard Ordinary Least Squares methods.

Dependent Variable: EBITDA	**Coeff.**	***Heteroscedasticity consistent*** **Std. Error**	**Robust t-statistic**	**P>|t|**	**95% Interval**	**Confidence**
INVT	0.217	0.097	2.250	0.025	0.028	0.407
AT	0.032	0.012	2.820	0.005	0.010	0.055
SALE	0.247	0.049	5.040	0.000	0.151	0.343
COGS	-0.280	0.041	-6.760	0.000	-0.361	-0.199
IND1	211.232	81.351	2.600	0.010	51.632	370.831
IND2	(dropped)					
IND3	401.307	66.068	6.070	0.000	271.692	530.923
IND4	-32.947	54.669	-0.600	0.547	-140.201	74.307
IND5	91.630	86.105	1.060	0.287	-77.296	260.556
IND6	64.904	56.153	1.160	0.248	-45.260	175.068
IND7	133.747	58.146	2.300	0.022	19.672	247.821
IND8	19.835	52.978	0.370	0.708	-84.100	123.770
IND9	34.275	56.758	0.600	0.546	-77.075	145.626
IND10	3.673	52.233	0.070	0.944	-98.802	106.147
Constant	-5.201	55.818	-0.090	0.926	-114.708	104.306

Panel B: Industry Specific Results

This table coefficient of inventory (INVT) from the regression equation involving EBITDA, INVT, AT and SALE of the form $EBITDA = \beta_0 + \beta_1(INVT) + \beta_2(AT) + \beta_3(COGS) + \beta_4(SALE)$. The last column signifies if the coefficients are statistically significant or not.

Industrial Sector	Coefficient	Robust Std. Err	R-Square	Result Significant
Aerospace/Defense	-0.076	0.043	0.991	Yes (at 10% level)
Trucks and Parts	-0.431	1.195	0.871	No
Containers (Metal and Glass)	-0.228	0.242	0.991	No
Electrical Equipment	0.215	0.236	0.914	No
Engineering and Construction	-0.107	0.031	0.991	Yes (at 5% level)
Machinery (Diversified)	0.283	0.066	0.994	Yes (at 5% level)
Manufacturing (Diversified)	0.0096	0.385	0.973	No
Manufacturing (Specialized)	0.147	0.052	0.981	Yes (at 5% level)
Metal Fabricators	-0.181	0.078	0.969	Yes (at 5% level)
Office Equipment and Supplies	0.611	0.481	0.701	No

A key concern for the regressions estimated is the possible presence of *heteroscedasticity*. In the presence of heteroscedasticity, error terms are not identically and independently distributed with a constant variance. Instead, $E(u_i^2) = \sigma_i^2$ and in general $\sigma_i^2 \neq \sigma_j^2$ where $i \neq j$. This invalidates the standard assumption of Ordinary Least Squares $u_i \sim iidN(0, \sigma^2)$ for all $i = 1, 2, ..., N$. This can bias the estimation results standard errors and produce inaccurate t values and raising questions about the statistical validity of the results.

Given the highly heterogeneous nature of the constituents of the capital goods industry, the results are appropriately adjusted for possible heteroscedasticity. Following the need to adjust for heteroscedasticity and report heteroscedasticity-consistent t-statistics (Mackinnon and White 1985), robust standard errors and heteroscedasticity-consistent t-statistics are reported in both Table 2.

3.4 Regression Model: System of Structural Equations

Simple regression models may not be powerful enough to control for all different sources of partial relationships and control for the various channels through which inventories can affect earnings. To control for the various partial relationships and account for the various pathways, a system of equations is estimated where SALE are assumed to be a function of INVT, COGS, and NAT where $NAT = AT - INVT$. It is also assumed that NAT is a function of SALE and industry-specific dummies. It is postulated that non-inventory assets are going to be demanded differently in different industries. Furthermore, INVT is assumed to be a function of SALE and NAT. Finally, EBITDA is assumed to be driven by INVT and NAT. Since, INVT is a function of SALE and NAT and NAT is function of SALE and industry dummies and SALE is a function of INVT, COGS and NAT hence, EBITDA is ultimately driven by NAT, SALE, COGS, INVT and industry dummies. But the system of equations allows us to model the impact of different variables on each other and offers a sharper picture about the overall dynamics. More formally,

$$\begin{aligned} EBITDA &= \alpha_0 + \alpha_1(INVT) + \alpha_2(NAT) \\ INVT &= \beta_0 + \beta_1(SALE) + \beta_2(NAT) \\ NAT &= \gamma_0 + \gamma_1(SALE) + \sum_{i=1}^{10} \theta_i(IND_i) \\ SALE &= \varphi_0 + \varphi_1(INVT) + \varphi_2(COGS) + \varphi_3(NAT) \end{aligned} \tag{3}$$

Clearly, the system of structural equations presented above has four endogenous variables: EBITDA, SALE, INVT, and NAT. Also, the exogenous variables are IND1, IND2, IND3, IND4, IND5, IND6, IND7, IND8, IND9, IND10, and COGS. IND2 is dropped from the system of structural equations to avoid perfect multicollinearity between the industry dummies. COGS is treated to be an exogenous variable as the market of inputs are assumed to be given, and prices in those markets are assumed to be determined outside the model that is being solved here.

This system of structural equations is modeled using a *Three-Stage Least Squares* method, and it is ensured that the divisor for the covariance matrix of the equation errors is adjusted for potential small sample differences. This is convenient especially because the sample firms are not equally distributed between different industries, and some industries have a considerably smaller number of firms compared to others.

Table 3. Estimation Results from System of Equations

Endogenous variables: EBITDA, INVT, NAT, SALE							
Exogenous variables: IND1, IND2, IND3, IND4, IND5, IND6, IND7, IND8, IND9, IND10, COGS							
		Coeff.	**Std. Err**	**z**	**P>|z|**	**95% Conf. Interval**	
EBITDA							
	INVT	0.078	0.145	0.540	0.592	-0.207	0.362
	NAT	0.080	0.017	4.740	0.000	0.047	0.112
	CONSTANT	115.691	22.020	5.250	0.000	72.532	158.849
INVT							
	SALE	0.121	0.043	2.830	0.005	0.037	0.204
	NAT	0.010	0.037	0.260	0.794	-0.063	0.083
	CONSTANT	50.287	24.688	2.040	0.042	1.899	98.676
NAT							
	SALE	1.143	0.013	87.140	0.000	1.117	1.168
	IND1	844.223	446.415	1.890	0.059	-30.734	1719.180
	IND2	-653.378	508.915	-1.280	0.199	-1650.834	344.078
	IND3	**Dropped to avoid Multicollinearity**					
	IND4	963.701	400.712	2.400	0.016	178.320	1749.081
	IND5	-1016.955	412.888	-2.460	0.014	-1826.200	-207.710
	IND6	1920.518	490.302	3.920	0.000	959.545	2881.492
	IND7	1651.450	496.322	3.330	0.001	678.676	2624.223
	IND8	1486.174	426.372	3.490	0.000	650.501	2321.847
	IND9	770.608	408.045	1.890	0.059	-29.146	1570.362
	IND10	798.511	454.294	1.760	0.079	-91.888	1688.910
	CONSTANT	-1564.094	409.486	-3.820	0.000	-2366.671	-761.518
SALE							
	INVT	-1.556	0.580	-2.690	0.007	-2.692	-0.420
	COGS	1.084	0.103	10.560	0.000	0.883	1.285
	NAT	0.321	0.079	4.050	0.000	0.166	0.476
	CONSTANT	377.376	84.111	4.490	0.000	212.522	542.230
Equation	**R-sq**				**Equation**	**R-sq**	
EBITDA	0.713				**NAT**	0.856	
INVT	0.821				**SALE**	0.927	

4. Discussion of Results

4.1 Summary Results

Table 1 contains the definitions of the basic variables used in the paper. Values are measured in millions of dollars. Panels B and C of Table 1 contain summary statistics of the basic variables used. An average firm in the capital goods sector had about $4.6 billion in total assets (95% CI $3.8 - $5.3 billion). It earned about $477 million (95% CI $409 - $545 million) before interests, taxes, depreciation and amortization while spending $2.8 billion (95% CI $2.4 - $3.2 billion) to produce, distribute and incur other necessary expenses for the goods that the sold. Average sale of capital goods producing firm was $3.9 billion (95% CI $3.3 - $4.4 billion). That firm also carried about $555 million of inventories of which $237 million was an inventory of finished goods, and the rest was distributed in raw materials and work in progress.

Panel D of Table 1 shows that amount of inventory carried varies widely across different industries. An average firm in the Aerospace and Defense industry carried about $847 million of inventory while that in the office equipment and supplies industry carried only $68 million of inventory. Other industries like trucks and parts ($386 million), electrical equipment ($435 million), diversified machinery ($666 million), etc. differed considerably regarding the average inventory that a representative firm in that industry carried. The differences in the amounts of inventories carried in different industries are quite expected given the differences in their product offerings. For example, aviation parts may be more costly than steel fixings routinely used in office furniture.

Clearly, inventories represent a considerable fraction of the total assets of the firms (Panel C of Table 1). The contribution of inventories in total assets is about 18.2% (95% CI 17.5% - 18.8%) for the overall capital goods sector. The corresponding shares are 24.3% (95% CI 20.5% - 28.1%) in aerospace and defense, 12.8% (95% CI 10.6% - 15.1%) in metal and glass containers, 20.3% (95% CI 19.1% - 21.5%) in electrical equipment, 11.3% (95% CI 8.3% - 14.3%) in engineering and construction, 13.3% (95% CI 12.3% - 14.4%) in diversified manufacturing and nearly 17% (95% CI 14.2% - 19.9%) in office equipment and supplies. More details about other industries are presented in table 3.

The composition of inventory carried by different firms in different industries varies considerably (Panel D of Table 1). Overall, about 43% of the inventories are tied up in finished goods, and that fraction varies greatly across industries. For example, the corresponding numbers are 15% in aerospace and defense, 59% in metal containers, 3.7% in engineering and construction, 55% in diversified machinery and 58% in office equipment and supplies. These differences possibly point to the strategic importance of inventories in different industries. Since technologies often change very fast in technologically evolved sectors hence, these sectors are also expected to carry a smaller fraction of finished goods. On the other hand, industries in which products are more commoditized are also the ones that are expected to carry a larger volume of finished goods since those finished goods are not expected to be obsolete in the near term.

About 30% of the inventory is in work in progress in the capital goods sector. That number is also different across different industries. The corresponding numbers are 61% in aerospace and defense, 13% in trucks and parts, 7.6% in electrical equipment, 32% in diversified manufacturing, 29% in metal fabrication, and 9.3% in office equipment and supplies. These differences point towards the different nature of the ordering and production cycles in different inventories. Naturally, aerospace and defense industries are characterized by some of the longest production cycles.

Panel E of Table 1 reports the number of days on inventory carried by different firms. Overall, a representative firm in the capital goods sector carries about 63.7 days of inventory (95% CI 61-66.4 days) at hand. The corresponding numbers are 98.5 days in aerospace and defense (95% CI 79.9 – 117.1 days), 50.4 days in trucks and parts (95% CI 46.4 – 54.5 days), 29.9 days in engineering and construction (95% CI 21-38.5 days), 75.3 days in diversified machinery (95% CI 65.7 – 84.9 days) and 43.3 days in office equipment and supplies (95% CI 35-51 days).

4.2 Full Sample and Industry Specific Regression Results

Table 2 contains the full and industry specific sample regression results. Panel A of Table 2 contains the full sample results, and Panel B contains the industry-specific results. The key purpose of the full sample regression measures the impact of inventory holding for the entire capital goods sector. This regression controls for the firm size (as measured by the size of its total assets, sales, and cost of goods sold) and the industrial category that the firms belong to. Overall, each dollar of inventory held increases EBITDA by about 21.7 cents (95% CI 2.8 – 40.7 cents). This is significant at 5% level. Considering that an average firm holds over $554.8 million of inventory, it seems that the EBITDA in the capital goods sector may be higher by about $120.4 million per firm. Taking into account the 95%

confidence interval of the coefficient estimate, the number could be as low as $15.53 million or as high as $225.76 million.

Other variables seem to have a predictable impact on firms' earnings. Each dollar of inventory adds to about 3.2 cents to firms' earnings while each dollar of sale adds about 24.7 cents. Every dollar spent in the producing and distributing the goods sold reduces earnings by about 28 cents. These results point to the positive effects of assets and sales on firms' earnings and the negative effects of cost of goods sold on firms earnings.

To avoid multicollinearity among the dummy variables, dummy for trucks and parts are dropped from the full sample regression and other industries are compared against that benchmark. Therefore, compared to trucks and parts and keeping other relevant variables constant, EBITDA is higher by $211 million in aerospace and defense, $401 million in metal and glass containers, $91.63 million in engineering and construction, $133.75 million in diversified manufacturing and $3.67 million in office equipment and supplies. However, compared to the same benchmark, it is $32.95 million lower in the electrical equipment industry.

The full sample results point to the credibility of treating inventory as an asset in a traditional accounting statement. However, given the differences between industries, it is important to ask if inventory has a positive impact across all industries. That is why separate regressions are performed for each industry and the contribution of each dollar of inventory on firm earnings is calculated and presented in Panel B of Table 2.

Each dollar of inventory leads to about 7.6 cents of loss of earning in the aerospace and defense industry. In other words, an average firm loses about $64.39 million in the aerospace and defense industry because it carries about $847.2 million in inventory. The carrying of inventory also leads to financially negative outcomes in engineering and construction and metal fabricator industries. Each dollar of inventory leads to a loss of 10.7 cents of earnings in engineering and construction and 18.1 cents of earnings loss in metal fabricators. Considering the amount of inventory carried by an average firm in those industries, representative firm loses about $71.37 million in engineering and construction and $80.76 million in metal fabricator industry.

In some industries, carrying inventory is financially beneficial to the firms. For example, in diversified machinery, each dollar of inventory contributes about 28.3 cents to the earnings and in specialized manufacturing; each dollar of inventory contributes about 14.7 cents to firm earnings. Considering these marginal impacts and factoring in the volume of inventory carried by the firms in those industries, an average firm adds $188.6 million and $71.67 million in diversified machinery and specialized manufacturing respectively.

Carrying inventory has a no statistically significant impact on earnings in trucks and parts, metal and glass containers, electrical equipment, diversified manufacturing and office equipment and supplies. Although not statistically significant, each dollar of inventory leads to 43.1 cents of earnings loss in trucks and parts and 22.8 cents of earnings loss in metal and glass containers, 21.5 cents of earnings gain in electrical equipment, 0.96 cents of earnings gain in diversified manufacturing and 61.1 cents of earnings gain in office equipment and supplies.

Industry specific regression results point to the heterogeneous role that inventories play in the context of different industries. In some cases, holding inventory is economically beneficial (like diversified machinery, specialized manufacturing, etc.) and in others, inventory holding is financially disadvantageous (like in aerospace and defense, metal fabricators, etc.)

4.3 Results from the Estimation of System of Structural Equations

Results from the system of structural equations are presented in Table 3. It is found that every dollar of inventory contributes about 7.8 cents to firm's earnings although this amount is not statistically significant. However, every dollar of assets other than inventories contributes about 8 cents [95% CI: 4.7 to 11.2 cents] towards firm earnings. This result is statistically significant. It is also found that every dollar of SALE contributes about 12 cents [95% CI: 3.7 to 20.4 cents] to additional inventory holding while the same dollar of SALE contributes $1.14 [95% CI: $1.12 to $1.17] in additional assets that are not related to inventories.

It is important to note that the main channel through which earnings of the firms get affected stems from the dynamics of SALE and NAT. Other things remaining constant, every dollar of NAT contributes about 32 cents to additional SALE [95% CI: 16 to 48 cents]. This result is statistically significant and financially very important for the firm. Combining the effects of NAT on SALE and SALE on NAT it is found that every dollar of NAT creates an additional stream of 36.9 cents of NAT through the SALE channel. (Note 6) Also, note that NAT does not have any statistically significant impact on INVT.

Another vital insight comes from the effect of INVT on SALE. Note that this effect is negative. In other words, every additional dollar of INVT depresses SALE by almost $1.56. This effect is not only quite large, but it is statistically significant also. Furthermore, every dollar of COGS leads to an additional $1.08 in SALE. These two results can be interpreted quite easily. Higher costs of goods sold leads to higher sales presumably because of the market power that the firms in the capital goods producing industry enjoy. Higher input prices can be easily passed through to the buyers if the firms in the market enjoy market power. Note that market power is highest if a firm enjoys a monopoly in the market and lowest in the case of perfect competition. The market power of firms declines as the number of firms increases.

On the other hand, INVT and NAT are substitutes. Higher sales also lead firms to acquire more inventories, but that also take valuable resources away from NAT. Some of the crucial elements of NAT may be helpful for the firms to buy advertising, afford a better production line, offer competitive financing deals to their buyers, take more responsibilities as far as the warranties are concerned, etc. All these activities are helpful towards increasing the earnings of the firms, and they also help them gain a competitive advantage in the market.

Instead of investing in tangible assets and engaging in sales enhancing activities, the higher holding of inventories may be limiting a firm's potential to engage in the financially beneficial activities. This may have a depressing effect on the sales that may in turn adversely affect NAT and hence, EBITDA. This result may be derived in the following way: A dollar of additional inventory reduces SALE by $1.56 which in turn has a negative impact on NAT to the tune of $1.78. Since every additional dollar of NAT contributes about 8 cents to EBITDA, a negative impact of $1.78 reduces EBITDA by about 1.42 cents. *In a nutshell, although inventories do not affect EBITDA directly, they might adversely affect EBITDA through the asset channel*.

This insight assumes significance for several reasons. There is no doubt that inventories are valuable resources to the firms. Also, it is indisputable that inventories offer valuable cushion during demand spikes and allow firms to maintain well-stocked shelves and gain a competitive advantage in the market. However, accumulation of inventories, besides being costly activities by themselves, also crowds out investments in other assets that may boost the financial fortunes of the firms. For example, consider two firms; one has well-stocked shelves, and another offers customers three months same as cash option but carries lower stock of inventories. Both of them are costly activities, but the same as cash option partially subsidizes the cost to the customers as they do not have to pay right away and use their resources for other alternative purposes. That does not mean that the same as cash firm loses money on the deal. By being able to demonstrate to the suppliers by its larger base of non-inventory assets, the same as cash firm convince to pay them in three months without much penalty. Such deals may be difficult to strike if the firm does not have enough assets as backups. Assets tied up in inventories may not be very convincing for getting good deals from the suppliers as suppliers may suspect the firm's ability sale if there is a large stock of inventories.

5. Concluding Remarks

Inventories, traditionally treated as assets in traditional accounting statements, may have a complex range of effects on earnings and hence, shareholders' equity. This paper studies the impact of inventories on earnings and shareholder equity for different industries in the capital goods sector in the U.S. It does so by analyzing 1265 firm-year data for the years 2009-2012. Simple regressions indicate that an additional dollar of inventory contributes about 21.7 cents to corporate earnings in the US capital goods sector.

However, the effects of inventories on corporate earnings are not uniformly positive in the simple regression framework. While inventories make a positive impact on diversified machinery, aerospace and defense, and specialized manufacturing, they have a negative impact in engineering and construction and metal fabricators. Differences in results raise significant confusion about the actual effects of inventories on corporate earnings and do not address the co-determination of some endogenous variables like corporate income, sales, inventories, etc.

The system of structural equations helps us disentangle the effects of inventories on corporate earnings into two main channels: a *direct* channel and another *indirect* channel that works through sales and assets that are not inventory related. These structural equations provide a far more granular view of the relationship between several endogenous variables like corporate earnings, sales, inventories and assets that are not inventory related and other exogenous variables like industry types and input costs. It is found inventories do not have any statistically significant impact on earnings through the *direct* channel. However, every additional dollar of inventory reduces corporate earnings by as much as 1.61 cents when the asset (*indirect*) channels are taken into consideration. Overall, it seems that carrying inventories may be depressing corporate earnings in the capital goods sector of the US economy.

The final result that inventories may lead to lower corporate earnings raises non-trivial questions about the economic attractiveness of inventories. It may be noted that inventories are not the only (potentially) *costly* assets. There are other examples of such costly assets in the standard accounting statements like accounts receivables. For every dollar that the firm has in accounts receivables, it loses money because of that non-receipt. Furthermore, a firm may have to pay to its suppliers even though its customers are late in paying. That might mean that firm might have to borrow or maintain higher cash balances.

It may be interesting to note a potential inconsistency that might be stemming from the current accounting practices. This concerns the treatment of inventories vis- à-vis research and developments (R&D). R&D costs are expensed, and intellectual capital gained through R&D does not get accounted as assets on firm's balance sheets. This is despite the fact that intellectual know-hows are often more potent growth sources than finished products or products in the making. This may be creating a distortionary bias in the accounting statements. It is difficult to sustain the position that inventories (even if they are not accretive) are assets while R&D projects with game-changing knowledge benefits are considered expenses even though firms can potentially capitalize it. Such discretionary (and potentially distortionary) accounting practice may not be consistent with the information economy that we live in. Thus, current accounting practices may be more suitable for economies with mostly products and commodities and very slow or non-existing technological progress.

It may be easier to think about all inventories as expenses since recovery of these expenditures may be driven by a host of variable factors including technological change, stochastic demand situations, changes in consumer tastes and preferences, and volatile economic situations. This proposed treatment might help bring accounting treatment of inventories closer to the operative treatment of inventories. Thus, accounting treatment of inventories may be more in synch with lean inventory and supply chain management practices. It may also provide managers with the right kind of incentives to fine tune their inventory holdings and not artificially increase the asset side of the firm even if it is costly in net terms.

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Notes

Note 1. These figures are based on calculations performed on the firm level data collected from COMPUSTAT. More details are available from the data and methods and results sections. Refer to Table 1 for more details.

Note 2. This numbers are easy to derive given the results presented in Tables 1 and 2. Details of how these tables are derived are presented in the data and methods section below.

Note 3. These results can be derived from using numbers in Table 3 using the following calculation:

(-1.556*1.143*0.010*0.080)+(-1.556*0.121*0.078). More details are available in the results section below.

Note 4. It is important to note that the rate of physical depreciation is not the same as the rate of accounting depreciation. For an example, a building may have a useful physical life of fifty years of rendering economically meaningful services to a firm but that building may be fully depreciated from an accounting standpoint is ten years. Just because the building is fully depreciated in ten years from an accounting standpoint that does not mean that the building ceases to exist. It is still an asset to the firm and may be sold way past its fully depreciated accounting life adding gains to the firm’s income statements.

Note 5. This aspect is beautifully captured in the popular novel "The Goal: A Process of Ongoing Improvement" by Eliyahu M. Goldratt (Author), Jeff Cox (Author), David Whitford (Contributor), North River Press; 25 Anniversary Revised edition (June 2012)

Note 6. Note that every dollar of NAT leads to 32.1 cents of additional SALE and every dollar of SALE leads to $1.143 of additional NAT. Hence, every dollar of NAT leads through SALE channel additional (0.321)*(1.143)=0.367 of additional NAT.