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African Journal of Business Management

Review

Accounting, taxation, and the cost of capital

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This paper investigates the link between accounting and taxation and its implications for the cost of equity capital. Using a simple model, we characterize the determinants of the cost of capital in a setting where reporting rules combine accounting and taxation estimations. Accounting and tax rules usually result in different estimates of true earnings, each one with its own estimation error. The correlation between these errors and the rule of combination of accounting and tax estimates characterizes the degree of connection between accounting and taxation. These two variables determine the overall precision of the public reports issued by the companies and, among other things, influence the cost of capital. The paper characterizes how the cost of capital varies with precision of accounting and tax estimates, with the correlation of estimation errors and with the rule of combination between accounting and tax estimates. The most interesting result is that for low enough or negative levels of the correlation between estimation errors, more precise accounting/tax estimation principles may result in higher cost of capital.

Key words: Cost of capital, information, precision, accounting, taxation.

INTRODUCTION, LITERATURE REVIEW AND ORGANIZATION OF THE PAPER

Conventional wisdom predicts that the cost of equity capital declines when risk-averse investors have more precise information. The argument in favor of this conclusion is that higher information precision lowers the assessed variance of future cash-flows (the estimation risk component of the cost of capital). In turn, this lowers the risk premium required by investors and hence it lowers the cost of equity capital. A second argument is that higher quality information decreases the information asymmetry on the market, increases market liquidity and the share prices and decreases the cost of capital (the information asymmetry component). Given these lines of thought, one may expect corporations to prefer reporting rules that induce the highest possible precision, so that the cost of capital declines. And, indeed, the reduction in the cost of capital seems to be one of the economic effects that major accounting standard setters (e.g. International Accounting Standard Board – IASB and Financial Accounting Standards Board – FASB) have in mind when they issue reporting standards. However, even if a single or just a few sets of reporting standards are to be used world-wide, the application of such standards is not uniform but jurisdiction dependent. A wide network of country-specific institutional factors shapes the application of accounting standards (Ball et al., 2000). In this paper, we study analytically the

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implications for the cost of capital of one such institutional factor, namely the link between accounting and taxation.

It is well known that accounting and tax principles are different in most, if not all, jurisdictions. The two sets of principles yield different estimates with different precisions of the economic or true earnings. Our paper proves that, in jurisdictions where the two systems interact, the combination between accounting and tax estimations affects the overall precision of reported earnings and the cost of capital in a non-trivial manner. Understanding the relationship between accounting and taxation and the implications of this relationship for the cost of capital is thus essential. Our paper takes some first steps in accomplishing this. It develops this relationship mathematically and provides analytical results about some of the institutional determinants of the cost of capital. Briefly, the paper describes how the cost of capital varies with the degree of inclusion of accounting and tax estimates in the public earnings report, with the precision of accounting and tax estimates as well as with the correlation between the error terms of these estimates. While some classical results still hold in our model (e.g. the cost of capital increases in the volatility of future cash-flows), some of our findings are more surprising and hence interesting. For instance, we prove that, for some features of the link between accounting and taxation, the cost of capital actually increases with the precision of accounting or tax estimates. This result stands in contrast with conventional wisdom regarding the relationship between information precision and the cost of capital. Overall, our paper proves that a careful analysis of the institutional factors involved in a certain setting is required in order to have a clear picture of how information precision influences the cost of capital.

The literature on the relationship between disclosure, information quality and the cost of capital is rich and growing. The topic is studied both empirically and analytically. Given the breadth of the literature we do not attempt here a comprehensive review. One such review may be found in Botosan (2006). Instead, we only focus on those papers that are most relevant to our analysis and highlight the ties between our work and prior literature.

The empirical side of the literature provides results regarding the association between the level of disclosure and the cost of capital. Botosan (1997) and Leuz and Verrechia (2000) provide evidence that increased levels of disclosure decrease the cost of equity capital. These results proved to be quite robust and over time the literature moved the center of interest from the level of disclosure to the information quality. Francis et al. (2004) study the relationship between earnings quality and the cost of capital. Their evidence supports the idea that higher information quality decreases the cost of capital. However, their aim is to investigate a relative ranking between several measures of earnings attributes and document how these measures relate to the cost of capital. They find that accounting-based measures of earnings quality such as accrual quality, persistence, predictability and smoothness have the highest effect on cost of capital. Francis et al. (2008) study the relationship between voluntary disclosure, earnings quality and the cost of capital. They find that firms with good earnings quality also have strong voluntary disclosure systems and that disclosure levels are negatively correlated with cost of capital. However, after controlling for earnings quality, the effect of disclosure disappears. Their findings are interesting because they prove that when both disclosure levels and earnings quality measures are present in a regression, the negative association with the cost of capital is picked-up by the latter. The empirical paper closest to our work is Botosan et al. (2004). This paper studies the effect of information precision on the cost of capital. In line with prior literature, the authors find that precision of public information is negatively correlated with the cost of capital. However, the precision of private information is positively associated with the cost of capital because it increases the information asymmetry on the market. The influence of asymmetric information on the cost of capital is also studied in analytical papers such as Armstrong et al. (2010) and Hughes et al. (2007). These papers present conditions under which asymmetric information affects the cost of capital. Our paper studies analytically only the effect of the precision of public reports on the cost of capital and does not relate to the information asymmetry problem. In addition, we study the relationship between the effect of precision in accounting and taxation rules and how their interaction affects the precision of the final public earnings report. Contrary to the results reported by Botosan et al. (2004), our paper predicts that the cost of capital may under certain circumstances increase with the precision of accounting estimates.

Surprisingly, Daske (2006) did not document a negative relationship between the cost of capital and adoption of high quality financial reporting standards (such as the International Financial reporting Standards – IFRS - and the American Generally Accepted Accounting Principles – the US-GAAP). However, in later work, Daske et al. (2008) found that, under certain circumstances, positive economic consequences (improved liquidity and lower cost of capital) are associated with IFRS adopters. However, this study points out that the capital market benefits (liquidity and low cost of capital) appear exclusively in countries with strong incentives for transparency and strong legal enforcement. Their results add to the list of institutional factors investigated by Hail and Leuz (2006). These authors show that the cost of equity capital is lower in jurisdictions with extensive disclosure requirements and strong securities regulations. Relative to these findings, our paper identifies the link between accounting and taxation as a different institutional factor that may explain differences in the level of cost of capital across jurisdictions.

The analytical side of this literature studies how the share price and risk premia are determined in equilibrium and how equilibrium cost of capital varies with its determinants. Our paper takes a similar tack. Easley and O'Hara (2004) consider both the estimation risk and information asymmetry in the formulation of an equilibrium price. They describe how information affects equilibrium prices and the cost of capital. Lambert et al. (2007) also study the effect of accounting information on the cost of capital. Unlike Easley and O'Hara (2004) they use a Capital Asset Pricing Model (CAPM) approach and focus on how accounting reports help investors assess the variance of the firm's cash-flows as well as the covariation of the firm's cash-flows with the cash-flows of other firms on the market. Our paper is very close to Lambert et al. (2007) because it is analytically tracking the properties of accounting information (like precision) to the formula of the cost of capital.

A recent trend in the literature is to study the effect of disclosure and information quality on the cost of capital when decisions about the level of disclosure and precision are made simultaneously with other decisions such as investment and capital structure decisions. For instance, Li et al. (2011) study how different informational settings affect both the cost of capital and investment decisions when they are jointly determined in equilibrium. Also, Bertomeu et al. (2011) point out that the relationship between information and cost of capital is more subtle. While their model predicts a negative association between the cost of capital and the extent of voluntary disclosure, they cannot find a causal relation between the two. Instead, they show how exogenous mandatory disclosure requirements and endogenous capital structure decisions also influence the cost of capital. Finally, Gao (2010) studies the relationship between disclosure quality, investor welfare and cost of capital in production economies with perfect competition among investors. One of his findings is that, under certain conditions, the cost of capital may increase with disclosure quality. Our paper is closest to Gao's paper in that it predicts a positive correlation between cost of capital and quality of information. However, our paper posits a different reason for this positive association, namely the link between accounting and taxation.

The paper is organized as follows. Section 2 introduces a basic model of the cost of capital. It also characterizes the effects of precision of the public earnings reports on the cost of capital. Section 3 introduces our modeling. It adds further detail to the information structure described in section 2 and describes in mathematical terms what we mean, from an informational perspective, by "the link between accounting and taxation". Section 4 contains our results. It includes a static analysis regarding the variation of the cost of capital with the variables that determine the overall precision of the public reporting system. Since the underlying mathematics is accessible to any reader we included short proofs of our statements in the body of the paper. However, longer and more detailed proofs are available on request from the author. Section 5 reviews our results and discusses limitations.

Basic model of cost of capital

This section presents a simple model of the cost of capital. It also discusses how the precision of a reporting system influences the cost of capital. Since the model is well known in the literature, our exposition is kept short and concise. We only present and emphasize those features of the model that prove useful in the preparation of our own modeling in section 3. In addition, unlike Easley and O'Hara (2004), our model only considers the estimation risk component of cost of capital. It does not touch on the information asymmetry problem. In this sense, our baseline model of cost of capital follows the arguments in Li et al. (2011) but a similar formula for the cost of capital can also be derived by following the arguments in Lambert et al. (2007) and those in Gao (2010).

Cost of capital

Consider an entrepreneur who owns a firm with a terminal cash-flow $\tilde{x}$. The cash-flow is a random variable which is realized at a certain point in the future. It is assumed to be normally distributed with mean μ and variance σ_x^2. In shorthand notation (which will be used from now on) $\tilde{x} \sim N(\mu, \sigma_x^2)$. At an interim data, prior to the realization of the terminal cash-flow, the entrepreneur must sell (say for consumption purposes) a fraction α of the firm. The firm is priced by risk-averse and rational investors.

To influence investors' perceptions about the cash-flow, the entrepreneur issues a public report $\tilde{r}$ whose realization we denote simply as r. We assume investors do not search for private information but only rely on this public report. For tractability reasons, investors are assumed to have constant absolute risk aversion utility functions characterized by risk-aversion coefficient θ. The expression of such a function is $U(w) = -e^{-\theta w}$ where w is the wealth of a representative investor. Also, investors are uniformly distributed over the unity interval. If a fraction α is to be sold to these investors then Li et al. (2011) prove that the cost of capital has the following formula:

Lemma 1 The cost of capital (C) is a multiple of the cash-flow variance conditional on all available information on the market.

$C = \alpha\theta Var[\tilde{x}|r]$

Proof: As in Li et al. (2011), a representative investor's potential wealth is given by $\tilde{w} = (\tilde{x} - p)\delta$. In this expression p gives the equilibrium market price and δ is the demand of the representative investor. The expression reflects the fact that the investor pays the equilibrium price *p* per share and expects to receive uncertain cash-flow $\tilde{x}$. It is well known (Christensen and Feltham, 2002) that when investors have CARA utility functions and their prospective wealth is normally distributed then maximization of expected utility reduces to the maximization of the $E[\tilde{w}|r] - \frac{1}{2}\theta Var[\tilde{w}|r]$. Since $Var[\tilde{w}|r] = Var[(\tilde{x} - p)\delta] = \delta^2 Var[\tilde{x}|r]$ and $E[\tilde{w}|r] = (E[\tilde{x}|r] - p)\delta$ it then follows that the investor chooses demand δ that maximizes function $(E[\tilde{x}|r] - p)\delta - \delta^2 Var[\tilde{x}|r]$. Taking the first order derivative with respect to δ and solving for δ we obtain the demand of a representative investor:

$$\delta = \frac{E[\tilde{x}|r] - p}{\theta Var[\tilde{x}|r]}$$

Given the uniform distribution assumption about the investors then market clearing condition which requires total supply α to equal total demand $\int_0^1 \delta di = \delta$ implies that $p = E[\tilde{x}|r] - \alpha\theta Var[\tilde{x}|r]$ which further yields $C = E[\tilde{x}|r] - p = \alpha\theta Var[\tilde{x}|r]$

The cost of capital is equal to the risk premium the risk-averse investors require to invest in the firm.

Basic information structure

The entrepreneur can influence the cost of capital by issuing a public report $\tilde{r}$ which changes investors' assessment of the cash-flows variance. As it is common in the literature, we assume that report $\tilde{r}$ is an unbiased estimate of the cash-flow $\tilde{x}$. Thus, by assumption, $\tilde{r} = \tilde{x} + \tilde{\omega}$ with $\tilde{\omega} \sim N(0, \sigma_\omega^2)$ and $Cov(\tilde{x}, \tilde{\omega}) = 0$. Given these assumptions about the basic information structure, the following lemma holds:

Lemma 2 The cost of capital increases in the volatility of the terminal cash-flow σ_x^2 and in the noise in the information system, σ_ω^2.

The proof is simple and follows from the well known result that (given normality of $\tilde{r}$ as above) $Var[\tilde{x}|r] = \frac{\sigma_x^2\sigma_\omega^2}{\sigma_x^2+\sigma_\omega^2} = \frac{1}{\frac{1}{\sigma_x^2}+\frac{1}{\sigma_\omega^2}}$. The variation of $Var[\tilde{x}|r]$ and hence that of the cost of capital with σ_x^2 and σ_ω^2 is then clear.

Lemma 2 establishes that the cost of capital moves in the same direction with the variance of the error in the public report. We use this lemma later in paper to ease the exposition of our results. All results that hold for the variance of the error in the public report also hold for the cost of capital.

Modeling the link between accounting and taxation

In this section, we maintain the notation so far and add extra structure to the general information system described in section 2. The aim is to make precise what we mean by "the link between accounting and taxation". Our approach is purely informational in the sense that the set of tax principles is viewed as an earnings estimator much like the accounting one. Three ideas are key to our modeling. First, the accounting and tax estimates of cash-flows have different precisions. Thus, accounting and taxation systems induce two different estimators or signals:

The accounting signal $\tilde{y} = \tilde{x} + \tilde{\varepsilon}$ with $\tilde{\varepsilon} \sim N(0, \sigma_\varepsilon^2)$
The taxation signal $\tilde{z} = \tilde{x} + \tilde{\tau}$ with $\tilde{\tau} \sim N(0, \sigma_\tau^2)$

We assume that the error terms are not correlated with the cash-flow. Formally, $Cov(\tilde{x}, \tilde{\varepsilon}) = Cov(\tilde{x}, \tilde{\tau}) = 0$. We make no assumption on which of the two estimators yields more precise earnings estimates.
Second, while different, the error terms in the accounting and taxation estimation functions are assumed to be related. We assume the error terms $\tilde{\varepsilon}$ and $\tilde{\tau}$ exhibit correlation and we allow this correlation to be either positive or negative depending on how accounting and tax estimation principles are set-up. Formally, estimation errors $\tilde{\varepsilon}$ and $\tilde{\tau}$ are assumed to have a bivariate normal distribution characterized by N(0,0, σ_ε^2, σ_τ^2, ρ). The degree of correlation between the error terms of the two estimates, ρ represents one feature of the link between accounting and taxation. That is we allow for accounting and tax rules to be framed in a wide varieties of ways such that the correlation between the error terms that they induce can be either positive, negative or zero.

Third, we conceive the public reported signal $\tilde{r}$, as a linear combination between the accounting and tax signals. Thus in our modeling, the reporting rule combines a purely accounting estimate with a tax estimate. The weight placed on each of the two signals captures the second feature of the link between accounting and taxation. Denote φ the weight place on the accounting estimate $\tilde{y}$. Then $1 - \varphi$ is the weight placed on the tax estimate $\tilde{z}$. With this notation, the accounting report r can be written as:

$$\tilde{r} = \varphi\tilde{y} + (1 - \varphi)\tilde{z}$$

Variable φ captures the relative dominance of accounting and tax rules in the public report. When $\varphi = 1$, accounting estimations dominate and public reporting is completely detached from tax principles. Assuming investors know the informational properties of signals $\tilde{y}$ and $\tilde{z}$ (like we do in this model), a combination rule that places all weight on the accounting estimate renders the tax estimate useless for reporting purposes. When $\varphi = 0$, tax principles dominate public reporting. Any $\varphi \in (0,1)$ reflects a non-trivial link between accounting and taxation in the set-up of the public report. To make sure the random variable $\tilde{r}$ associated with the public report is normally distributed as in section 2 above, we needed to make the further assumption that $\tilde{\varepsilon}$ and $\tilde{\tau}$ are jointly normal. This assumption was needed because both $\tilde{\varepsilon}$ and $\tilde{\tau}$ were assumed to be dependent and, in general, a linear combination of normally but not independently distributed random variables may not be normal. However, assuming joint normality of $\tilde{\varepsilon}$ and $\tilde{\tau}$ ensures that $\tilde{r}$ is a normally distributed random variable and preserves the validity of lemma 2 mentioned before.

Analytically, the pair $(\sigma_\varepsilon^2, \sigma_\tau^2)$ reflects the volatility of the accounting and tax estimations. The inverse of the volatility is usually associated with precision of the estimates induced by the application of accounting and tax principles. The pair (ρ, φ) captures the notion of the link between accounting and taxation. These four variables $(\sigma_\varepsilon^2, \sigma_\tau^2, \rho, \varphi)$ represent the determinants of the variance of the public report and hence the determinants of the cost of capital in our model. The following lemma shows how these variables affect the variance of the public report:

Lemma 3

$Var[\widetilde{r}] = \sigma_x^2 + \varphi^2\sigma_\varepsilon^2 + (1-\varphi)^2\sigma_\tau^2 + 2\rho\varphi(1-\varphi)\sigma_\varepsilon\sigma_\tau$

Proof: From $\tilde{r} = \varphi\tilde{y} + (1-\varphi)\tilde{z} = \varphi(\tilde{x} + \tilde{\varepsilon}) + (1-\varphi)(\tilde{x} + \tilde{\tau})$ it follows that $\tilde{r} = \tilde{x} + \varphi\tilde{\varepsilon} + (1-\varphi)\tilde{\tau}$. Since $\tilde{x}$ is independent of $\tilde{\varepsilon}, \tilde{\tau}$ and the covariance of $\tilde{\varepsilon}$ and $\tilde{\tau}$ can be written as $Cov(\tilde{\varepsilon}, \tilde{\tau}) = \rho\sigma_\varepsilon\sigma_\tau$, the result then follows from the application of the variance formula to the last expression of $\tilde{r}$.

Accounting taxation and the cost of capital

The above modeling of the connection between accounting and taxation allows us to perform some static analyses to see how the cost of capital varies with its determinants.

The analysis in this section is simplified by the observation in section 2 that it is sufficient to study how a variable influences the variance of the error term in the public report in order to determine the effect of that particular variable on the cost of capital. The following propositions represent the main findings of our study. Each is followed by a proof and a brief discussion.

Results on correlation (ρ)

Proposition 4 – *The cost of capital unambiguously increases with increases in the correlation coefficient between the error terms in the accounting and taxation estimators.*

Proof: From lemma 3 it follows that the earnings variance is an increasing linear function of ρ. Coefficient of ρ in the formula of $Var[\widetilde{r}]$ is $2\varphi(1-\varphi)\sigma_\varepsilon\sigma_\tau$ which is positive.
One consequence of proposition 4 is that taking the other variables as given, the cost of capital is at its minimum when ρ is minimum (ρ= -1). Another interesting result about the correlation is captured in the following proposition:

Proposition 5 – There exists levels of correlation between accounting and tax estimates (ρ) and combination rules φ such that the variance of an earnings report (and hence the cost of capital) with accounting and taxation estimates is lower than the variance of the earnings report (and cost of capital) that relies only on accounting estimates.

Proof: The variance of the error term in the public report when accounting and taxation interact is $\varphi^2\sigma_\varepsilon^2 + (1-\varphi)^2\sigma_\tau^2 + 2\rho\varphi(1-\varphi)\sigma_\varepsilon\sigma_\tau$ while the variance of the error term in the public report when accounting estimations dominate is simply σ_ε^2. For the mixed reporting setting (accounting and tax estimations) to dominate the purely accounting setting we need to have:

$$\varphi^2\sigma_\varepsilon^2 + (1-\varphi)^2\sigma_\tau^2 + 2\rho\varphi(1-\varphi)\sigma_\varepsilon\sigma_\tau < \sigma_\varepsilon^2 \quad (1)$$

Working out this inequality one obtains the cut-off point

$$\rho < \frac{(1+\varphi)\sigma_\varepsilon^2 - (1-\varphi)\sigma_\tau^2}{2\varphi\sigma_\varepsilon\sigma_\tau}$$

Further, the term on the right-hand side of the inequality is well behaved (is between -1 and 1) if and only if $\frac{\sigma_\tau - \sigma_\varepsilon}{\sigma_\tau + \sigma_\varepsilon} < \varphi < \frac{\sigma_\tau + \sigma_\varepsilon}{\sigma_\tau - \sigma_\varepsilon}$. It can be easily seen that when the variance in the accounting estimate is bigger than the variance in the tax estimate $(\sigma_\varepsilon > \sigma_\tau)$ the inequality (1) above holds true for any ρ. This is hardly surprising because adding to the mix an estimate with lower variance (bigger precision) decreases the overall earnings report variance and with it, decreases the cost of capital. The more interesting case is when the variance in the tax estimate is bigger than the variance of the accounting estimate $(\sigma_\varepsilon < \sigma_\tau)$. In this case, it is still possible that the mixed earnings report dominates the pure accounting report provided $\frac{\sigma_\tau - \sigma_\varepsilon}{\sigma_\tau + \sigma_\varepsilon} < \varphi$ and

$$\rho < \frac{(1+\varphi)\sigma_\varepsilon^2 - (1-\varphi)\sigma_\tau^2}{2\varphi\sigma_\varepsilon\sigma_\tau}$$

Thus, for high enough φ but low enough levels of correlation ρ, a reporting system that combines accounting and tax estimates yields a lower cost of capital than a reporting system where accounting alone dominates. But in this second case, the condition derived in proposition 5 that the level of correlation should be low enough is essential. The low or negative correlation outweighs the larger volatility induced by the tax estimation and induces a smaller total variance of the public report.

Results on precision

This section looks at how precision of accounting and tax estimates as captured by the inverses of their variances $(\sigma_\varepsilon^2, \sigma_\tau^2)$ manifests in the cost of capital. As it becomes clear from the proposition below, the nature (the sign) of the correlation between accounting and tax estimation error is essential in the analysis.

Proposition 6

a) For positively correlated accounting and taxation estimation errors (ρ>0), the cost of capital unambiguously decreases when their precision increases.

b) For negatively correlated accounting and taxation estimation errors (ρ<0) and, for small enough standard deviations (large enough precisions), the cost of capital increases when precision increases.

Proof: Taking the first-order derivative of the earnings variance with respect to σ_ε and σ_τ respectively we find:

$$\frac{\partial Var[\tilde{r}]}{\partial \sigma_\tau} = 2(1-\varphi)^2\sigma_\tau + 2\varphi(1-\varphi)\rho\sigma_\varepsilon$$
$$\frac{\partial Var[\tilde{r}]}{\partial \sigma_\tau} = 2\varphi^2\sigma_\varepsilon + 2\varphi(1-\varphi)\rho\sigma_\tau$$

If ρ>0 then both derivatives are positive so the earnings variance and the cost of capital increase as $\sigma_\tau$and $\sigma_\varepsilon$increase (or, alternatively, increase as the precision of the accounting and taxation estimates decrease) which proves part a.)

However, if ρ<0, each of the two derivatives above has a unique root:

$$\sigma_\tau^* = -\frac{\varphi}{1-\varphi}\rho\sigma_\varepsilon$$
$$\sigma_\varepsilon^* = -\frac{1-\varphi}{\varphi}\rho\sigma_\tau$$

It follows that for $\sigma_\tau < \sigma_\tau^*$ and $\sigma_\varepsilon < \sigma_\varepsilon^*$ the two derivatives are negative. Mathematically, taking $\sigma_\tau^2, \varphi, and\ \rho < 0$ as given, this triple defines a cut-off point $\sigma_\varepsilon^* = -\frac{1-\varphi}{\varphi}\rho\sigma_\tau$ for the volatility of the accounting estimates. Below this point, decreases in the volatility of accounting estimates have the effect of increasing the cost of capital. Similarly, taking $\sigma_\varepsilon^2, \varphi, and\ \rho < 0$ as given, this triple defines a cut-off point $\sigma_\tau^* = -\frac{\varphi}{1-\varphi}\rho\sigma_\varepsilon$ for the volatility in the tax estimate. Below this point, decreases in the volatility of tax estimates have, again, the effect of increasing the cost of capital.

Economically, this means that, other things being equal, for small enough estimation variances, adding a bit of extra noise could actually decrease the variance of the public report and hence the cost of capital. This holds true for both the accounting and tax estimate variances. Put differently, starting at high levels of the estimation variances, reduction in these variances decreases the cost of capital but only up to some level. Decreasing the variances below this level starts increasing the variance in the public report and cost of capital. In short, proposition 6 proves that in some cases (negative correlation between accounting and tax estimates) what is beneficial to the cost of capital is more but not unbounded information precision. This result contradicts conventional wisdom regarding the relationship between information precision and the cost of capital. The reason for this result is the negative correlation between the estimation errors generated by the application of accounting and tax principles. Positive or zero correlations render the first order derivatives strictly positive and take us back to the conventional wisdom of the negative relationship between the cost of capital and information precision. However, negative correlation changes that relationship. When the link between accounting and taxation is characterized by negative correlations between accounting and tax estimates, increases in precision (decrease in estimation variance) of either accounting and tax estimations is desired but only up to a level. Beyond that level, increasing precision actually increases the cost of capital.

Results on the rule of combination between accounting and tax estimations ($\boldsymbol{\varphi}$)

This section looks at how the rule of combination, φ, of accounting and tax estimates influences the cost of capital. Like in the analysis of the previous propositions, the results in this section depend on the degree of correlation ρ. In addition, the relationship between the degree of correlation ρ and the relative precision of accounting and tax estimates $({}^{\sigma_\varepsilon}/_{\sigma_\tau})$ also influences the analysis.

Proposition 7 – Given a triple $(\rho, \sigma_\varepsilon, \sigma_\tau)$ then,

(a) if the tax estimation dominates in precision the accounting estimation ($\frac{\sigma_\tau}{\sigma_\varepsilon} < 1$) and the correlation co-efficient is positive and large enough ($\rho \in [\frac{\sigma_\tau}{\sigma_\varepsilon}, 1]$) then the earnings report variance and the cost of capital increases in φ.
(b) if the accounting estimation dominates in precision the tax estimation ($\frac{\sigma_\tau}{\sigma_\varepsilon} > 1$) and the correlation coefficient is positive and large enough ($\rho \in [\frac{\sigma_\varepsilon}{\sigma_\tau}, 1]$) then the earnings report variance and the cost of capital decreases in φ.
(c) in all other cases, there exists a cut-off point $\varphi^* = \frac{\sigma_\tau^2 - \rho\sigma_\varepsilon\sigma_\tau}{\sigma_\tau^2 + \sigma_\epsilon^2 - 2\rho\sigma_\varepsilon\sigma_\tau}$ such that the cost of capital strictly decreases in φ if $\varphi < \varphi^*$ and strictly increases in φ if $\varphi > \varphi^*$.

Proof: Taking the first order derivative of the report variance in respect to φ

$$\frac{\partial Var[\widetilde{r}]}{\partial\varphi} = 2\varphi\sigma_\varepsilon^2 - 2(1-\varphi)\sigma_\tau^2 + 2(1-2\varphi)\rho\sigma_\varepsilon\sigma_\tau$$
$$= 2[\varphi(\sigma_\tau^2 + \sigma_\epsilon^2 - 2\rho\sigma_\varepsilon\sigma_\tau) - \sigma_\tau^2 + \rho\sigma_\varepsilon\sigma_\tau]$$

and solving $\frac{\partial Var[\widetilde{r}]}{\partial\varphi} = 0$ for φ, we obtain the cut-off point φ^* as stated in the proposition. The second order derivative of the report variance in respect to φ is:

$$\frac{\partial^2 Var[\widetilde{r}]}{\partial\varphi^2} = 2(\sigma_\varepsilon^2 + \sigma_\tau^2 - 2\rho\sigma_\varepsilon\sigma_\tau)$$

This is always positive, since $\rho \in [-1;1]$. This means that, when well behaved, the cut-off point φ^*as in part (c) of proposition 7 gives a point of minimum. The three cases above, (a) through (c) are then obtained by analyzing conditions under which φ^* is well behaved (i.e. $\varphi^* \in [0,1]$).

To prove part (a), assume $\frac{\sigma_\tau}{\sigma_\varepsilon} < 1$ and $\rho \in [\frac{\sigma_\tau}{\sigma_\varepsilon}, 1]$. This implies $0 < -\sigma_\tau^2 + \rho\sigma_\varepsilon\sigma_\tau$. But then, since $(\sigma_\varepsilon^2 + \sigma_\tau^2 - 2\rho\sigma\varepsilon\sigma\tau > 0$ it follows that $0 < -\sigma\tau 2 + \rho\sigma\varepsilon\sigma\tau <$ $\varphi(\sigma_\tau^2 + \sigma_\epsilon^2 - 2\rho\sigma_\varepsilon\sigma_\tau) - \sigma_\tau^2 + \rho\sigma_\varepsilon\sigma_\tau$. Therefore $\frac{\partial Var[\widetilde{r}]}{\partial\varphi} > 0$ and hence the variance of the earnings report and the cost of capital increase in φ. A similar proof follows for part (b). Part (c) follows from solving $\frac{\partial Var[\widetilde{r}]}{\partial\varphi} = 0$.

Setting aside the mathematics underlying the argument, what parts (a) and (b) of proposition 7 say is that it is only when the correlation coefficient is positive and large enough then, by placing more weight on the more precise (lower variance) signal strictly lowers the cost of capital. If the aim is to lower the cost of capital then, taking the positive correlation and the estimation variances $(\sigma_\varepsilon^2, \sigma_\tau^2)$ as given, the reporting rule should place more weight on the most precise estimation. Such a conclusion is in line with conventional wisdom about precision and the cost of capital. However, part (c) of the proposition proves that when the coefficient of correlation is positive but sufficiently low, the relationship between φ and the cost of capital becomes blurred. In particular, part (c) identifies an interior solution φ^* which limits the extent to which emphasis should be placed on the more precise (lower variance) estimate.

In particular, part (c) says that when $\frac{\sigma_\tau}{\sigma_\varepsilon} < 1$ but $\rho < \frac{\sigma_\tau}{\sigma_\varepsilon}$ (i.e., the tax estimation is more precise and correlation is low enough) then, decreasing the weight of the accounting signal beyond the level of φ^*, starts increasing the variance of the earnings report and the cost of capital. Part (c) also says that, for instance, when $\frac{\sigma_\tau}{\sigma_\varepsilon} > 1$ but $\rho < \frac{\sigma_\varepsilon}{\sigma_\tau}$ (that is, the accounting signal is more precise but there is low correlation) then, increasing the weight of the accounting signal (φ) is beneficial to the cost of capital only up to the level of φ^*. Beyond this level, the variance of the earnings report and the cost of capital start increasing. That is, even if the accounting estimate is more precise than the tax estimate, placing a weight on the accounting estimate that exceeds the interior solution φ^* increases the cost of capital. If the aim is to diminish the cost of capital then, taking precisions and the degree of correlation as given, the cost of capital is at its minimum when the reporting rule follows the cut-off point φ^*. Placing all weight on the most precise estimate is not necessarily conducive to lower cost of capital. As in proposition 5 above, the reason is, partly, the low enough correlation. However, unlike the case of proposition 5 where results depend entirely on the negative correlation (*ρ<0*), in proposition 7 a non-trivial interior point $\varphi^{**} = \frac{\sigma_\tau^2}{\sigma_\tau^2 + \sigma_\epsilon^2}$is obtained even with no correlation (ρ=0). This means, that the relative weight of accounting and tax estimates (φ) has a role of its own independent on the correlation coefficient.

DISCUSSION AND CONCLUSION

This paper analytically explores the relationship between accounting and taxation and its implications for the cost of capital. The approach was purely informational. That is, we looked at taxation as at another measurement device which conveys information about the true earnings of a company. Depending on the jurisdiction, the information in the tax estimation may be more or less precise then the information in an accounting estimation. Essential for our analysis is that accounting and tax estimations may be correlated. The degree of correlation between the two estimates is viewed as one feature of the link between accounting and taxation. The other feature is the rule of combination (the reporting rule) of accounting and tax estimates in the public report. The precisions of the two estimates, their correlation and the combination rule represent the informational determinants of the cost of capital in a setting where accounting and taxation rules coexist. Key for our results is the coefficient of correlation between the errors in the accounting and tax estimates. We found that the cost of capital unambiguously increases in this coefficient. When this coefficient is given, positive and high enough, we found that many of the classical results about information and cost of capital hold in our model too: cost of capital decreases in the precision of information. Hence, reporting rules should place more weight on the estimate that is most precise. However, when accounting and tax estimates exhibit either low but positive or negative correlations we found interior solutions for both precisions of estimates and the combination rule. This means that, taking the other determinants as given, there exists limits beyond which increasing precision of estimates (accounting or tax) may actually increase the cost of capital. Such an idea is in sharp contrast with conventional knowledge about information and cost of capital and proves that institutional factors such as the link between accounting and taxation must be considered when analyzing the relationship between public earnings reports and the cost of capital.

A few words about the limitations of our study are in order. First, the paper did not explore how tax rules shift cash-flows between periods. This is the cost we paid for taking a purely informational approach. Second, our analysis is developed in exogenous terms. All determinants of the cost of capital are taken as given. They do not appear as equilibrium results in a certain game or on a certain market. Therefore, most of our results are driven purely by the statistical properties of the public report. Setting aside these limitations, we believe the paper has the merits of exploring theoretically the effects of an institutional factor (the link between accounting and taxation) on the cost of capital. It generates interesting empirically testable propositions in settings where public reports are affected by accounting as well as tax estimates.

Conflict of Interests

The author has not declared any conflict of interests.

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MS excel functions as supply chain fraud detector

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Information technology (IT) is playing a vital role in increasing the productivity, profitability of businesses and optimizing decisions at each stage of Supply Chain Networks (SCN). Supply chain manager must often trust data for decision making even reported from vendors/suppliers. These types of data are vulnerable to manipulation and creating an opportunity for 'supplier opportunism'. Use of MS excel functions is a simple solution. The purpose of this empirical study is to find the intentionally manipulated data with help of excel functions. This finding can allow supply chain managers to segregate suspect data from decision-making until they can be validated and thus mitigate supplier opportunism.

Key words: Information technology, MS excel function, supply chain.

INTRODUCTION

In a digital age, internet has become the necessity of life that generates e-risks by fraudsters, though data interception, data interference, system interference or illegal access by e-mail spoofing or forgery, phishing, email spam, Denial of service attacks, unauthorized access physically or virtually to computer/computer system/computer networks, web jacking physically damaging the computer system etc are exponentially growing the addition cost to the organization/government to manage the e-risk in their supply chain networks. Fraud is a deceit, trickery, sharp practice or breach of confidence, perpetrated for profit or to gain some unfair or dishonest advantage (dictionaty.com). Broadly fraud can be categorized into the three categories: Asset misappropriations—Involving the theft or misuse of an organization's assets; Corruption—When fraudsters wrongfully use their influence in a business transaction to procure some benefit for themselves or another person, contrary to their duty to their employer or the rights of another; Fraudulent statements—Involving the falsification of an organization's financial statements .Within the above three global categories, ACFE (2013) identifies more than 70 areas of fraud. Organizational fraud can be classified into 15 categories: Bribery/illegal gratuities/ economic extortion, Conflicts of interest, Fictitious revenues/timing differences, Understated liabilities and expenses, Overstated assets/valuation, improper disclosures, Non-financial fraudulent statements Cash larceny, Skimming ,Inventory misuse/larceny, Billing schemes, Payroll schemes, Expense reimbursement schemes, Check tampering and Register disbursements. Supply chain data are soft targets for fraud by asset misappropriation, bid rigging, phantom bids, nepotism, substitution, false count, counterfeiting, creating fictitious accounting entities e.g., ghost employee, fake vendor, fake customer or vendor payments, falsified hours etc.

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It is very challenging for detective agencies to find frauds that occur in virtual supply chain environment. In this era, the scenario has undergone tremendous change because bytes are replacing bullets in the crime world. The Computer Assisted Audit Tools (CAATs) software and digital tools are absolutely essentials for these agencies but these are costly. Spreadsheets are one of the most popular and ubiquitous software packages on the planet. Every day, millions of business people use spreadsheet programs to build models of the decision problems they face as a regular part of their work activities (Ragsdale, 2007), forecasting with Excel (Radovilsky and Eyck, 2000), An Excel Based Case Using Financial Statement Analysis to Detect Fraud (Ragan, 2008) etc. This paper identifies the different MS Excel Functions and investigates its role and applications in managing supply chain frauds. The details of the research methodology are presented in Section 3. A brief review of the Excel function is presented in Sub-Section 4.1 and 4.2 related to data cleaning for analysis. Further onward section 4.3 of section 4, excel function with its use in digital analysis is discussed which was also tested as fraud detector on supply chain data of an organization. In discussion section the different types of supply chain frauds were reviewed for detection. Finally, result and conclusions are presented.

Microsoft excel

Microsoft excel is a spreadsheet which helps us to organize data in rows and columns of cells and it is simpler than most CAAT tools . It is also highly flexible, with huge list of functions, possible to install Add-Ins with advanced features, powerful Data Import feature, and lower cost for installation. Microsoft Excel has many powerful features and by using this can easily detect and prevent fraudulent activity; it has some limitations: it cannot log or document the audit work done, involves complex procedures to do detailed analysis, is prone to errors/tampering as data is open, risk of hidden rows and columns, takes much longer to process large data and data size limitation of processing only one million rows or records of data (Excel, 2007). Data lying in any of the formats: Text Files (*.TXT), Comma Delimited Files (*.CSV), Database Files (*.DBF), Extendible Markup Language Data Files (*.XML), Microsoft Access Database (*.MDB), Lotus 123 Databases (*.WK_) can easily be opened in Excel. It also supports Import of External Data through ODBC. Using SQL Data Queries, perhaps any data source can be accessed. This could range from SQL Server, Oracle to IBM DB2 database.

Excel function

Functions are formulas that Excel has predefined. An Excel function is a preset formula that calculates a specific result based on the criteria/variables/arguments; all functions start with the equal sign followed by the function's name and criteria/variables/arguments. It makes simple but cumbersome formulas easier to use, enables one to include complex mathematical expressions in worksheets that otherwise would be difficult or impossible to construct using simple arithmetic operators and enables one to include data in applications that could not be accessed otherwise. However, Excel's logical functions are designed to create decision-making formulas (McFedries, 2007, 2010).

RESEARCH METHODOLOGY

The study was conducted to review different Microsoft excel functions, which were part of Excel version 2007, 2010 and 2013. These functions were reviewed and sorted on the basis of their utilization in digital analysis. Further, these sorted functions were tested on an organizational data related to invoice data of vendor, sales data of customer as cleaning of data, counting, stratifications, ageing, gap analysis, duplicate check, etc. It can be replicated similar type of detection as duplicate check may be used for checking duplicate vendor, duplicate invoice etc. Further, in discussion section, the different types of supply chain frauds were reviewed and use of excel function for detection is also discussed. Data were collected primarily through books on Excel of different versions and from some e-journals search engines available in intranet or organisational library that are in the areas of digital analysis, excel and excel function, fraud etc.

MS excel functions as fraud detector

The commonly used Audit softwares are ACL, ActiveData For Excel, IDEA, TopCAATs etc. But Microsoft Excel is an ever-present tool and easily use for data analysis because spreadsheets are easy to navigate and flexible enough. Excel allows users to calculate a specific result on the basis of the user criteria, which start with the equal sign followed by the function's name; and criteria or variables or arguments as Sort, Subtotal, Filter, and Merge data etc. This is done by using inbuilt functions and it performs statistical analysis also. There are a total of 455 Excel Functions in Excel 2013; however 299 functions were in 2001 version (Excel 5.0) as shown in Appendix I and categories wise shown in Appendix II. These functions are separated into compatibility, cubes, databases, date and times, engineering, financials, information, logical, lookup and references, math and trigonometry, statistical, texts, user defined add-ins and webs. Hence, Microsoft Excel has become an industry standard in managing and analyzing organizational data. Some Excel functions as IF, combination of IF, AND, SUM, OR, VLOOKUP are very powerful tools for auditing or investigating agencies for detecting fraud from supply chain networks.

Excel data cleaning functions

During investigation or auditing we receive or retrieve data in different formats such as Text, Comma Separated Value (CSV) or Web Page formats. For analyzing these retrieved data in excel, this is a requirement to clean it first to match the criteria that we specify. There is so many features in excel to perform the cleaning activities. Some of the following excel functions for cleaning data are: CLEAN function (syntax CLEAN (text)) removes all non-printable characters from text. This function can be used on text imported from other applications that contain characters that may not print with certain operating system. For example, we can remove some low-level computer code that is frequently at the beginning and end of data files and cannot be printed. TRIM function (syntax is TRIM (text)) removes all spaces from text except for single spaces between words. TEXT function converts a value to text in a specific number format. Its syntax is TEXT (value, format_text), where value is a numeric value, a formula that evaluates a numeric value or a reference to a cell containing a numeric value; and format_text is a number format in text form from the Category box on the Number tab in the Format Cells dialog box. CONCATENATE function joins several text strings into one text string. Its syntax is CONCATENATE (text1, text2,...). The "&" operator can be used instead of this function to join text items.

LEFT Function (syntax LEFT (text, num_chars)) returns the first character or characters in a text string, based on the number of characters specified. Similarly RIGHT returns the last character or characters in a text string, based on the number of characters specified. MID returns a specific number of characters from a text string, starting at the position we specify, based on the number of characters specified. FIND function finds one text string (find_text) within another text string (within_text), and returns the number of the starting position of find_text, from the first character of within_text. SEARCH function returns the number of the character at which a specific character or text string is first found, beginning with start_num. Use SEARCH to determine the location of a character or text string within another text string so that we can use the MID or REPLACE functions to change the text. But unlike SEARCH, FIND is case sensitive and does not allow wildcard characters. REPLACE function replaces part of a text string, based on the number of characters we specify, with a different text string. SUBSTITUTE function substitutes new_text for old_text in a text string. This function is used when we want to replace specific text in a text string; but REPLACE function is used when we want to replace any text that occurs in a specific location in a text string. LOWER function converts all uppercase letters in a text string to lowercase and similarly UPPER function converts text to uppercase. PROPER function capitalizes the first letter in a text string and any other letters in text that follow any character other than a letter.

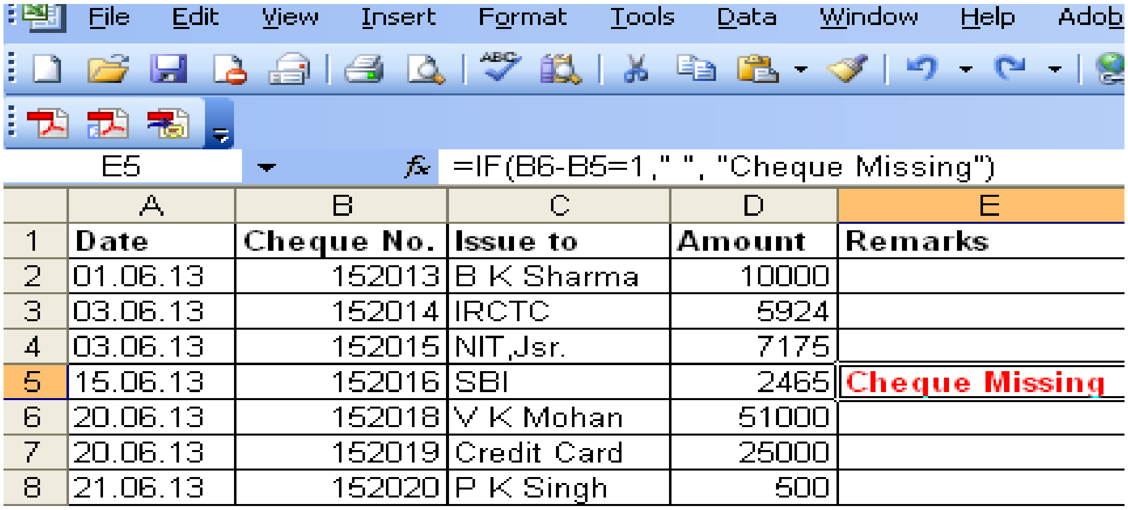
It converts all other letters to lowercase letters. FIXED function rounds a number to the specified number of decimals, formats the number in decimal format using a period and commas, and returns the result as text. Its syntax is FIXED (number, decimals, no_commas), where number is the number we want to round and convert to text, decimals is the number of digits to the right of the decimal point and no_commas is a logical value that, if TRUE, prevents FIXED from including commas in the returned text. LEN function returns the number of characters in a text string. VALUE function converts a text string that represents a number to a number. CODE function returns a numeric code for the first character in a text string.

The returned code corresponds to the character set used by our computer. CHAR function returns the character specified by a number. Use of this function is to translate code page numbers we might get from files on other types of computers into characters. CELL function returns information about the formatting, location, or contents of the upper-left cell in a reference.
DOLLAR function converts a number to text format and applies a currency symbol. RTD function retrieves real-time data from a program that supports COM automation. TRIMMEAN function returns the mean of the interior of a data set. This function can be used for excluding outlying data from analysis.

Rounding and formatting function

ROUND function rounds a number to a specified number of digits and MROUND returns a number rounded to the desired multiple. TRUNC function truncates a number to an integer by removing the fractional part of the number. CEILING function returns number rounded up, away from zero, to the nearest multiple of significance and similarly FLOOR rounds number down, toward zero, to the nearest multiple of significance. INT rounds a number down to the nearest integer, ODD returns number rounded up to the nearest odd integer, EVEN returns number rounded up to the nearest even integer and ROUNDDOWN rounds a number down, toward zero.
The evaluations of financial information made by a study of plausible relationships among both financial and non-financial data to assess whether account balances appear reasonable (AICPA, SAS 56) for analytical Tests like horizontal analysis (increase or decrease over two or more periods), vertical analysis, ratio, etc by simple excel functions.

The following functions are more useful to detect frauds in supply chain environment.



	A	B	C	D	E
1	Date	Cheque No.	Issue to	Amount	Remarks
2	01.06.13	152013	B K Sharma	10000	
3	03.06.13	152014	IRCTC	5924	
4	03.06.13	152015	NIT,Jsr.	7175	
5	15.06.13	152016	SBI	2465	Cheque Missing
6	20.06.13	152018	V K Mohan	51000	
7	20.06.13	152019	Credit Card	25000	
8	21.06.13	152020	P K Singh	500	

Figure 1. Gap analysis of missing document.

IF function

The most common and powerful of the logical functions in Excel is the IF function. The syntax of IF function is '=IF (logical_test,value_if_true,value_if_false)'.The IF function is used for ageing analysis, gap detection, duplicate records finding, locating multiple records, extracting records meeting certain criteria etc. This is very useful function of decision making. IF function had been used for finding sequential missing of data as shown in Figure 1.

Gap analysis by using IF function

This is a tool which is used for identifying gaps of missing within a specified field in a file for sorted and indexed data. These gaps analysis may be applied for manipulated or intentionally deleted entry from serial sequence control documents, products identification, certification, human resource data etc. Excel makes it possible to identify if there are any gaps in any column of data which is expected to have a sequential numbering. It can be accomplished in a very simple manner. We can sort the data serially on the said column and then in a new column, calculate the difference of the value from the value in the above row. The calculated values should be 1 if there is no gap. We are using IF function. Given screen sort for missing cheque of an individual data, the syntax for E5 field is '=IF (B6-B5=1," ", "Cheque Missing")'

Nested IF function

This is IF within IF function. It is used when evaluating either the *value_if_true or value_if_false* arguments.

Use of nested IF in stratifications, count and ageing

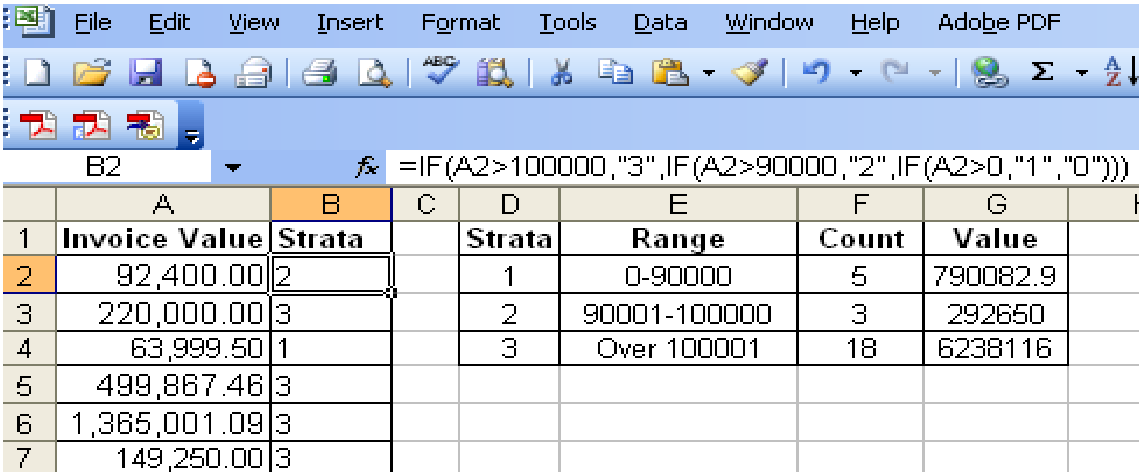
Stratifications, counting and ageing for SCM data provide a useful view into the largest, smallest, and average transactions within specified intervals/group. It is also an important tool for auditors and detecting agencies for analytical test of data (Figure 2).

IF function with AND / OR function

If simultaneous confirmation for logical actions is required then we may use AND or OR with the IF function. It is often necessary to perform an action if and only if two conditions are true. In Excel, And conditions are handled, appropriately enough, by the AND() logical function: AND(logical1 [, logical2 ,...]). Similar to an And condition is the situation when you need to take an action if one thing or another is true. Or conditions are handled in Excel by the OR() function: OR(logical1 [, logical2 ,...]).

Excel function as duplicate checker

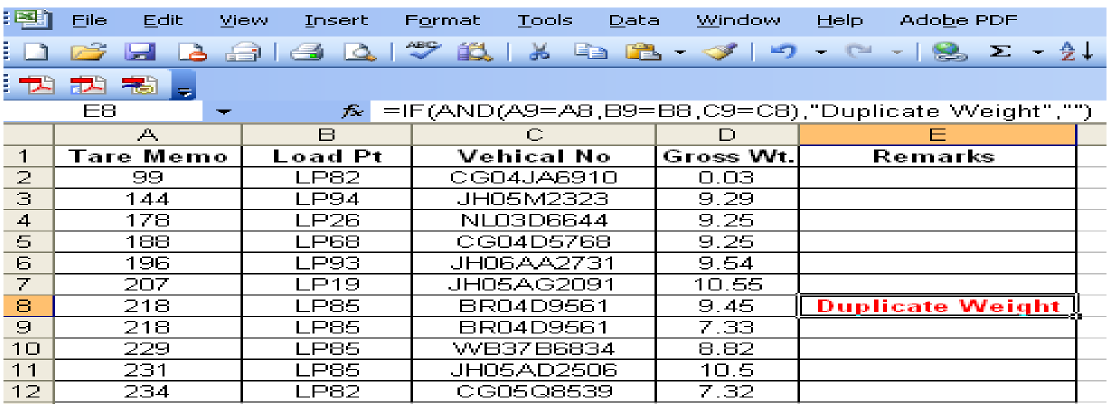
This is converse of gap analysis where the serial control sequence should not be repeated. It is used for detecting duplicate data within a specified field in a file, e.g. duplicate vendors, duplicate invoices and other duplicate entries which lead to fraudulent transaction in the supply chain networks. It can be also applicable where same-same-different checks are required by auditing or detecting agencies as cluster of vendor code and their invoice numbers for excess or double payment to fraudulent vendor. Here excess weight done in the system against tare memo no. 218 against a sell data of an organization and its syntax appears in the given screen shot (Figure 3).



B2 =IF(A2>100000,"3",IF(A2>90000,"2",IF(A2>0,"1","0")))

	A	B	C	D	E	F	G
1	Invoice Value	Strata		Strata	Range	Count	Value
2	92,400.00	2		1	0-90000	5	790082.9
3	220,000.00	3		2	90001-100000	3	292650
4	63,999.50	1		3	Over 100001	18	6238116
5	499,867.46	3					
6	1,365,001.09	3					
7	149,250.00	3					

Figure 2. Stratifications and count.



E8 =IF(AND(A9=A8,B9=B8,C9=C8),"Duplicate Weight","")

	A	B	C	D	E
1	Tare Memo	Load Pt	Vehical No	Gross Wt.	Remarks
2	99	LP82	CG04JA6910	0.03	
3	144	LP94	JH05M2323	9.29	
4	178	LP26	NL03D6644	9.25	
5	188	LP68	CG04D5768	9.25	
6	196	LP93	JH06AA2731	9.54	
7	207	LP19	JH05AG2091	10.55	
8	218	LP85	BR04D9561	9.45	Duplicate Weight
9	218	LP85	BR04D9561	7.33	
10	229	LP85	WB37B6834	8.82	
11	231	LP85	JH05AD2506	10.5	
12	234	LP82	CG05Q8539	7.32	

Figure 3. Duplicate entry checking.

Count IF function

The Count IF function is used to analyze the master data (material, service, vendor, customer, employee etc.) of any organizations with the user criteria. It helps the investigator in filtering, sorting, duplicating verification and applying Benford's analysis etc. The syntax of Count IF function is '=COUNTIF (range, criteria)'.

The screen shot (Figure 4) shows the number of time the tare memo appears in column A , which indicates that there is a violation of serial control mechanism. This can be appliied to check the duplicate vendor though different entities like telephone number, tax code, address etc.

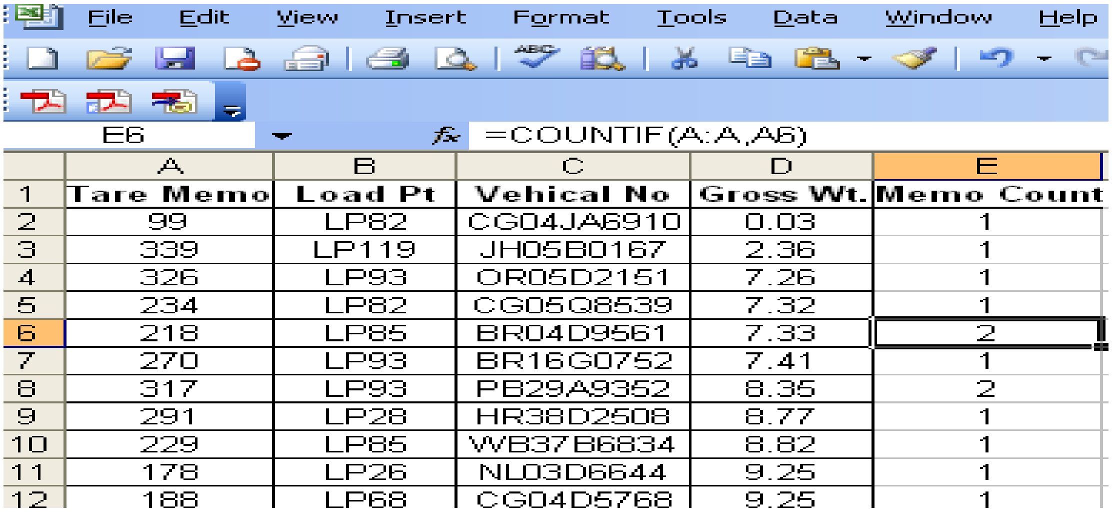
SUMIF function

The summation of the cells value of specified by a given/user defined criteria can be performed with the application of SUMIF function. This function works as Pivot Table command but this function is useful where real time data are analyzed. It may be used for strata calculation. Its syntax is "=SUMIF (range,criteria,sum_range)".

In Figure 5, it appears that vehicles No. enter in cell C6 loaded more than one time with weight appearing in cell value E6.

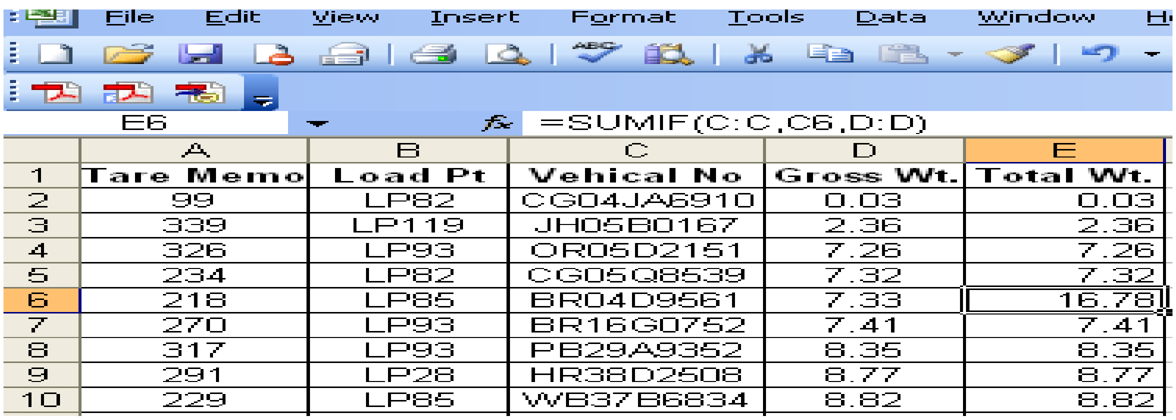
VLOOKUP Function

This function is useful for auditor in combining specified fields from two different files into a single file using key fields. It creates relational databases on key fields. There are several applications of this function in auditing or investigation which depends upon the circumstances and subject matters. The syntax is "=VLOOKUP (lookup_value,table_array,col_index_num,range_lookup)" , where Lookup_value is the value to be found in the first column of the array. Lookup_value can be a value, a reference, or a text string; Table_array is the table of information in which data is looked up. Use a reference to a range or a range name, such as Database or List, Col_index_num is the column number in table_array



	A	B	C	D	E
1	Tare Memo	Load Pt	Vehical No	Gross Wt.	Memo Count
2	99	LP82	CG04JA6910	0.03	1
3	339	LP119	JH05B0167	2.36	1
4	326	LP93	OR05D2151	7.26	1
5	234	LP82	CG05Q8539	7.32	1
6	218	LP85	BR04D9561	7.33	2
7	270	LP93	BR16G0752	7.41	1
8	317	LP93	PB29A9352	8.35	2
9	291	LP28	HR38D2508	8.77	1
10	229	LP85	WB37B6834	8.82	1
11	178	LP26	NL03D6644	9.25	1
12	188	LP68	CG04D5768	9.25	1

Figure 4. Counting of entry.



	A	B	C	D	E
1	Tare Memo	Load Pt	Vehical No	Gross Wt.	Total Wt.
2	99	LP82	CG04JA6910	0.03	0.03
3	339	LP119	JH05B0167	2.36	2.36
4	326	LP93	OR05D2151	7.26	7.26
5	234	LP82	CG05Q8539	7.32	7.32
6	218	LP85	BR04D9561	7.33	16.78
7	270	LP93	BR16G0752	7.41	7.41
8	317	LP93	PB29A9352	8.35	8.35
9	291	LP28	HR38D2508	8.77	8.77
10	229	LP85	WB37B6834	8.82	8.82

Figure 5. Use of SUMIF.

from which the matching value must be returned and Range_lookup is a logical value that specifies whether we want VLOOKUP to find an exact match or an approximate match.

Join / Relate for master data

This combines specified fields from two different files into a single file using key fields. This function is used to create relational databases on key fields. For example, the vendor master file could be related to the invoice file to obtain address information for cheque clearing bank account no. against each invoice.

LOOKUP function

LOOKUP functions are functions which lookup the value of a selected cell in another data table and return the corresponding detail of the matching cell. Using LOOKUP functions we can create a MASTERTRANSACTION, or a PARENT-CHILD relationship between different data tables. Lookup functions can be used to check the data integrity of tables and also to link data from multiple tables. This function returns a value either from a one-row or one-column range or from an array. The LOOKUP function has two syntax forms: vector and array. The vector form of LOOKUP looks in a one-row or one-column range (known as a vector) for a value and returns a value from the same position in a second one-row or one-column range. The array form of LOOKUP looks in the first row or column of an array for the specified value and returns a value from the same position in the last row or column of the array. The array form of LOOKUP looks in the first row or column of an array for the specified value and returns a value from the same position in the last row or column of the array. Use this form of LOOKUP when the values we want to match are in the first row or column of the array. Use the other form of LOOKUP when we want to specify the location of the column or row. The array form of LOOKUP is very similar to the HLOOKUP and VLOOKUP functions. The difference is that HLOOKUP searches for lookup_value in the first row, VLOOKUP searches in the first column, and LOOKUP searches according to the dimensions of array.

RAND and RANDBETWEEN Function

Excel provides two tools for generating random numbers. The RAND function (syntax "RAND()") in Microsoft Excel allows to generate random numbers from the uniform distribution. It is a volatile function, which means it will be recalculated any time the enter key is pressed, so the random number constantly changes. RANDBETWEEN returns a random number between the numbers as specified.

Cross Tabulate

Cross Tabulate analyzes character fields by setting them in rows and columns. By cross tabulating character fields, we can produce various summaries, explore areas of interest, and accumulate numeric fields. Excel effectuates cross-tabulation through its Pivot Tables .The pivot table quickly summaries or analyses large data as subtotaling, aggregating, categorizing, creating custom calculation and formula. It also helps in filtering, sorting and grouping the data. Because a Pivot Table report is interactive, we can move rows to columns or vice-versa. To apply the Pivot Table, we firstly select the icon and navigation through interactive dialogue box. By selecting appropriate range of data and output table area, it is easily crosstabs as row and column labels. It is a data consolidate approach that sums automatically, can be used as pivot, drillable, table formatting etc. for detecting frauds.

Data analysis tools

The Data Analysis add-in has much more than just a Correlation tool. It includes a tool that returns descriptive statistics for single variable, tools for several inferential tests (Carlberg, 2010). By help of univariate Statistics (statistics relating to a single variable) we can find out the mean, median, mode, standard deviation, skewness, kurtosis and various other statistical data relating to the variable. This gives a general idea about the behavior pattern of data but also forms a support base for conducting further statistical analysis of the data for fraud detection.

DISCUSSION

There are possibilities of different type of fraud risk in supply chain network as bid rigging, phantom bids, nepotism, substitution, false count, counterfeiting, creating fictitious accounting entities e.g., ghost employee, fake vendor, fake customer or vendor payments, falsified hours etc. We can easily detect and prevent fraudulent activities by help of above discussed excel function. There is some following application of excel sheet functions which were discussed above in overcoming the fraud in supply chain.

1. Conflict of Interest - Officials involved in Supply Chain Management have to act their duties in organizational interest. If they perform duties to gain any benefits to their family member or friends is the part of conflict of interest. For detection this matching algorithms are suitable as employee – vendor key field as telephone no, e-mail address, social ID no, bank account number by using IF, MATCH, VLOOKUP etc. functions. As shown in Figure 3 can be replicate for detecting this fraud.

2. Fake customer or vendor Payment – Duplicate payments are far more common than most organisations realize or are prepared to admit. *Core Algorithms* is a logic that identifies all duplicate payments by using four fields of vendor payment i.e; vendor code, invoice number, invoice date and invoice amount with exact (E),Similar (S) and different (D) combination matching on these fields. The possible combinations are EEEE (means exact matching of vendor code, invoice no., date and amount), DEEE, ESEE, EESE, EEES, ESES, ESSE, EESS and DESE. We can use IF, combination of IF AND function for getting the core algorithms combinations. The type of fraud is detected by using this core algorithms common name and address of employee for payment. As shown in figure 3 can be replicate for detecting this fraud.

3. Duplicate vendor – This is the occurrence of multiple vendor code in name of any vendor's proprietor. Generally, auditors or detecting agencies are using the address, tax id, and bank number or vendor sensitive data. For this IF with AND function and the condition formatting is useful for duplicate check. As shown in Figure 3, it can be replicated for detecting this fraud.

4. Ghost Employee – It is someone on the payroll who does not actually work for a victim organization. It can be detect by analysis of payments being made to employees that are not reconciling to other independent employee data sources.

5. Piggyback Fraud – This is the malicious entry with valid of person or data or material. This can be detected by comparing or matching data by using IF function.

6. Missing Vendor or Customer data – IF function may be used for identify the blank fields of vendor or customer data. As shown in Figure 2, it can be replicated for detecting this fraud.

On application of excel function on the sample data (although the amount of individual data is proprietary) of an organization, has been selected from procurement cycle of Supply Chain Network, vendor master, employee master, etc. for verification of above mention supply chain fraud because vendor and employee are essential components of supply chains. As discussed above during our experiment, duplicate invoices had been detected. Further, duplicate check was replicated on vendor master data extracted in excel sheet from SAP system with vendor code and its telephone nos. The vendors with common telephone numbers were detected in the system and they were eliminated as further action. The vendor and employee with common mobile numbers or address were also detected, which was the part of conflict of interest. During the course of work, a concern was received that there was profiteering by several vendors in this organization. Prima facie verification of records reflected that the amounts billed by the contractors were logical. At this point the combined function as LEFT for finding significant digit (FSD), SUBTOTAL,COUNTIF for frequency of FSD has been implemented during detecting supply chain fraud by using Benford's distribution for same organization. As detected most payments were made between Rs.90000 to Rs.99999 to avoid the higher approval authorities limit, i.e. one lakh, which was the generation of procurement fraud due to splitting of purchase orders, and the repeat orders were awarded to the vendors to manipulate payment with ulterior motives (Varma and Khan, 2013). On further analysis, it was observed that the these fraudulent activities were made due to incomplete or vague job specification, selection of vendor without proper capability assessment, and wrong inputs/ incomplete data in negotiation sheet to highlight capability of vendor, etc., which lead to a major investigation after which strong nexus between officers and vendors was found .

Conclusion

Microsoft Excel can be used to develop some management decision making supporting tools for the sake of easy use and low cost of ownership. We illustrated application in supply chain for auditing and investigating. Technology is always a double-edged sword. Society that is dependent more and more on technology, cyber crimes are bound to increase because bytes are replacing bullets in the crime world. History is the witness that no legislation has succeeded in totally eliminating crime. The advanced quantitative modeling techniques (such as multiple regression, etc.) are involved; Excel add in called Data Analysis should be activated and use for quick and advance analysis with big data.

Conflict of Interests

The authors have not declared any conflict of interests.

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Appendix I.

Excel Functions	
Version	**No.**
Excel 5.0	299
Excel 2002	40
Excel 2003	0
Excel 2007	5
Excel 2010	61
Excel 2013	50
Total	455

Appendix II.

Functions in Excel 2013	
Category	**No.**
Compatibility	38
Cubes	7
Databases	12
Date and times	24
Engineering	54
Financials	55
Information	20
Logical	9
Lookup and references	19
Math and trigonometry	79
Statistical	101
Texts	30
User defined with add-ins	4
Webs	3

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