Working Capital and Profitability—Establishing the Causality

Tapan P BAGCHI[1]

Abstract: Working capital (WC) management has a marked impact on the liquidity of a firm. It is also widely observed that WC is closely associated with profitability—declared by many correlation studies. Furthermore, the financial performance data of scores of manufacturing, trading and service firms indicate that a negative relationship seems to exist between the constituents of WC—inventories, accounts receivable, cash and bank deposit and accounts payable—and the firm's net operating profitability (NOP). However, such inferences are almost all correlation-based—a statistical procedure that quantifies association but does not establish causality. The present study takes a different path to probe this conjectured dependency—it sets up a first-principles model and statistical experiments. The model is crafted to represent the cost of net working capital with which the factors hypothesized to be influencing NOP can be varied systematically and the consequent effect on it examined. Thus conducted, the results establish statistically valid affirmation of causation of WC, if any, on NOP. We conclude, unlike earlier studies, that there is no exclusive prescription for managing WC to raise NOP, as "it depends!"

Keywords: Working Capital, Profitability, Causality, Economic Cost Modeling, Statistical Experiments

1 Profitability and Working Capital

A firm's ultimate objective is to maximize profit or the wealth generated for its stakeholders, by conducting its operations in the most prudent manner. Wal-Mart's ways in this regard have been unique. In order to generate *additional* profits for itself it has been innovative and counter-conventional. With a daily revenue of $1.2 billion (2012), Wal-Mart currently maintains accounts payable (AP) of $30-40 billion, while its accounts receivables are close to $4 billion. Accounts payable is the amount that Wal-Mart is yet to pay to its suppliers for the inventory it has purchased, while accounts receivable (AR) is the sales revenue that Wal-Mart is yet to collect from its customers. Wal-Mart's "Every day low price!" to raise profits has an enabler--"Delay payments; Collect cash from customers immediately!"—a strategy that frees up a great deal of cash with which it finances its short term operations. To be fair, this strategy is not for everyone. Wal-Mart has been able to maintain the wide difference between payables and receivables because of its influence over the suppliers and the brand image that it has built over the years. For its business, those high payables balances now allow Wal-Mart to hold significant cash and bank deposit that it can invest in its *own* business or that can earn interest. Significantly, by managing its working capital this way, Wal-Mart earns over $2 million per day based on earning a modest 3% annualized return on $40 billion of cash *yet to be paid* to its suppliers.

Furthermore, other than AP and AR, Wal-Mart manages yet another component of WC smartly. It holds inventories that are only 8-10% of its annual sales. Thus it

[1] Director, NMIMS University's Shirpur Campus, Shirpur, MH India 425405 tapan.bagchi@nmims.edu

rotates its entire inventory almost every month. Such action further reduces net working capital (the accounting term defined as the difference between current assets and current liability, or Cash and bank deposit + Accounts Receivable + Inventory – Accounts Payable) for Wal-Mart, freeing up additional cash for investment. As a way to maximize shareholders' wealth Wal-Mart acknowledges this mode of its conducting business as a *formal strategy* as follows:

> "We generally operate with a working capital deficit due to our efficient use of cash and bank deposit in funding operations and in providing returns to our shareholders in the form of stock repurchases and the payment of dividends." (Walmart 2012).

Thus, in practice, by applying good leveraging, Wal-Mart orders goods that it is supposed to pay for within 30 days. However, working efficiently, by the sixth or seventh day Wal-Mart already puts those goods on the shelves of its stores across the country. Typically, by the twentieth day, they are all sold and the cash collected generates a profit in the process—all before Wal-Mart has *paid* a penny to the supplier. Thus, it doesn't really need to have enough cash and bank deposit on hand to pay all of its accounts payables. As long as the transactions are timed right, Wal-Mart can pay each bill as it comes due, which maximizes its own efficiency. This total process as we shall see later generates a *negative working capital* for Wal-Mart.

Several things are to be noted in this example. A negative working capital is a sign of managerial efficiency in a business that has developed highly favorable accounts payable arrangements for itself, and also low inventory, and low accounts receivable (operating on an almost strictly cash basis). Clearly this is workable for a firm with the reputation and market clout comparable to Wal-Mart's. In any other situation, large payables are a sign that the firm may be in serious financial trouble. Still, be that as it may, it raises an intrigue—how does negative working capital impact a company's bottom line? If this effect can be proven to be advantageous, it would impel any firm's policy makers to create conditions so one may indeed strive to sustain negative working capital.

Liu and Wang (2011) recall that working capital is the amount of money that a firm needs to stay in business. They go on to observe that Wal-Mart actually needs no working capital because it negotiates deals in such a way that it pays for things it buys up to 3 months after buying it. Most of the time, the stuff it buys is long sold by then. Customers who come to Wal-Mart to buy stuff will pay on delivery, which means that Wal-Mart is actually sitting on a pile of cash and bank deposit that it really does not own. Thus emerges the concept of Negative Working Capital. Thus, a firm that takes money immediately, and pays its debts slowly, it can make additional money by investing the money it has collected but not paid out yet. On the flip side, a poor supplier of goods to Wal-Mart will need lots of money just to keep its business running, for it needs to at least pay salaries and wages to its employees before it gets paid by Wal-Mart. So here the supplier would need to arrange for a working capital loan to sustain his *own* business.

A firm's *operating cycle* typically comprises three activities—purchasing resources, producing the product, and distributing (selling) the product. These activities create in/out flow of funds that are both unsynchronized and uncertain.

These flows are unsynchronized because cash and bank disbursements often occur before collection of receivables. And uncertainty enters here because future sales and costs cannot be forecast with complete accuracy. These factors make the prudent management of the circulating capital a major challenge while sales are sustained, and at the same time too much money is not tied up in business.

That there is an observable *association* between working capital, and more specifically, between net working capital (NWC) and a firm's profitability, has been reported by several authors (Shin 1998, Deloof 2003, Kithii 2008, Gill et al. 2010, Rahman 2011, Ashraf 2012, Napompech 2012, Owolabi et al. 2012, Ray 2012,Arora 2013, Korankye et al. 2013). However, almost all of these studies were either descriptive or they merely computed correlations between NWC and profitability and then went on to say that NWC "impacts" or "affects" profitability, thereby implying *causation*. Such implication is quite far from being valid. Correlation *does not* imply causation (Bernard 1982, Holland 1986). Indeed as Holland notes, no causation can be detected without manipulation. Such deliberate manipulations are the subject covered by statistical design of experiments, where the object is to test the hypotheses that certain factors are indeed causes of the effects observed.

The study by Liu and Wang (2011) uses ANOVA to draw inferences about causation. However, this too is not satisfactory to suggest causation. Northcott (2008) has invoked a substantial amount of statistical theory to state that *ANOVA is formulated purely in terms of actual data, and essentially just tracks patterns of correlation within that data. Similar criticisms apply to related statistical measures, such as r^2, heritability, and others—all defined, broadly speaking, in terms of ratios of variances of actual data (Northcott 2005; Pigliucci and Kaplan 2006). Such statistical techniques are consequently all unsatisfactory measures of causal strength*.

This study, therefore, takes a different path to probe such causality between WC and profitability—it sets up statistical experiments in which the factors hypothesized to be influencing NOP are varied systematically while the consequent effect on the response—NOP—is examined. Thus done, the results would establish statistically valid affirmation of causation of WC, if any, on NOP (Montgomery 2013).

We conduct this cause-effect inquiry by first developing an analytical model for the cost of working capital—from first principles. Next we conduct certain L_8 statistical experiments with it to probe causalities if any (Montgomery 2013). We begin by defining below key terms used later in this paper.

Inventory

Inventory must be visualized as stacks of money sitting on forklifts, shelves, pallets, storage tanks, trucks, tankers and planes while in transit. At minimum, this money is not earning any interest, nor is available to be immediately invested in some profitable venture. So, a firm should try to get all inventories down as far as possible. However, inventory serves some vital purposes—it de-couples systems working in tandem, or helps one cope with uncertainty (Chase et al. 2006). In financial terms, inventory constitutes a key component of working capital and its prudent management reduces the risk of work or supply stoppages. It also ensures good customer service—thus improving profitability of the firm through higher sales. In accounting, inventory is measured as the appropriate monetary value of the goods being held in stock. For raw material inventory it is the FOB price paid at purchase, while for finished goods it is generally the cost of goods sold. A typical arrangement of inventory management at a retail store is described by Danuri et al. (2011).

Cash and bank deposit

Firms, particularly small businesses, frequently suffer due to lack of money, for they need operating cash and bank deposit to pay bills, wages, etc. and for unforeseen expenses while conducting day-to-day operations. Thus without the requisite liquidity on hand a firm can come to a quick, brutal end. On the first day of the month cash and bank deposit available is the "cash and bank deposit on hand." Then as sales occur, deposits are made, standing orders are paid and cheques are written. Thus cash *flows*—it comes in and goes out—with money left over at the end of the month. This balance cash and bank deposit carries over to the next month. Other than holding only raw cash and bank deposits, a firm may put extra cash also into marketable securities, easily convertible to cash if needed. Cash flow management aims at avoiding cash and bank deposit flow gaps between the outgoing and incoming cash—throughout the life of the business. While time rolls on, in order to survive and grow the firm must strive to keep cash flowing while it chases sales targets, expands, hires and fires employees and pays taxes. And with cash flow tracking, a firm can pinpoint when it requires money, perhaps a loan, without which it can go out of business. If money is tied up in inventories or uncollected receivables, then there may be profit on paper but no cash on hand to finance current operations. In such instances firms strive to turn inventory quickly or settle outstanding receivables to free up some cash.

Furthermore, cash flow and profits are not the same thing. Cash flow tracks money that comes into the business and that goes out. Its management aims at having sufficient cash and bank deposit to service the firm's financial obligations in a timely manner. This is ensured by having optimum liquidity. *Profits* on the other hand are the money left over from sales and other transactions known as income (and indicated in the firm's annual profit and loss statement) after taking care of all expenses incurred in that year. *Profitability* is the return generated on the firm's assets or equity.

Accounts Payable

Accounts payables (AP) are created by credit purchases—for buying goods and services for which payments are not immediately made to suppliers. Generally this relies on mutual trust and the reputation of the firm. In cash and bank deposit management creditors form a vital part and a firm generally attempts to slow down cash payments to creditors and pays them as late as possible, consistent with its own credit standing with suppliers. This allows the firm to make most efficient use of the money it already has. Expanding AP has the general effect of reducing the firm's working capital requirement.

Accounts receivable

Accounts receivables (AR) are created to attract customers, for these allow customers to assess product or service quality and to enjoy its consumption before paying. Such arrangement generally increases sales, though it requires the firm to recover the receivables later, and possibly also incur bad debts that are never paid back. Slow payment by customers indeed may cripple the firm, to minimize which it may set up credit sale policies. Expanding AR has the general effect of raising working capital requirement.

Bank deposits

Bank deposits are extra cash kept either in current accounts in a bank or in certificates of deposit. These are a component of current assets of the firm, available for payment of AP as they become due and all other operating expenses. In the context of working capital, bank deposits are a part of current assets.

Risk and liquidity

Kithii (2008) notes that certain *costs* are incurred with excesses and also with shortages of working capital. In this respect, the goals of the firm become dual—(a) managing the cost of the excesses, and also (b) ensuring sufficient liquidity to meet of all current expenses including petty payments to allow all operations to continue without interruption. The latter goal aims at minimizing the risk of not being able to sustain routine and running operations (Owolabi et al. 2012). Management of liquidity—funds immediately available to meet such expenses while keeping excesses in control—affects profitability and is akin to maintaining the optimum amount of safety stock in inventory management (Hofmann 2005). This is so because such short term cash and bank deposit requirements randomly fluctuate—like customer demand for finished products—imposing uncertainty and the risk of running out of liquid funds (Chakravarty 2009).

Working Capital

Working capital (WC) is the money needed to fund the normal, day to day operations of a business. WC ensures that the firm has enough cash to pay its debts and expenses as they fall due. Net working capital (NWC) is the difference between current assets and current liabilities. If the former is less than the latter, then NWC is negative. A firm that generates negative working capital is using supplier credit as *a source of capital*. Wal-Mart and Dell do this as regular strategy to grow. However, supplier credit is generally not free. Delayed payments of bills may lead to loss of cash discounts and other price breaks. Thus it would be prudent to compare costs of WC to the interest paid in traditional borrowing. Furthermore, a negative non-cash working capital is often viewed by rating agencies as a source of default risk, which may lead to the firm's incurring higher interest rates on loans that it takes. Still, negative net working capital can sometimes be good for a firm, as we do find later on. Since current liabilities are money owed but not paid, the firm here is effectively using other people's money to finance its day to day operations (Lardbucket books 2012).

Working Capital (or Operating) Cycle

As Bose (2013) describes, a firm can improve its profits if it can translate the cash outflow into inflow from operations within the same operating cycle. Otherwise it will have to borrow to raise working capital. The twin goals of profitability and liquidity must therefore be synchronized. Investments in current assets cannot be avoided for one must ensure smooth delivery of goods and services to customers. However, to support sales if cash is blocked, say be extending credit to customers, this will lengthen the cash operating cycle. Extending credit may increase profitability by those extra sales, but it may also hurt profitability due to the cost of funds that remain tied up in granting credits (AR, a part of working capital) or in higher inventory (to improve customer service), while lowering liquidity (the risk of not being able to pay all bills that come due in the cycle).

Cash and bank deposit Conversion Cycle (CCC)

It is possible to track and measure the efficiency of a firm in managing corporate liquidity—inventory, accounts receivable and accounts payable. The measure is *cash and bank deposit conversion cycle* (CCC), which indicates how long the firm's cash is tied up in working capital. Cash gets tied up between the expenditure for the purchase of raw materials and the collection of sales of finished goods. Having encountered this, some firms have not only reduced CCC to zero (0), but have also made it negative, generating what is called *negative working capital* for the firm. In the lingo of finance, CCC is the theoretical amount of time between the firm spending cash and bank deposit to purchase goods or services from vendors and receiving cash from customers when sales occur. Figure 1 is the enhanced depiction of the different cyclic physical, informational and monetary transactions that occur as a firm operates, sketched originally by Bose (2013). One measure of CCC *in days* is given by Owolabi et al. (2012) as

CCC = 365(Average Inventory/Annual Cost of Goods sold + Average Accounts Receivable/Annual Sales – Average Accounts Payable/Annual Purchases)

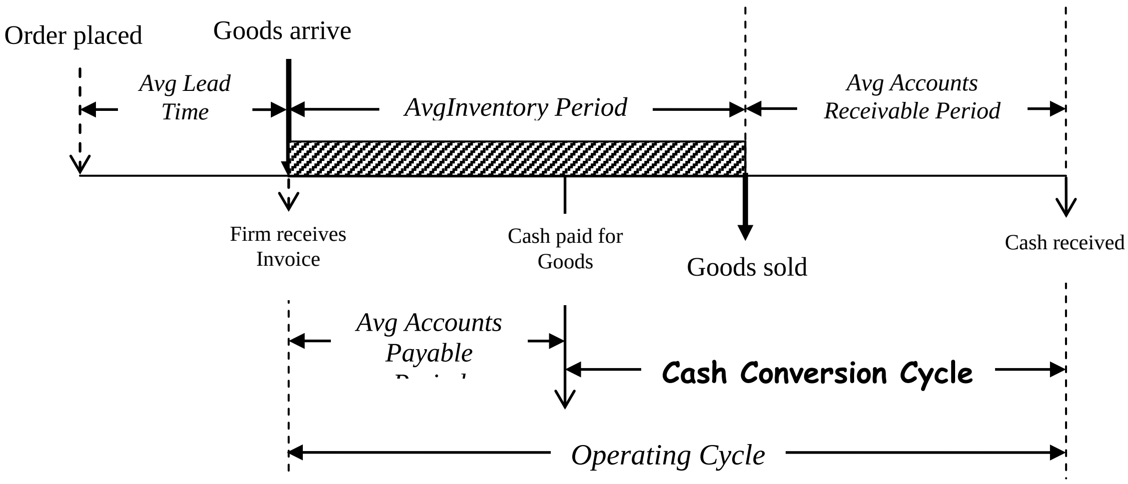

Figure 1 Cash Conversion Cycle

As stated, CCC can be positive, as well as negative. A positive CCC indicates the number of days a firm must tie up capital or borrow while awaiting payment form a customer. A negative CCC on the other hand quantifies the average number of days a firm's receiving cash collected from sales before it pays its suppliers. The firm that manages its working capital well in order to maximize its profitability aims for low CCC, and even negative CCC, to be efficient in managing its cash flow. As typical examples, Wal-Mart maintains CCC of 10 days, well below that of Target's 27 days but above CostCo's 4.5 days.

Profitability

A firm's Gross profit equals the Cost of Goods Sold subtracted from annual sales. Net Operating Profitability (NOP) is a measure of the firm's profitability, defined as (Operating Income + Depreciation)/ (Total Assets – Financial Assets). Hence for a given firm for which the impact of different policies that oversee working capital management is to be studied, tracking the impact of such policy changes on *Operating Income* alone would suffice, while all other quantities—depreciation and total and financial assets—are held constant.

2 Literature Survey

Financial experts remind us that the goal of working capital management is to enable a firm to maximize profits of its operations while meeting both short term debt and upcoming operational expenses. The latter is best done by preserving liquidity (Ashraf 2012). Firms that do it well are able to combat liquidity problems relatively easily. But whether working capital affects profitability is still being debated (Arora 2013). Intuition says that unless a minimum level of investment of working capital is there, sales cannot be maintained, thus lowering profits as fixed assets then become inoperative. On the other hand, some companies—the most cited examples being Wal-Mart and wireless communication and broadcasting firms—get down to operating with *negative* working capital; they run their business on other peoples' money. To probe this, till date, several *association* studies have been conducted that suggest that the result is mixed. Some sugar, cement and fertilizer industries show a *positive* relationship between working capital and profitability. Still other studies suggest that firms should avoid under-investment in working capital if they wanted higher profits. Others, cited below say the opposite.

Recent studies suggest that *negative* working capital can also improve profitability. Arora (2013), for instance, studied correlations to suggest positive association existing between negative working capital and profits—without, however, establishing *causality*. By observing correlation, Liu and Wang (2011) also detected association between these two variables and on the strength of this detection alone concluded *influence* (causality) and went on to conduct *regression*. Kornakye et al. (2013) used correlations to probe any possible impact that working capital management might showon profitability. Their study revealed that the *length* of the working capital cycle is negatively associated with the firm's profitability. This study cited the negative relationship between cash conversion cycle (Figure 1) and profitability, again only by observing correlation. Others who also studied this association also only by correlation include Kithii (2008), Gill et al. (2010), Chary et al. (2011), Ashraf (2012), and Bose (2013). Ashraf argues in favor of shortening the cash and bank deposit conversion cycle, however, again by invoking correlation and regression, but not by establishing causality. He cites Pearson's correlation coefficient as the basis of his argument, when statistical literature clearly states that correlation *does not* imply causality. As stated at the outset of this paper, correlation *does not* imply causation (Bernard 1982, Holland 1986). As Holland notes, no causation can be detected without manipulation. Such deliberate manipulations are the subject covered by statistical design of experiments, where the object is to test the hypotheses that certain factors (tested at different treatment levels) are indeed causes of the effects on the response observed.

More recent research has attempted to employ system dynamics modeling to set a conceptual platform to study any detectable association among the variables of interest (Lyneis and Reilly 1973, Thompson and Shreckengost 1984, Bivona 2000, Bianchi 2002, Bou and Satorra 2009). The inferences drawn here, however, generally are qualitative.

To the best of our knowledge, in respect to finding causality between working capital and profitability, empirical manipulations of decision variables that contribute to a firm's cost of employing working capital have not been attempted yet, so correlation-based assertions of causality such as those cited above cannot be accepted on their face value.

3 A typical business that employs working capital—a petrol pump

Operational details

This study aims at discovering the *causal* relationship between working capital and profitability, if it exists. In this respect, we probe whether the manipulation of working capital has a measureable effect on a firm's profits. Our approach combines modeling and experimentation (Montgomery 2013), the experiments being conducted with a model containing the operational essence of a running business that uses working capital retained in its various constituents—the current assets and current liabilities. This stance is taken in view of well-founded affirmation that correlation does not imply causality (Holland 1986). Such implication has been falsely asserted in several studies relating working capital and profitability, cited earlier in this paper.

To build such a model the representation of a firm significantly involving working capital needed to be adopted. Manufacturing firms would make excellent candidates here. Others to act as limited test beds would be service organizations. In between are businesses that buy stuff, inventory, and process it if needed, and then sell it to customers using some channels. Here the operational steps in-between would employ working capital. For the present, we chose a petrol pump that, to put simply, bought petrol from a gas company’s distribution depot, tank trucked to its own location, stored the petrol in tanks, pumped it into customer’s vehicles and collected cash. Working capital is engaged here from the moment petrol is put in the tanker at the distribution centre(accounts payable), the tanker runs on the highway to the petrol pump where petrol is unloaded into the pump’s storage tank (inventory), sold as demanded at the pump (accounts receivable), and finally cash collected.

The particular “pump,” an agency of a large petrochemical enterprise that sells petrol at retail level directly to customers was observed closely over three months by the authors. It is located at the outskirts of an urban locale on a national highway, with one pump servicing all drive-in customers. Only one grade of petrol is sold, the storage tank at the station being of 20,000 litre size. Tankers bring loads of 6000 or 12,000 litres of petrol in each trip, when ordered by the pump. The storage tank is fitted with a calibrated dip stick gage, the readings being converted into litres upon gaging. Each morning the tank is dipped, and on-hand inventory compared with an *informal* re-order level. When an order is to be placed, it is placed electronically on the distributing depot. Simultaneously a bank draft is electronically requested from the local bank to transfer the required money on-line to the gas company. Upon intimation of payment by the gas company’s bank, the distributor releases the tanker, which travels for about 4 hours to reach the pump, where it is unloaded.

To obtain the basic operational data the authors personally collected three months’ morning inventory numbers, tracked every tanker load received and recorded daily sales, all in litres. Table 1 displays the sales data. Figure 2 highlights its daily fluctuations while Figure 3 shows a histogram of the daily demand, which is nearly normally distributed. Subsequently, petrol’s purchase cost at delivery and selling price at the pump were noted in Indian rupees (रु, 1 US$ = रु 60). Other expenses were found to be fixed and allocated to sold litres. The pump station did provide some other services such as air, lube sale and tire repair etc. to customers on cash and bank deposit payment basis, but these amounts were insignificant when compared with petrol sales.

Overall the pump runs efficiently and owners cannot recall ever being out of stock. Petrol is bought at 75.35 रु/litre and sold at 80.02 रु/litre. The gas company pays a commission of 1.50 रु/litre to the pump owners, whose other expenses are estimated to be about 3.00 रु/litre, by the allocation of all “fixed costs”—rent, wages, utilities, maintenance, insurance, etc. The pump services customers in the conduct of its business very well even though no scientific basis of inventory management is employed.

Table 1 Daily Petrol Sales in Litres over three Months

1-Jun	3619	1-Jul	2896	1-Aug	1673
2	4661	2	2269	2	1908
3	6279	3	2505	3	3249
4	3023	4	2405	4	2059
5	3970	5	2432	5	2950
6	2917	6	2548	6	2829
7	3072	7	2255	7	2935
8	2960	8	3021	8	2419
9	2279	9	3052	9	2745
10	3187	10	2704	10	2455
11	3062	11	2395	11	2854
12	3677	12	2403	12	3551
13	3613	13	2866	13	2499
14	3290	14	2338	14	2905
15	3607	15	2157	15	2505
16	1616	16	3250	16	2576
17	2848	17	3657	17	2665
18	2318	18	3153	18	2636
19	3023	19	2563	19	4492
20	3056	20	2521	20	4351
21	2730	21	2390	21	2653
22	2271	22	2781	22	2818
23	2373	23	1794	23	1831
24	2943	24	1744	24	1889
25	2352	25	1932	25	2468
26	2803	26	2124	26	2830
27	2341	27	2253	27	2831
28	2845	28	1780	28	2728
29	2786	29	2796	29	2680
30	2156	30	2798	30	2975
		31	2210	31	2987

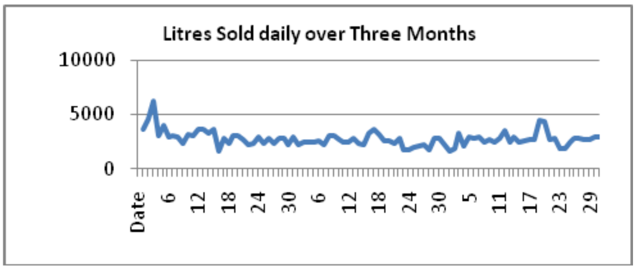

Figure 2 Daily Fluctuation of Petrol Sales

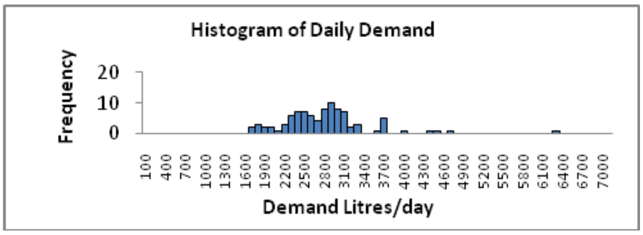

Figure 3 Distribution of Daily Petrol Sales

4 An Economic Cost Model of Profitability

The mission in this study is to help in managerial decision making in a firm in regard to its managing its working capital so as to maximize its profitability. One may intuitively acknowledge that both excess (say in inventories and accounts receivable) and shortage (say to support payables and of liquid cash and bank deposit to meet everyday expenses) are bad for a firm. Out of the two, shortage of working capital is more dangerous than taking steps such as extending credits to boost sales. To probe this issue quantitatively (and not just looking to find historical association or correlations) one would be advised to construct *economic cost models*. This is attempted in this section, starting with defining certain key terms as follows.

Net Cost of delaying Accounts Payable = π रु / AP rupee/day

This net cost equals the incremental increase in the cost of borrowing, loss of business, and the cost of foregoing discounts and the benefits from alternate uses of idle cash. This cost could include consequent lowering of the firm's credit rating—leading to raising the cost of borrowing money from financial institutions, or even loss of conducting favorable business with suppliers, or as stated, foregoing discounts caused by delayed payments made to suppliers, etc. Benefits of large AP are reduction in cash and bank deposit requirement to meet many current expenses.

Delaying AP is a strategy called *stretching* AP when it is accomplished without damaging the firm's credit rating. We observe that many CFOs intuit the benefits delaying AP to far outweigh the costs listed here; delaying payments for purchases is a common practice in many firms that attempt to free liquidity in-hand, to be utilized towards the payment of other current liabilities.

Net Cost of Accounts Receivable = ρ रु / AR rupee/day

Note that while operating with AR one is not only postponing receiving cash from customers, when ARs become large or are unacceptably aged while the firm needs cash on hand, but also one may have to *sell* the due AR at a lower value to a third party who bothers about collection—a method known as factoring.

Costs associated with AR are collection cost, capital cost, delinquency cost, and default cost (Khan and Jain 2007). On the other hand, there are benefits generated by operating with AR—increased sales due to extended credits, and anticipated profits due to sales retention. Such benefits increase profit. Indeed Khan and Jain state, “The objective of liquidity of receivables management is to promote sales and profit until that point is reached when the ROI in further funding receivables is less than the cost of funds raised to finance that additional credit.”

Net Cost of managing (holding + ordering) Inventory = σ ₹ / unit of inventory/day

Sustaining the cost of managing inventory (holding, then processing, or selling) and ordering materials in repeated order cycles is common in firms. The development of this cost will be illustrated below in a separate section.

Net Cost of holding Cash and bank deposit = η□₹ / rupee held as liquid/day

This would include opportunity loss of not putting cash and bank deposit on hand in risk-free investments, and any advantages of improved liquidity. Cash (and bank deposit) kept on hand is liquid and it helps the firm meet day-to-day expenditures. Such cash and bank deposit holding is akin to safety stock incorporated in raw materials or finished goods inventories. Here the Miller-Orr model of cash and bank deposit management (Miller and Orr 1966) or Baumol’s stochastic model (Gregory (1976) becomes relevant, which states that cash and bank deposit on hand should comprise an average cash demand plus a stochastic safety (buffer) amount.

The term “cost” in respect to the quantities π, ρ, σ and ηis used here as *generic constructs*. Each of these may be a true cost, leading to a *payment* to be made by the firm. These quantities may also represent benefits where the firm somehow *gains*. We retain this generality as we develop the economic cost model in this section.

The additional terms of relevance are defined as follows.

Annual Purchases = P ₹ /year

Cost of Goods Sold = COGS ₹ /year

COGS is total cost to produce the finished goods *sold during the year*. It comprises all costs (including AP for raw materials and services), conversion costs, wages, utilities, administration + any carry forward adjustment due to unsold inventory of goods held over from the previous year.

X_{AP} = average Accounts Payable in rupees over the year

X_{AR} = average Accounts Receivable in rupees over the year

X_{I} = average Inventory valued in rupees held by the firm over the year

$X_{\$}$ = average Cash and bank deposit in rupees held by the firm over the year

Annual sales = S = total revenue generated by selling goods in ₹ /year

Therefore, we shall seek a first principles expression in the form:

Total annual cost of working capital = $f(\pi, X_{AP}, \rho, X_{AR}, \sigma, X_I, \eta$□□ $X_{\$}$, P, S, COGS) (1)

The Cash and bank deposit Conversion cycle (CCC) in days is calculated from three dependent MIS “dashboard” variables as follows.

Days of sales outstanding (goods supplied but payment not received) averaged over the year = Average Accounts Receivable/ (Annual Sales/365)

Days of sales in inventory = Average Inventory/ (Cost of goods sold/365)

Days of Average Accounts Payables outstanding (bills received by not immediately paid) = Accounts Payable/ (P/365)

Hence, using the earlier notation,

$$CCC = 365(X_I/COGS + X_{AR}/S - X_{AP}/P) \quad (2)$$

Constraints on the decision variables (X.) are as follows:

$0 \leq X_{AP}$

$0 \leq X_{AR}$

$0 \leq X_I$ (assuming no backorders allowed)

$0 \leq X_{\$}$

We restate that the quantities π, ρ, σ and η are used in (1) as *generic constructs*. Each of these may be a true cost, leading to a *payment* to be made by the firm. But these quantities may also represent benefits where the firm somehow *gains*. We retain this generality as we develop the economic cost model in this section. Developing a model for the annual total cost of working capital/day from first principles would require working out two expressions, beginning with

Annual Operating Profit = Operating Revenue generated from Operations – COGS

= *g*(working capital and other decision variables and constraints) (3)

By definition, the net working capital (NWC) for a firm is given by

NWC = Current Assets – Current Liabilities

= Value of average Inventory held + Value of AR held

+ Value of Cash and bank deposit held and Bank deposits – Value of AP (4)

5 Derivation of the Annual Cost of Maintaining Working Capital

Now to determine the cost incurred by the firm over its *one* operating cycle, we need to focus on the cost over its *average inventory holding period only,* since the operating cycles overlap (Figure 4), and we must avoid “double dipping” or ignoring the costs of managing with AR, Cash and bank deposit and bank deposit and AP, where operationally, the different inventory holding periods get juxtaposed as idealized by Figure 4. Figure 4 lays out on the time line each such inventory holding period (inventory cycle in days) contributing its share to the total cost of maintaining the working capital—AR, Cash and bank deposit, AP and Inventory. In order to develop this we use the relationship COGS/XI = Inventory turnover per year. Hence XI/COGS = fraction (measured in year) covered by a single operating cycle (OC) of a full year. Thus $Cost_{NWC}$ over each operating cycle picks up cost contributions of each NWC constituent as follows. The cost contributions of each NWC component over *one operating cycle* (measured in year) are

Net Cost of holding Inventory per operating cycle = $365\ \sigma X_I \frac{X_I}{COGS}$

Net Cost of AR per operating cycle = $365\ \rho X_{AR} \frac{X_{AR}}{S}$

Net Cost of AP per operating cycle = $365\ \pi X_{AP} \frac{X_{AP}}{P}$

Net Cost of holding Cash and bank deposit and bank deposit per operating cycle = $365\ \eta X_\$ \frac{X_\$}{COGS}$

It may be shown that $X_I/COGS = X_{AR}/S = X_{AP}/P$.

Note that when we add the four above net costs, different operating cycles and hence their respective costs overlap (Figure 4), but these respective costs are incurred in *each* OC. Each operating cycle here indicates how cash and bank deposit, goods and information flow in each round of purchases, holding and selling goods—a process that repeats itself in every successive operating cycle. However, in each successive OC the business itself operates by placing order ahead of sales keeping in perspective the lead time, and transacts activities that produce income by the purchase, stocking and selling of goods *without any break in servicing customers*. Therefore,

$Cost_{NWC}^{OC} = Cost_{NWC}^{Inventory\ Cycle}$

= (Net Cost of holding inventory/unit/day × Average Inventory held over Operating Cycle × Average Inventory holding period in days)

+ (Net Cost of AR/rupee/day × Average AR held over Operating Cycle × Average days age of AR)

+ (Net Cost of AP/rupee/day × Average AP held over Operating Cycle × Average days age of AP)

+ (Net Cost of holding Cash and bank deposit and bank deposit/rupee/day × Average Cash and bank deposit held over Operating Cycle × Average Inventory holding period)

(5)

Therefore, the *Annual* Cost of holding net working capital

$$= 365\ \frac{COGS}{X_I}\left[\sigma X_I \frac{X_I}{COGS} + \rho X_{AR} \frac{X_{AR}}{S} + \pi X_{AP} \frac{X_{AP}}{P} + \eta X_\$ \frac{X_\$}{COGS}\right]$$

$$= 365\,[\sigma\, X_I + \eta X_\$] + 365\,\frac{COGS}{X_I}\left[\rho\, X_{AR}\,\frac{X_{AR}}{S} + \pi\, X_{AP}\,\frac{X_{AP}}{P}\right]$$

$$= 365\,[\sigma\, X_I + \eta X_\$] + 365\,\frac{COGS}{X_I}\left[\rho\,\frac{X_{AR}^{\;2}}{S} + \pi\,\frac{X_{AP}^{\;2}}{P}\right] \qquad (6)$$

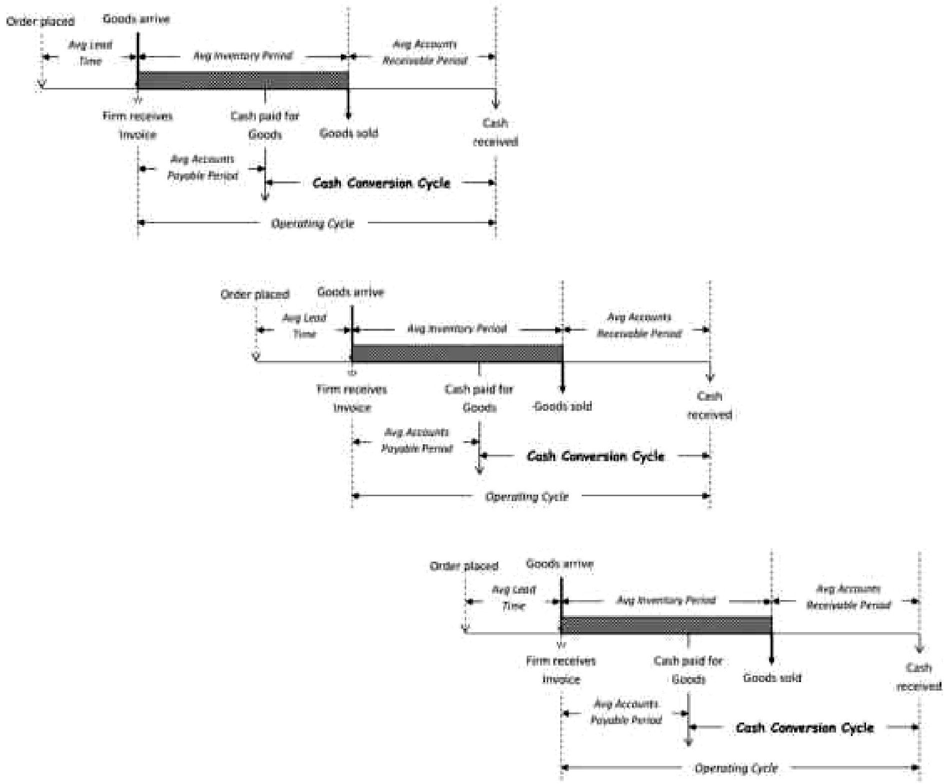

Figure 4 A firm's sequential juxtaposition of Inventory cycles to sustain customer service

6 Interpretation and Significance of Model

Equation (3) provides the general form of the expression for the firm's annual operating profit, a relationship for which the cost of working capital is derived and displayed in (6).

Equation (6) is a close form expression for the annual cost of holding net working capital—with the assumptions stated earlier. It is eminently clear that this annual cost is a *linear* function of average inventory X_I held by the firm, a *linear* function of cash and bank deposit and bank deposits $X_\$$ held by the firm, a *quadratic* function of the average accounts receivable level X_{AR} of the firm and a *quadratic* function of the average accounts receivable level X_{AP} of the firm. Model (6), forgiven values of X_I, $X_\$$, X_{AR} and X_{AP}, is a *linear* function of each generic cost parameters π, ρ, σ and η. Furthermore, (6) tells us that how changes in the four NWC components—X_I, $X_\$$, X_{AR} and X_{AP}—affect the firm's annual profit will depend on the relative values and *signs* (positive or negative) of the generic costs π, ρ, σ and η defined in Section 5. Assuming that they are all *positive* (i.e., cause the firm a "*cost*"), it would behoove the firm to minimize average inventory held, cash and bank deposit held, accounts receivables and accounts payables. Indeed it is easy to see that the most desirable values of AP and AR should then be both zero—"Have no payables and also have no receivables when $\rho > 0$ and $\pi > 0$!"However, this is not always true. For instance, if the money under payable (AP) can be invested by the firm to generate a higher return than the cost (η) of capital held as liquid, it would be smart to *delay* payments—for such benefits would rise *quadratically* proportional to the unpaid AP. Thus, not surprisingly, operating with a WC deficit is a strategy that sits close to the core of Wal-Mart's business (Walmart 2012). In fact, when X_{AP} is made really high, CCC given by (2) can become negative! In that case NWC given by (4) will also become *negative*. This last condition is what impels many firms to delay payments, and indeed use those funds to finance their own short term operational expenditures that generate higher returns and thereby improve overall profitability. Wal-Mart concedes this publicly.

Thus we have established the quantitative evidence that in some situations *it pays* to work with negative working capital, while in others *it may not*. In the section below we study the viability and the limits of this strategy—experimentally.

7 Experimental Setup for Parametric Study of Profitability

Expression (6) makes the study of the sensitivity of a firm's profitability to a variety of scenarios possible. For a firm these scenarios would possibly change based on the *values* and *signs* of the generic cost parameters, and X_{AP}, X_{AR}, X_I and $X_\$$. To study this we utilized (6) and invoked2-level orthogonal array (OA) computational experimentation (Montgomery 2013) to manipulate the factors involved—to check the causality hypotheses (Holland 1986).In the rest of this section we focus on describing experiments that established the impact of the different factors on the cost of net working capital (NWC). We chose here not to directly evaluate profits, assuming that annual sales revenue S remained constant for a firm. In the illustrative calculations the costs assumed were π = - 0.25 ₹/year/₹ AP = - 0.000685 ₹/day/₹ AP, ρ = 0.365₹/year/₹ AR = 0.001000₹/day/₹ AR, σ =0.3 ₹/year/₹ Inventory = 0.000822 ₹/day/₹ Inventory and η = 0.05 ₹/year/₹ Cash = 0.000137 ₹/day/₹ Cash. (Note that each ₹ held here in AP generates a benefit.)

To proceed we first tested the sensitivity of NWC to cost parameter settings, by holding X_{AP}, X_{AR}, X_I and $X_\$$ at fixed levels. To manipulate the "Experimental Factors" π, ρ, σ and η, we selected two reasonable working levels (settings or treatments), all values set symmetrically about the daily costs given above. For each factor the "high" setting was a higher daily cost value, the "low" setting being a similarly set other value. In the present case we used combinations of these settings to conduct the computational experiments with (6) as guided by the L_8 orthogonal array (Table 2) (Bagchi 1993, page 191). Each experiment (a row in Table 2) simulated a firm's operation when its cost parameters π, ρ etc. would exist as specified in that row, with the "response" NWC cost in each row computed by using (6). The results in the form of "factor effects" on NWC cost are shown in Figure 5. In all these experiments it was assumed that for the illustrative firm annual sales S were ₹500, COGS was ₹400 and annual purchases were ₹300. In a row, a positive quantity under the NWC column head would indicate a resulting *cost* (reduction in profit) whereas a negative quantity would indicate a *benefit* (increase in profit).

Figure 2, for the specific values of X_{AP}, X_{AR}, X_I and $X_\$$ values shown in Table 2, indicates that when π changes from ₹ -0.000342to -0.001027per day (now a benefit, for the sign is negative), it contributes a *reduction* in annual NWC cost (the cost line slopes down and becomes *more* negative). The other daily cost parameters—ρ raised from ₹ 0.000500 to 0.001500, σ raised from ₹ 0.000616 to 0.001027 and η raised from ₹ 0.000103 to 0.000171—each *increase* the annual NWC cost (each effect lines rises and becomes *less* negative). For the example shown, a higher numerical value of π (in this case its becoming more negative or beneficial to the firm) has the largest impact on reducing the annual cost of NWC. One infers from this that with such benefits (accruing when any of the costs π, ρ, σ or η is negative and becomes *more* negative), the firm gains by an increase in its net profitability.

Table 2: L_8 Experiments conducted by manipulating genetic WC costs π, ρ, σ and η

Experiment #	π	ρ	Σ	η	X_{AP}	X_{AR}	X_I	$X_\$$	NWC Cost ₹
1	-0.000342	0.000500	0.000616	0.000103	30.0	10.0	25.0	20.0	1.0
2	-0.000342	0.000500	0.001027	0.000171	30.0	10.0	25.0	20.0	5.2
3	-0.000342	0.001500	0.000616	0.000171	30.0	10.0	25.0	20.0	2.6
4	-0.000342	0.001500	0.001027	0.000103	30.0	10.0	25.0	20.0	5.9
5	-0.001027	0.000500	0.000616	0.000171	30.0	10.0	25.0	20.0	-10.5
6	-0.001027	0.000500	0.001027	0.000103	30.0	10.0	25.0	20.0	-7.3
7	-0.00102	0.001500	0.000616	0.000103	30.0	10.0	25.0	20.0	-9.9

	7								
8	-0.001027	0.001500	0.001027	0.000171	30.0	10.0	25.0	20.0	-5.6

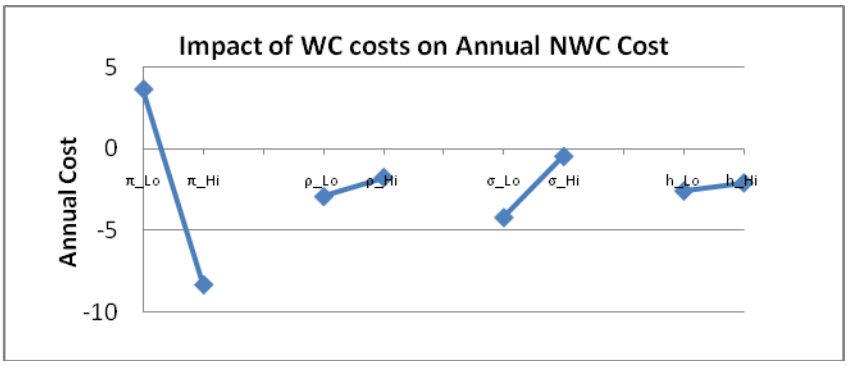

Figure 2 Sensitivity of Annual Cost of Net Working Capital to costs π, ρ, σ and η

Next the same study was repeated, with different inputs. This time the daily cost parameters π, ρ, σ and η were held constant at their mid-points of the first set of experiments, while X_{AP}, X_{AR}, X_I and $X_\$$ were manipulated to probe their causality on cost of NWC, each set at two different levels as guided by the L_8 array. Table 3 was thus created to guide these next set of eight computational experiments. The results are displayed in Figure 3. For the causalities detected, increase in accounts payable (X_{AP}) improved profitability (annual cost of NWC reduced) while an increase in average inventory (X_I) raised annual cost of NWC, hurting profitability. The other two components of NWC—X_{AR} and $X_\$$—did not significantly impact profitability for the particular cost values for π, ρ, σ and η selected.

Since the effects of X_{AR} and X_{AP} on annual cost of net working capital are quadratic as they appear in (6), it would be tempting to see this effect graphically. Figure 4 shows their joint effects—holding values of daily working capital costs π, ρ, σ and η stationary as shown in Table 3.

For any other situation experienced by a firm, the impact of the decision maker's adjusting the working capital components X_{AP}, X_{AR}, X_I and $X_\$$ may be assessed with the help of (6). To do this one would need to estimate the corresponding actual costs or benefits (π, ρ, σ and η) and then substitute those into (6).

One therefore *cannot* state in general that a reduction in investment in working capital always *raises* profitability as asserted by the studies by Liu and Wang (2011), Arora (2013), Bose (2013), Korankye and Adarquah (2013) and several others.

Table 3: L_8 Experiments conducted by manipulating Working Capital components X_{AP}, X_{AR}, X_I and $X_\$$

Experiment #	π	ρ	σ	η	X_{AP}	X_{AR}	X_I	$X_\$$	NWC Cost रु
1	-0.000685	0.001000	0.000822	0.000137	22.5	7.5	18.8	15.0	-1.7
2	-0.000685	0.001000	0.000822	0.000137	22.5	7.5	31.3	25.0	5.8
3	-0.000685	0.001000	0.000822	0.000137	22.5	12.5	18.8	25.0	0.3
4	-0.000685	0.001000	0.000822	0.000137	22.5	12.5	31.3	15.0	6.2
5	-0.000685	0.001000	0.000822	0.000137	37.5	7.5	18.8	25.0	-17.2
6	-0.000685	0.001000	0.000822	0.000137	37.5	7.5	31.3	15.0	-4.3
7	-0.000685	0.001000	0.000822	0.000137	37.5	12.5	18.8	15.0	-16.2
8	-0.000685	0.001000	0.000822	0.000137	37.5	12.5	31.3	25.0	-2.9

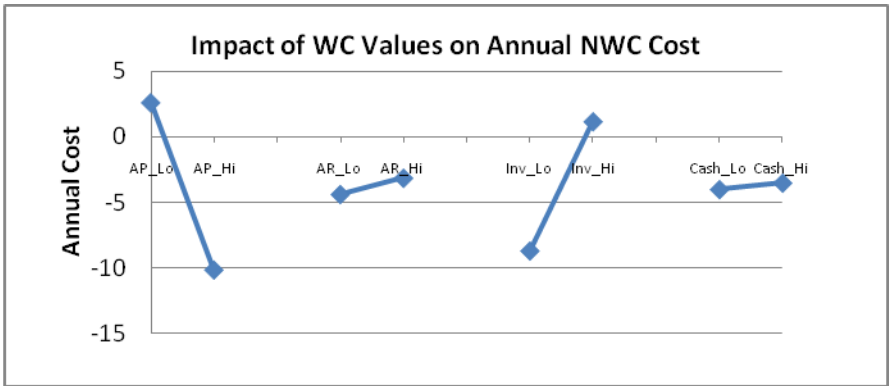

Figure 3 Sensitivity of Annual Cost of Net Working Capital to X_{AP}, X_{AR}, X_I and $X_\$$

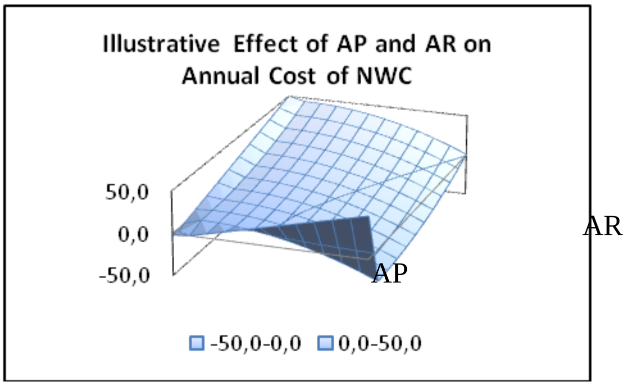

Figure 4 Sensitivity of Annual Cost of Net Working Capital to AP and AR

8 Establishing Causality

A *causal effect* is defined as finding that change in one variable leads to change in another variable, *ceteris paribus* (other things being equal). More specifically, a causal effect is said to occur if variation in the independent variable is followed by variation in the dependent variable, when all other things are equal. *Correlation*—observing that two variables merely vary together—*does not* imply causation (Bernard 1982, Holland 1986). Indeed as Holland notes, no causation can be detected without manipulation of the hypothesized "independent" variable (suspected to be the cause) and observing any consequent influence on the hypothesized "dependent" variable. Such deliberate manipulations are the subject covered by statistical design of experiments, where the object is to test the hypotheses that certain factors are indeed causes of the effects observed. A vast body of procedures to guide such systematic manipulations ("statistical experiments") and the associated data analysis procedure (ANOVA) to test the causality hypotheses are owed to Fisher (1925, 1935). In the present study we hypothesized that factors AP, AR, Inventory and Cash caused an effect on a firm's profitability and applied the L_8 experimental design to probe this. The details of the procedure may be found in Montgomery (2013). Table 4 is a subset of the information displayed in Table 3 that retains data relevant to the targeted causality test. As shown in Table 4, the hypothesized "cause" factors were varied here in accordance with the L_8 design, sufficient to study "main factor" effects (Montgomery 2013), whereas the consequent NWC cost calculated using the economic cost model (6) was the response. In all these experiments (each row in Table 4 representing the factor settings or "treatments" in one experiment) the generic costs or benefits (π, ρ, σ and η) were held constant as shown in Table 3. It is redundant to state that if these costs/benefits were all zero (0), model (6) would immediately suggest that none of the working capital components would have any effect on the cost of net working capital (NWC), hence on the firm's profitability.

Table 4: L_8 Experiments conducted by manipulating X_{AP}, X_{AR}, X_I and $X_\$$

Experiment #	X_{AP}	X_{AR}	X_I	$X_\$$	NWC Cost ₹
1	22.5	7.5	18.8	15.0	-1.7
2	22.5	7.5	31.3	25.0	5.8
3	22.5	12.5	18.8	25.0	0.3
4	22.5	12.5	31.3	15.0	6.2
5	37.5	7.5	18.8	25.0	-17.2
6	37.5	7.5	31.3	15.0	-4.3
7	37.5	12.5	18.8	15.0	-16.2
8	37.5	12.5	31.3	25.0	-2.9

To test causation between the four working capital components and the cost of NWC the data in Table 4 were subjected to ANOVA. SAS-produced results are shown in Table 5. For the cost/benefit values of π = - 0.000685 ₹/day/₹ AP, ρ = 0.001000 ₹/day/₹ AR, σ =0.000822 ₹/day/₹ Inventory and η = 0.000137 ₹/day/₹ Cash, factors accounts payable (X_{AP}) and inventory (X_I) are indicated to be significant causes that affect NWC Cost (hence profitability), whereas the effects of X_{AR} and $X_\$$ were not significant. Clearly, such inferences are totally dependent on the values of the generic costs π, ρ, σ and η. As noted earlier, if these values are all zero, none of the working capital components would affect profitability in any manner—a consequence of model (6).

Thus the present approach of analytically modeling the impact of working capital components on profitability has established (a) a valid approach to look for *causality* and its *direction*, given estimates of NWC component costs, and (b) a way to determine the impact of the various cost (benefit) parameters and WC conditions—*individually*. Correlation studies do not yield such information.

Table 5: The ANOVA Procedure executed by SAS

Dependent Variable: NWC cost

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	4	527.0800000	131.7700000	19.13	0.0179
Error	3	20.6600000	6.8866667		
Corrected Total	7	547.7400000			

R-Square	CoeffVar	Root MSE	NWC cost Mean
0.962281	-69.97989	2.624246	-3.750000

Source	DF	ANOVA SS	Mean Square	F Value	Pr > F
X_{AP}	1	327.6800000	327.6800000	47.58	0.0062
X_{AR}	1	2.8800000	2.8800000	0.42	0.5639
X_I	1	196.0200000	196.0200000	28.46	0.0129
$X_\$$	1	0.5000000	0.5000000	0.07	0.8051

9 The Petrol Pump Example Revisited

The petrol pump, like the firms mentioned in this paper, engages working capital in all its four forms. Whether these are beneficial to the pump, or a drag on profits, can be determined using (6) and appropriate cost data. In this section we focus on one part of assets tying up working capital—inventories—and illustrate how this component of the working capital may be managed to raise profits.
As affirmed in the introduction of this paper, the petrol pump too would be wise to visualize its inventory of petrol in stock as cash sitting in its storage tank, producing no return but enabling the pump to service customers who drive in randomly throughout the day. At minimum, this “cash” is not earning any interest, nor is available to be immediately invested in some profitable venture. So, the pump should try to get this stock of petrol down as far as possible within its customer service objectives. Indeed, inventory serves some vital purposes—it de-couples the supply received in tankers from the distribution centre, and customers needing fuel calling in without notice. As noted earlier, the contents in the storage tank constitute a key component of the pump’s working capital. But what purpose does it serve? Inventory control theory says that its prudent management reduces the risk of supply stoppages while it ensures good customer service; hence such stance would positively impact the petrol pump’s profitability.

The operational data (daily sale of petrol) over three months are shown in Table 1. Figures 2 and 3 show the same data graphically, from which it is clear that there is considerable randomness in daily quantities of petrol sold. Such situations require the incorporation of inventories and this is what the station has done by installing its storage tank. Note that the ideal situation would be to have a pipe connected straight at the distributor’s storage to this petrol station and connecting a flexible hose with a metered dispenser to it that can be inserted straight into the customer’s vehicle—approaching JIT (Chase et al. 2006). (This is frequently how cooking gas is supplied to households.) In the pump’s case, however, this possibility does not yet exist, hence we must see how its petrol stock can be managed to be maximally beneficial to the pump.

Inventory management from almost the beginning of industrial revolution has been scientifically studied using accounting and cost data, statistics, optimization and other operations management tools (Chase et al. 2006). Without reproducing that text we zero in on the issues of when to re-order petrol from the distributor, and how much to order, in order to maximally benefit the petrol pump owner. The pump gages its storage every morning. When this stock on hand would fall below the re-order point, an order should be placed. The most economical quantity (order size) would be chosen to balance storage cost, and ordering cost—to best manage inventory. The resulting minimum cost is the parameter σ/litre/day—used earlier in this paper. The optimal order quantity is EOQ (economic order quantity, elaborated in almost all texts of operations management). Repeated application of EOQ every time the morning’s inventory falls below the re-order point would drive σ—the daily cost of managing inventory, a cost component of money put into working capital—to its minimum possible value.

For the petrol pump we include the relevant calculations here minimally, to help a comparison of the pump's existing practices to a policy that would raise their profitability. Table 4 presents the analysis. Certain assumptions about the relevant costs have been made here. The statistical parameters—average daily demand and its standard deviation—were estimated from Table 1. Customer service level was set at 99%. The formulas used were taken from Chase et al. (2006).

Table 4 Calculation of Optimum (minimum) Inventory Management Cost

August Average Daily Demand (D)	2740 litres
Lead time L (days)	1
DL = Average demand during lead time	2740 litres
Stddev of demand during lead time	690
Service Level	0.99
k from Normal Table to assure service level	2.33
Safety Stock SS = k × stddev during lead time	1604 litres
Reorder Point = DL + SS	**4345 litres**
Actual Order Quantity in use by the petrol pump	6000 litres
hc Holding cost/day per litre	₹ 0.04
oc Ordering cost/order	₹ 100.00
EOQ = sqrt(2*D*oc/hc)	**3514 litres**
Optimal Total Inventory Management Cost/day	**₹ 155.96**
Actual Inventory Cost/day	₹ 724.48

This illustration shows that the petrol pump could save 724.48 – 155.96 or over ₹ 550/day by optimizing its inventory management practices, without significantly affecting customer service. Note that the pump is constrained by the tanker size as far as how much it should order every time inventory falls below the reorder point. Its current order size is 6000 litres/order. Table 4 shows that the optimal reorder point is 4345 litres and EOQ is 3514 litres/order. It may be additionally shown that the total inventory cost/day is relatively robust with respect to EOQ and indeed the daily cost would rise from ₹ 156 to about ₹ 180—not very significantly—if tankers of 3500-litre size were employed to bring petrol.

10 Conclusions

This study concludes that the impact of current assets and liabilities in a firm's working capital—accounts payable, accounts receivable, inventory and cash and bank deposits—on its profitability cannot be categorically stated as done in many earlier studies, most of which conclude that profitability is favorably affected by a negative working capital. Aside is the fact that almost all such studies reported in the public domain invoke correlation to falsely implicate a causality here, without regard to the well-respected foundations of the theory of causality (Holland 1986).

To address this gap, the present study has pursued the path of analytical modeling using first principles of economic costing, and then a parametric study using statistical experiments with the orthogonal array framework to indicate the *magnitude* and *direction*(visible in Figure 3) of causality.

Therefore anall-purpose answer to settle questions on the impact of working capital on a firm's profitability cannot be provided, because the implicated costs and benefits vary greatly firm to firm. Four components typically constitute working capital—accounts payable, accounts receivable, inventory and cash and bank deposits. Section 5 above has listed typical costs and benefits of investment constituting each of these. For instance, shortage of cash may drive the firm out of business, hence liquidity must be optimized. Extending credit to customers may boost sales, hence profits. Delaying payment to suppliers can free capital to invest in other short term prospects with higher return. Freely held abundance of cash cuts down on the opportunity to invest that current asset in gain worthy ventures. Finally, except in unusual circumstances, an optimum level of inventory of raw materials and finished goods can keep the business running smoothly especially when uncertainties in demand and supply abound.

A given firm's due diligence can thus reveal many such other costs and benefits linked to NWC—its current assets and liabilities. This undertaking should guide WC management policy formulation aimed to raise NOP.

The strength and uniqueness of this study come from the analytical methodology it has employed. By choice it stayed away from historical and anecdotal citations in earlier studies in which sound theoretical anchors were not sunk or the specific economic circumstances impinging on the firms or industries cited in these studies were not probed nor modeled.

7 References

Arora, A K (2013). Negative Working Capital and its Impact on Profitability, The Management Accountant, March, 308-313.

Ashraf C K (2012). The relationship between working capital efficiency and profitability, Journal of Accounting and Management, Vol 2(3)

Bagchi, Tapan P (1993). Taguchi Methods Explained: Practical Steps to Robust Design, Prentice Hall of India.

Bernard, G A (1982). "Causation", Encyclopedia of Statistical Sciences, Vol 1, eds. S Kotz, N Johnson and C Read, John Wiley, 387-389.

Bianchi, C (2010). An Educational Dynamic Model for Net working Capital Management in Trading Wholesale Firm, System Dynamics, Vol II.

Bivona, Enzo (2000). How to define and profitable and sustainable growth policy in a changing market? a case study: a small publishing company, Proceedings of the 18th International System Dynamics Conference, Bergen, Norway, August.

Bose, Biswajit (2013). The Impact of Working Capital Management Practices on Firm's Profitability, International Journal of Applied Research and Studies, Vol 2(6), June.

Bou, J C and A Satorra (2009). A Multigroup Structural Equation Approach, A Demonstration by Testing Variation of Firm Profitability Across EU Samples, Organizational Research Methods, Jan 26.

Bianchi, Carmine (2002). Introducing SD modeling into planning and control systems to manage SMEs' growth: a learning-oriented perspective, System Dynamics Review, Vol 18(3), 315-338.

Chakravarty, Ron (2009). Optimizing and right-sizing liquidity, http://www.citibank.com/transactionservices/home/oli/files/OptimizingandRightSizingLiquidity.pdf

Chary, T, R Kasturi and K Sampath Kumar (2011). Relationship between Working Capital and profitability—A Statistical Approach, IJRFM, Vol 1(7).

Chase, R B, F R Jacobs, N J Aquilano and N K Agarwal (2006). Operations Management for Competitive Advantage, 11th ed., McGraw-Hill.

Danuri, M and K I Satoto (2011). Design System Fuel Inventory Control in Gas Station with the concept of Min-Max Stock Level and Time Phased order Point, Proceedings of the 1st International Conference on Information Systems for Business Competitiveness (ICISBC).

Deloof, Mark (2003). Does Working Capital Management Affect Profitability of Belgian Firms? Journal of Business Finance and Business Accounting, Vol 4, April-May.

Fisher, R A (1925). Statistical Methods for Research Workers, Oliver and Boyd.

Fisher, R A (1935).The Design of Experiments, 9th ed., Macmillan.

Gill, A, N Biger and Neil Mathur (2010). The Relationship between Working Capital Management and Profitability: Evidence from the United States, Business and Economics Journal, Vol 2010:BEJ-10

Golas, Zbigniew, Anna Bieniasz and Dorota Czerwinska-Kayzer (2013). The relationship between working capital and profitability in food industry firms in Poland, Journal of Central European Agriculture, Vol14(1), p.52-63

Gregory, G (1976). Cash and bank deposit flow models: A review, Omega, Vol4(6), 643–656

Hofmann, E. (2005). Supply Chain Finance: some conceptual insights, Logistik Management - Innovative Logistikkonzepte, Wiesbaden, 203-214.

Holland, Paul W (1986). Statistics and Causal Inference, Journal of American Statistical Association, Vol 81 (396), 945-960.

Kithii, J N (2008). The relationship between working capital management and profitability of listed companies in the Nairobi stock exchange, MBA Project, University of Nairobi.

Korankye, T and R S Adarquah (2013). Empirical Analysis of Working Capital Management and its Impact on Profitability of Listed Manufacturing Firms in Ghana, Research Journal of Finance and Accounting, Vol 4(1).

Lardbucket books (2012). Net Working Capital Basics, http://2012books.lardbucket.org/books/finance-for-managers/s17-02-net-working-capital-basics.html

Liu, Na and D Wang (2011). Negative working capital management: an up-to-the limit application of the concept of supply chain management in corporate finance, Management Science and Economic Review, Vol 1(1), 43-53.

Lyneis, J and R R Reilly (1973). Working Capital Management: A Systems Dynamic Approach, Working Paper 873, Graduate School of Business Administration, University of Michigan.

Miller, M H and D Orr (1966). A Model of the Demand for Money by Firms, Quarterly Journal of Economics, Vol 80(3), 413-435.

Montgomery, D C (2013). Design and Analysis 0f Experiments, 8th Ed., Wiley

Napompech, Kulkanya (2012). Effects of Working Capital Management on the Profitability of Thai Listed Firms, International Journal of Trade, Economics and Finance, Vol 3(3).

Northcott, R. 2006. Causal efficacy and the analysis of variance. Biology and Philosophy 21(2):253–276.

Northcott, Robert (2008). Can ANOVA Measure Causal Strength? The Quarterly Review of Biology, Vol83(1), March 47-55.

Owolabi, S A and S S Solomon (2012). Liquidity Management and Corporate Profitability: Case Study of Selected Manufacturing Companies Listed on the Nigerian Stock Exchange, Business Management Dynamics, Vol 2(2), August, 10-25.

Pigliucci, M and Kaplan J(2006). Making Sense of Evolution: The Conceptual Foundations of Evolutionary Biology. Chicago (IL): University of Chicago Press.

Rahman, M M (2011). Working Capital Management and Profitability: A Study on Textiles Industry, ASA University Review, Vol5(1).

Sharma, D (2005). Working Capital Management: A Conceptual Approach, Himalaya Publishing House.

Shin H H and L Soenen (1998). Efficiency of Working Capital and Corporate Profitability, Financial Practice and Education 8, 37-45.

Ray, Sarbapriya (2012). Evaluating the Impact of Working Capital Management Components on Corporate Profitability: Evidence from Indian Manufacturing Firms, International Journal of Economic Practices and Theory, Vol 2(3).

Thompson Ray and R C Shreckengost (1984). Using System Dynamics to Improve the Management of Working Capital in a Small Business, http://www.systemdynamics.org/conferences/1983/proceed/parallel-vol2/thomp639.pdf

Walmart (2012). Walmart 2012 Annual Report, p. 25.

Zbigniew, GOŁAŚ, Anna BIENIASZ and Dorota CZERWIŃSKA-KAYZER (2013). The relationship between working capital and profitability in food industry firms in Poland, Journal of Central European Agriculture, Vol14(1), p.52-63