# CORPORATE GOVERNANCE AND MARKET REACTIONS

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## ABSTRACT

Defining good governance is a complex issue. Currently used conventional ranking methods typically use endogenous variables that can be controlled by the information providers. Recent accounting scandals have exposed this weakness. In this paper, we show that share mispricing, which is more exogenous and market determined is a simple but effective measure of corporate governance. Our methodology of measuring corporate governance using market reactions is consistent with the S&P ranking of corporate governance. However, by measuring the information adjustment process during event announcements, we believe deeper insights can be obtained. We find that companies based on S&P's governance ranking have different information adjustment processes. On the whole, shares of good governance companies are less mispriced compared to bad governance companies. However, good governance companies are more mispriced during event announcements compared to bad governance companies.

# 1. INTRODUCTION

The recent worldwide accounting scandals, have underscored the role of corporate governance in protecting the interests of investors. However, the growing awareness of corporate governance has also made it more difficult to define good governance. The complexities behind corporate governance can be classified into two broad categories. First, is the multi-disciplinary nature of the subject. Among other disciplines, Accounting, Financial economics, Law, Philosophy and Political Science have linkages with corporate governance. The diversity of disciplines involved makes it difficult to arrive at one single measure of corporate governance. Cultural diversity also contributes to the complexity. Allen and Gale (2002) state that Anglo-Saxon countries such as the US and UK equate corporate governance with firms pursuing the interests of shareholders. Whereas in countries like Japan, Germany and France, corporate governance is concerned with the interests of a wider set of stakeholders, including employees, customers and shareholders. In short, arriving at an objective definition of corporate governance is itself an important issue.

This paper aims at simplifying the process of measuring corporate governance. We use a new model based on the theoretical framework provided by Daniel, Hirshleifer, and Subramanyam (DHS) (1998). We define corporate governance in a much broader sense, compared to the existing definitions as cited by Allen and Gale (2002). We believe that good governance should not be limited to maximizing shareholders' wealth or other people closely associated with the organization. We define corporate governance *as a mechanism that involves effective allocation of resources in order to maximize social welfare[1]*. Each corporate entity should align its corporate purpose with this larger goal of social welfare. Though this may sound somewhat odd, we will attempt to show that this definition is not very much different from the existing definitions. At the same time, the methodology we use is objective, even as it tries to incorporate the various disciplines actively associated with corporate governance.

We believe market reactions provide the best measure of corporate governance. Stock mispricing is the core information that reflects corporate governance. Mispricing of shares in the stock market leads to sub-optimal capital structures. A sub-optimal capital structure leads to sub-optimal usage of scarce resources and in turn affects the welfare of society. This will also lead to spill over effects.

If a company's shares are overpriced, it attracts more equity capital than required from investors. If a company's shares are underpriced, the much-needed economic resources, which might increase growth, are not available to the company. In both cases, there is sub optimal utilization of economic resources. The logic holds even in the presence of alternative financing

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[1] Our definition of welfare is not strictly as defined in welfare economics. We define welfare as a common goal that maximizes benefits for the investing community.

methods. For example, underpriced companies may use debt as an alternative source of financing their projects. But increase in debt increases default risk and consequently the cost of capital.

Overpriced companies to borrow more as they have access to cheaper debt thus making them more underutilized. The Asian financial crisis is a classical example of this situation. Allen (2001) states that providing loans to corporate entities without good monitoring mechanism is the main cause of Asian crisis. The crisis also resulted in spill over effects to the neighboring states.

We believe that this is the first attempt to relate stock mispricing to corporate governance. Our definition is consistent with Market Efficiency Hypothesis (See Fama, 1970), which states that speed of information adjustment depends on the nature of information (private or public) and the role of disseminators. We believe that regulators, market structure/ design and market participants have an equally important role to play in ensuring the fair pricing mechanism that calls for instantaneous adjustment to information. Having said that, we feel the role of disseminators is more important as they are the source of the information dissemination process. This should hold at least when there is a substantial difference in the mispricing of good and bad governance companies. Thus, we assume that most of the mispricing is to poor corporate governance.

We test the following hypotheses:
1.     Good governance companies should have less mispricing compared to bad governance companies.
2.     Good governance companies should have less private information before events than bad governance companies.
3.     Good governance companies should have lower volatility compared to bad governance companies.

When we tested these hypotheses for the Indian stock market we found that the average mispricing is low for good governance companies compared to bad governance companies. However, we have inconsistent results for event-specific periods. We found that good (bad) governance companies are heavily overpriced (underpriced) during event announcements. We also found that over pricing in good governance companies is significantly high if the nature of information is more private than public. Whereas bad governance companies experience significant underpricing if the nature of information is more public than private. Supporting this evidence we found that good governance companies exhibit negative auto covariance between event date return and two months prior to the event date return and positive auto covariance returns with a month before the event date. This pattern occurs only for good governance companies. When we used DHS (1998) measure of excess volatility during the private information period, we found that good governance companies display more volatility in case of sale of assets, which is the most significant event for mispricing in case of

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such companies. Unless we test our hypotheses for other markets we cannot clearly site the reasons behind this inconsistency. Based on Marisetty's (2003) evidence that there is substantial over/under reaction in the Indian market compared to US market, we attribute much of mispricing in good governance to the noise trading and positive feedback trading than the governance mechanism itself. However, this is not a desirable attribute in good governance companies.

## 1.1 Good Vs Bad Governance

To address the stated hypotheses in Section 1 we have to first define good and bad governance companies. As there is no clear cut definition as explained in Section 1, for convenience we use Standard and Poors (S&P) corporate transparency rating of Indian companies as the basis for identifying good and bad governance companies. S&P ranking covers around 50 Indian companies[2]. The ranking is based on three broad categories namely, (1) Corporate structure and investor relations, (2) Transparency and information disclosure, and (3) Management structure and processes. Each category has 28, 35 and 35 attributes respectively. (For more details see Appendix 1). S&P's comprehensive ranking is on a scale of 1 to 10. We classify any company in our sample with a comprehensive ranking below (above) 5 as a bad (good) governance company. With this classification, we have 17 good governance companies and 25 bad governance companies. Table 1 shows the details of S&P ranking. As shown in the table, Infosys Ltd and SSI Ltd with a ranking of 7 out of 10 lead the governance ranking in India. Where as Cipla Ltd with a ranking of 2 out of 10 is the worst governed company in our sample. Our sample is biased toward large companies. The sample consists of NSE top 100 stocks. However, the large variation in corporate governance ranking within the sample covered, clearly indicates that size is not the only determinant of corporate governance. Moreover, there are difficulties in extending this methodology to small companies. Infrequency in trading for small companies is a big issue. Also, announcement of events in case of such companies is less widely reported. So, the kind of rich information which is available in the case of larger, better known companies is missing in the case of smaller companies. Thus the results on small companies may not be that accurate. Our methodology also indirectly tests the robustness of the ranking agency's ranking. Theoretically both the fundamentals based ranking of S&P and market valuation based rating as per our method should be symmetrical. However, it is beyond the scope of this paper to cover this issue in greater detail.

## 1.2 Events

DHS (1998) show that the nature of information is event specific. They argue that the degree of private and public information varies based on the event. Some events carry more information than

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[2] We checked for other Indian and international companies for corporate governance ratings. We found that CRISIL and ICRA, two Indian rating agencies also rate companies based on their corporate governance. However, the number of companies covered by these agencies is less than 10 and S&P's raking explicitly describes various attributes for their ranking methodology. The same is not found for the Indian ranking agencies.

others. This assumption gives us a good platform to test corporate governance. Good governance companies should not exhibit any abnormalities in case of both events. However, bad governance companies, due to their information leakages should exhibit more abnormality during events that have more private than public information. We have selected four such events which vary with respect to the nature of information, private or public: (1) Dividends, (2) Merger/takeovers, (3) Preferential allotment and (4) Sale of assets[3].

Dividends have a higher degree of public information than private information (See DHS, 1998).  This is due to the role of analysts who tend to follow dividend announcements closely and also due to the easy availability of information on past dividend historical trends.  Merger/ takeover events due to their price sensitivity have more private information. However, due to their externality, some analysts may come across signals prior to would-be merger/ takeover announcements by tracking prospective companies' interactions. The remaining two events namely, preferential allotment and sale of assets have the highest degree of private  information. Bertrand, Mehta and Mullainathan (2002) found that most of the Indian companies tunnel funds from their subsidiaries using various means including sale of assets. As indicated in the paper such tunneling is a major corporate governance issue in the emerging markets. There is also a lot of controversy in the Indian media on the preferential allotments. Media reports seem to indicate that family owned Indian companies use the preferential allotment route to increase their ownership in their subsidiary companies.

Thus, we expect bad governance companies to exhibit more mispricing than good governance companies during these four events. The mispricing should be more if the event has a higher degree of private information than public information.


## 2. METHODOLOGY

Existing methods heavily rely on financial statements in order to measure corporate governance. For instance, several papers use Tobin's Q, ownership structure, cash flow rights and other endogenously[4] defined variables (see Shleifer and Vishny, 1997). The results based on such variables need close scrutiny especially after the recent accounting scandals.

### 2.1 Theoretical framework

Following the theoretical framework of DHS (2002) we assume that there are four important dates in the price discovery process during event announcements.

Date 0, where all investors have identical prior beliefs;

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[3] Due to data insufficiency we limited our study only to four events. However, events like share buyback can be examined.
[4] Readers may find the way we defined endogenity as confusing. Even though the ranking of rating agencies is exogenous to the companies, it is ranked based on endogenous variables, i.e., variables whose measurements are controlled by the organization.  Compared to ranking of rating agencies market reactions are more exogenous, i.e., outside the control of the organization.
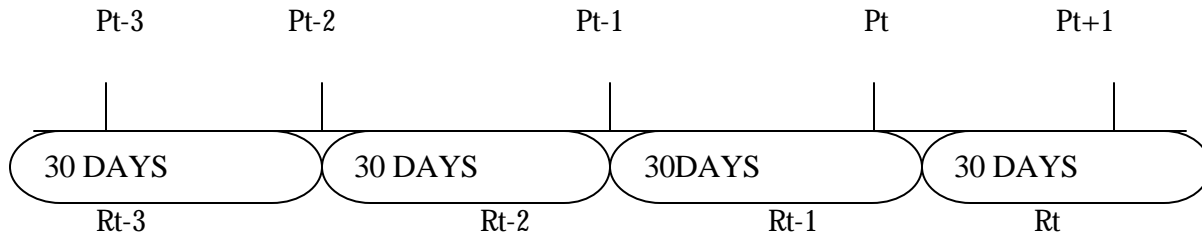
Date 1, where informed investors receive a noisy private signal about the underlying value of the security;

Date 2, noisy public information arrives and further trade occurs and

Date 3, conclusive public information arrives and securities pay liquidating dividends

The process is represented in Figure 1

<div align="center">FIGURE 1[5]</div>



From figure 1

Date 0 price process is represented by Pt-3 to Pt-2 and it is captured in the return

Rt-3 (Pt-2 – Pt-3)

Date 1 price process is captured by the return Rt-2 (Pt-1 – Pt-2)

Date 2 price process is captured by the return Rt-1 (Pt – Pt-1) and

Date 3 price process is captured by the return Rt (Pt+1 – Pt)

## 2.2 Testing for the information content

DHS (1998) used covariances of the returns to measure the information content at different time periods. For instance, Cov (Rt-2, Rt) should be less than zero or negative if the information in private information period (Pt-1 – Pt-2) is different from the public information period (Pt +1– Pt). Like wise, the Cov (Rt-1, Rt) should be more than zero or positive if the information in noisy public information period (Pt-1 – Pt-2) is similar to the public information period (Pt+1 – Pt). In an event study context, Pt is the stock price on the event announcement date and (Pt-2 to Pt) is the pre event window and (Pt to Pt+1) is the post announcement window.

In that case, the Cov (Rt, Rt-3) should be zero as both these time periods are independent of the information content of the event.

Based on the above discussion we propose the following relationships:

1. Cov (Rt-2, Rt) <0 representing partial adjustment due to private information[6]
2. Cov (Rt-1, Rt)>0 representing partial adjustment to noisy public information

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[5] We use windows of different durations ranging from 10 to 50 days. For simplicity, here, we used 30days window. While testing our model the duration of window to calculate return ranges from 10 days to 50 days. For instance, 30-30 window represents returns are calculated using 30 days as the duration for two return series. 10-50 window represents, returns are calculated with 10days and 50 days windows respectively. Taking the total window as more than 60 days will reduce our sample size drastically. Thus, we are limiting our overall window to 60 days.

[6] Cov (Rt-2, Rt) is assumed to be negative to be consistent with DHS model. It can as well be positive to represent price adjustment process.

3. Cov (Rt-3, Rt) = 0 representing the price process during pre-vent window and post-event window as independent.

There is no consistency on the duration to be used for measuring price adjustment process in the event study literature. The duration of price adjustment process varies from market to market and also from event to event. Most of the conventional event studies use 30 days before and 30 days after the event as the price adjustment process. In order to avoid any criticisms we use four different durations in our study. Duration 30-30 for calculating Cov (Rt-2, Rt) represents both Rt-2 and Rt are calculated for 30 days. The 30-30 window assumes that the price adjustment process during the Rt-2 period and Rt period are same. We also used 40-20, 20-40, 10-50 and 50-10 windows. Thus 10-50 window assumes that, in case of Cov (Rt-2, Rt), the price adjustment during Rt (Pt +1 to Pt) period is much longer than Rt-2 (Pt-1 to Pt-2). By using different windows we not only test the robustness of the results but also provide better understanding on the optimality of duration to calculate return in the event study context.

## 2.3 Measuring the Level of Mispricing

We define fair pricing first in order to better understand mispricing:

$$(P_t - P_{t-1}) = g \, (V_t - P_{t-1}) + u_t \qquad - \qquad 1$$

Where $P_t$ is the observed price at time $t$, $V_t$ is the intrinsic value at time $t$ and $u_t$ is the noise due to the valuation and interpretational errors. $u_t$ can be interpreted as white noise with zero and finite variance $s^2$. g as shown in Amihud and Mendelson (1986) represents price adjustment coefficient. When g = 1 we mean fair pricing. g> 1 represents over pricing and g<1 represents under pricing. Thus, mispricing in this context is defined as the stock pricing during partial adjustment phase. In section 2.2 mispricing can be observed during Pt-2 to Pt time period (information adjustment period). The value of g at

Private information stage {second order auto covariance (Cov(Rt-2, Rt))} can be solved as shown in Marisetty (2003)[7]

$$g = 1- \{Cov \, (Rt-2, \, Rt)/Cov \, (Rt-1, \, Rt)\} \qquad -(2)$$

From equation 2 one can see that g =1 when Cov (Rt-2, Rt) and Cov (Rt-1, Rt) both are independent with value 0. In our case g >1 indicates overpricing and g<1 indicates underpricing. Higher (lower) g also indicates that mispricing is more during private (public) information adjustment process.

## 2.3 Excess volatility

DHS (1998) proposed excess volatility measure ($V_t^E$) at different price adjustment processes

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[7] See appendix 2.

$V^E_t = Var(Pt - Pt\text{-}1) - Var_R (Pt - Pt\text{-}1)$          - (3)

$$\underline{\phantom{V^E_t = Var(Pt - Pt\text{-}1) - Var_R (Pt - Pt\text{-}1)}}$$

         $Var_R(Pt - Pt\text{-}1)$

Where, $Var_R (Pt - Pt\text{-}1)$ is the variance when all individuals are rational. As $(Pt - Pt\text{-}1)$ period carries public information where investors act more rationally compared to $(Pt\text{-}1 - Pt\text{-}2)$ period we assume that the variance during $(Pt - Pt\text{-}1)$ is $Var_R (Pt - Pt\text{-}1)$ in the equation 2. Then, excess volatility during private information adjustment phase is given by

$V_t{}^{EP} = \underline{Var (Pt\text{-}1 - Pt\text{-}2) - Var_R (Pt - Pt\text{-}1)}$          - (4)

         $Var_R (Pt - Pt\text{-}1)$

We use equation 4 to test whether excess volatility varies between good and bad governance companies and also to test whether nature of event affects volatility.

## 3. DATA

We source our data from the S&P website to classify stocks as good and bad. The PROWESS database has been used for firm-specific information and for the event dates. We found only four events as mentioned in section 1.2 that have continuous data between 1996 and 2003. Firm-specific information before 1996 for the selected companies trading on NSE is very scanty. During the eight years of the study period, we selected 31 (13) events for sale of assets, 24 (26) events for preferential allotments, 13(11) events for dividend announcements and 14 (11) events for merger announcements for bad (good) governance companies. We selected only those events that do not have any overlap at least for 90 days with any of the other respective events. This filtering process, we believe, ensures the robustness of our results even though we use a smaller sample size. As indicated in the methodology we used daily price data in order to calculate returns for each event for a period of 90 days before the event and 30 days after the event.


## 4. RESULTS

The results are organized in Tables 2 to 7. The tables summarize results using average values grouped based on events and governance[8]. Tables 2 and 3 depict average auto covariances of good and bad governance companies for four different events with five different windows. Auto covariances of three sub-periods with respect to the announcement date namely, independent period (third order autocovariance), private information period (second order auto covariance) and semi-public period (first order auto covariance) are presented in three columns in the same order. All the results have z-values using Mann-Whitney test in parentheses. Z-values indicate whether the results between good and bad governance companies are significantly different. The negative covariance with respective to the announcement date is prominent in both independent period and private information period for

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[8] Readers interested to know the individual company results can mail the authors.

both good and bad governance companies in all the event windows except 10-50 window. This may indicate that there may be information leakages well before 60 days preceding the event. However, dividend events for good companies have positive autocovariance with respect to the announcement date even in case of private information period. This suggests that dividend information in case of good governance companies is correctly incorporated in the prices. Thus, the degree of public information for dividend announcements in case of good governance companies is high. On the contrary, dividend announcements of bad governance companies' are characterised by a higher degree of informational asymmetry. Interestingly, good governance companies exhibit more private information for sale of assets event. Except for 10-50 window the results between good and bad governance companies are not significantly different. Couple of merger and acquisition events and dividend events are exceptions.

10-50 window provides some interesting results. For good governance companies, autocovariance values are positive and exceedingly high and these are also significantly different from bad governance companies. We could not arrive at a clear cut conclusion for these results. By increasing the duration to calculate Rt to 50 days, the co-movement of Rt with respect to Rt-1, Rt-2 and Rt-3 (which are calculated using 10 days) is predominantly moving in the same direction for good governance companies. This may be due to the excessive length used to calculate Rt that hides all the price dynamics of 50 days. The results clearly indicate that calculation of price process in Date 3 exhibit similar to that of Date 2 and Date 1 when Rt is calculated with 50 days duration. However, the same results are no arriving when the window is reversed to 50-10. The window 50-10 has similar price process as found with other windows. Interestingly the results for the 10-50 window for bad governance companies are normal as that of other windows within bad governance companies. Thus, 10-50 window is unique to good governance companies. In summary, these results indicate that for good governance companies, all the price dynamics occur 50 days before Pt.

Tables 4 and 5 depict mispricing ratios of good and bad governance companies respectively. The average mispricing ratio of good governance companies is higher than bad governance companies. The results are irrespective of the window or the event. Good governance companies exhibit highest mispricing for sale of assets event and preferential allotment events. Consistent with Tables 2 and 3 results, 10-50 window results are significantly different between good and bad governance companies. The results of 10-50 window are not surprising as they are derived from the auto-covariances used in Tables 2 and 3. What is surprising though is that why good governance companies exhibit more mispricing during event sensitive periods.

We also report average g values (reported as "AMP" in the tables) for both good and bad governance companies over time (1996- 2003) to estimate average g values. This has been done by grouping companies that have all four events. The results based on average g values give a totally

different picture. The average g values are close to 1 in case of good governance companies. However, bad governance companies that have sale of assets and preferential allotment events are generally overpriced. This indicates that in general, shares of good governance companies are fairly priced. However, they are heavily mispriced during event periods. This result indicates that both good and bad governance companies are mispriced during the information adjustment process.

Finally, we present excess volatility ratios during the partial adjustment process in Tables 6 and 7. As mentioned in the methodology section, the higher the ratio, the more is the volatility during the private information period. Excess volatility ratios provide similar picture for 10-50 window except for dividend announcements. In case of dividend announcement events excess volatility of bad governance companies is much higher than good governance companies. On the other hand, excess volatility is higher for good governance companies during sale of assets and preferential allotment events. The statistical significant of excess volatility ratios is not found for 10-50 window.

## 5. CONCLUSION

In this paper we have defined corporate governance as a mechanism for allocating resources efficiently in order to maximize social welfare. We have shown that welfare costs are high if assets are not fairly priced. Mispricing has been linked to corporate governance with an assumption that most of the mispricing in the stock market is attributed to the information disseminators or the corporate entities. We have devised a method to measure mispricing during corporate announcements using DHS (1998) theoretical framework. We find that mispricing is low on an average for good governance companies compared to bad governance companies. Stock prices of good governance companies are closer to their intrinsic value compared to bad governance companies. However, during event announcement periods, the results do not hold. We find that good governance companies are highly mispriced during event announcements. We also find that mispricing varies based on the nature of event. Good governance companies are highly overpriced during sale of assets and preferential allotment events. On the other hand, bad governance companies are highly underpriced for the same events. The level of over/under pricing is not that high for merger/takeover and dividend announcements. In support of this evidence, we find that there is more private information before the announcement of sale of assets and preferential allotment events for good governance companies. We also find returns calculate with varying durations will have a significant effect on the overall results. The volatility in the private information period during sale of assets period is higher for good governance companies. Thus, sale of assets, which is not a widely addressed event in the literature, is an important event while measuring corporate governance.

We conjecture that governance mechanisms do not prevent companies from mispricing during event announcements. In our conclusions we are taking for granted that S&P ranking clearly segregates a good governance company from a bad governance company. However, the empirical results in this paper do not strongly support this assumption. Thus these results can also be used to know the efficacy of ranking agencies' ranking methodology. Future research should aim at controlling other factors associated with mispricing to provide more meaningful results. Testing the extent of mispricing for the same events in different countries may also provide more insights on the factors affecting mispricing.

The important implication of this paper is that, while ranking companies based on corporate governance, one should give different weights to different variables based on the sensitivity of the variable: which is determined by the market reactions.

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| Table 1: S&P governance ranking for the selected companies | | | | | | |
|---|---|---|---|---|---|---|
| Company Name | Strucutre and Investor relations (total 28 attributes) | Transperancy and information disclosure (total 35 attributes) | Management strucutre and processes (total 35 attributes) | Comprehensive ranking | Market Capitalisation (Rs. Crores) | % in the total market |
| **Good Governance Companies** | | | | | | |
| B P L Ltd. | 4 | 6 | 3 | 5 | 125.48 | 0.01 |
| B S E S Ltd. | 5 | 7 | 6 | 6 | 6961.97 | 0.71 |
| Digital Globalsoft Ltd. | 6 | 6 | 4 | 5 | 2169.01 | 0.22 |
| G T L Ltd. | 7 | 5 | 4 | 5 | 444.58 | 0.05 |
| Grasim Industries Ltd. | 6 | 7 | 4 | 6 | 8243.4 | 0.85 |
| Gujarat Ambuja Cements Ltd. | 5 | 6 | 4 | 5 | 4353.5 | 0.45 |
| Himachal Futuristic Communications Ltd. | 5 | 7 | 5 | 6 | 488.49 | 0.05 |
| Housing Development Finance Corpn. Ltd. | 7 | 6 | 6 | 6 | 13571.19 | 1.39 |
| I C I C I Ltd. [Merged] | 7 | 8 | 3 | 5 | 4810.24 | 0.49 |
| Infosys Technologies Ltd. | 5 | 8 | 7 | 7 | 32634.94 | 3.35 |
| Larsen & Toubro Ltd. | 4 | 6 | 5 | 5 | 9968.86 | 1.02 |
| N I I T Ltd. | 5 | 6 | 6 | 6 | 834.82 | 0.09 |
| Ranbaxy Laboratories Ltd. | 5 | 8 | 5 | 6 | 18963.12 | 1.95 |
| S S I Ltd. | 6 | 8 | 6 | 7 | 176.62 | 0.02 |
| Satyam Computer Services Ltd. | 6 | 6 | 3 | 5 | 10388.06 | 1.07 |
| Tata Tea Ltd. | 6 | 6 | 3 | 5 | 1456.38 | 0.15 |
| Videsh Sanchar Nigam Ltd. | 3 | 7 | 4 | 5 | 3853.2 | 0.40 |
| Total | | | | | 119443.86 | |
| **Bad Governance Companies** | | | | | | |
| Associated Cement Cos. Ltd. | 4 | 5 | 3 | 4 | 3940.8 | 0.40 |
| Bajaj Auto Ltd. | 3 | 5 | 3 | 4 | 10212.96 | 1.05 |
| Bharat Heavy Electricals Ltd. | 6 | 5 | 3 | 4 | 11460.89 | 1.18 |
| Cipla Ltd. | 2 | 4 | 1 | 2 | 7404.49 | 0.76 |
| D S Q Software Ltd. | 3 | 4 | 2 | 3 | 29.19 | 0.00 |

| | | | | | |
|---|---|---|---|---|---|
| Dr. Reddy'S Laboratories Ltd. | 3 | 6 | 2 | 4 | 10040.42 | 1.03 |
| H C L Infosystems Ltd. | 4 | 5 | 4 | 4 | 1178.74 | 0.12 |
| Hindalco Industries Ltd. | 5 | 6 | 3 | 4 | 11796.24 | 1.21 |
| Hindustan Lever Ltd. | 3 | 6 | 3 | 4 | 39435.28 | 4.05 |
| I T C Ltd. | 3 | 5 | 4 | 4 | 21580.09 | 2.21 |
| Indian Petrochemicals Corpn. Ltd. | 4 | 4 | 3 | 4 | 5336.85 | 0.55 |
| Mahanagar Telephone Nigam Ltd. | 3 | 5 | 2 | 3 | 7607.25 | 0.78 |
| Mahindra & Mahindra Ltd. | 6 | 4 | 3 | 4 | 4170.62 | 0.43 |
| Pentamedia Graphics Ltd. | 4 | 5 | 2 | 4 | 185.85 | 0.02 |
| Raymond Ltd. | 2 | 5 | 3 | 3 | 1168.08 | 0.12 |
| Reliance Capital Ltd. | 3 | 4 | 1 | 3 | 1399.68 | 0.14 |
| Reliance Industries Ltd. | 5 | 6 | 3 | 4 | 68736.68 | 7.05 |
| Rolta India Ltd. | 3 | 6 | 3 | 4 | 550.3 | 0.06 |
| Silverline Technologies Ltd. | 2 | 5 | 1 | 3 | 136.8 | 0.01 |
| State Bank Of India | 3 | 6 | 2 | 4 | 24757.1 | 2.54 |
| Sterlite Industries (India) Ltd. | 4 | 6 | 1 | 3 | 797.61 | 0.08 |
| Tata Iron & Steel Co. Ltd. | 5 | 5 | 3 | 4 | 13639.42 | 1.40 |
| Tata Motors Ltd. | 3 | 5 | 4 | 4 | 13911.14 | 1.43 |
| Zee Telefilms Ltd. | 3 | 5 | 2 | 4 | 5457.44 | 0.56 |
| Total | | | | | 264933.92 | |
| s&p cnx 500 market cap (Total Market) | | | | | 974888.23 | |

**Table 2: Covariance Analysis of Good Governance companies**

| | | Good Governance Companies | | | | |
|---|---|---|---|---|---|---|
| **Event** | | **30-30** | **40-20** | **20-40** | **50-10** | **10-50** |
| **Sale of Assets** | *Cov (Rt-3, Rt)* | -321.02 (-1.53) | -321.03 (-1.45) | -321.03 (-1.27) | -321.02 (-1.53) | 29673.87 (-4.56)** |
| | *Cov (Rt-2, Rt)* | -146.36 (-1.17) | -456.91 (-0.68) | -456.91 (-1.35) | -677.903 (-0.78) | 16616.52 (-4.33)** |
| | *Cov (Rt-1, Rt)* | 309.28 (-0.55) | 421.26 (-0.47) | 1096.23 (-1.50) | 235.27 (-0.45) | 3445.17 (-3.61)** |
| **Mergers and Acquisitions** | *Cov (Rt-3, Rt)* | -251.02 (-0.54) | -251.01 (-.60) | -251.01 (-0.87) | -251.01 (-0.60) | 3289.36 (-3.61)** |
| | *Cov (Rt-2, Rt)* | 259.71 (-2.02)* | 347.75 (-0.93) | 167.38 (-0.76) | 167.38 (-0.27) | 1420.94 (-3.88)** |
| | *Cov (Rt-1, Rt)* | 86.81 (-0.49) | 63.56 (-2.02)* | 146.57 (-0.60) | 146.57 (-1.82) | 1061.07 (-3.44)** |
| **Preferential allotment** | *Cov (Rt-3, Rt)* | -302.02 (-0.11) | -302.01 (-0.50) | -298.79 (-1.68) | -302.01 (-0.09) | 3155.57 (-5.72)** |
| | *Cov (Rt-2, Rt)* | -357.17 (-0.09) | 30.71 (-0.40) | -247.51 (-1.59) | 357.05 (-0.40) | 2876.65 (-5.61)** |
| | *Cov (Rt-1, Rt)* | 39.77 (-0.91) | -238.80 (-0.13) | 48.88 (-1.78) | -265.21 (-0.83) | 2092.63 (-5.39)** |
| **Dividends** | *Cov (Rt-3, Rt)* | 5.75 (-1.65) | 6.79 (-1.98)* | 5.75 (-2.11)* | 5.75 (-1.82) | 338.04 (-4.24)** |
| | *Cov (Rt-2, Rt)* | 1.58 (-0.97) | 1.12 (-1.30) | 1.72 (-1.13) | -0.99 (-0.26) | 125.09 (-4.24)** |
| | *Cov (Rt-1, Rt)* | -2.68 (-1.19) | -1.48 (-0.27) | -3.77 (-1.94)* | 0.03 (-0.43) | 34.94 (-4.23)** |

Note: Values in the parentheses are z-values using Mann-Whitney test. * and ** indicate significance at 5% and 1% level respectively. The table provides results of return auto-covariance between two return series with different window durations. For instance, Cov (Rt-3, Rt) with 30-30 window represents return Rt-3 is calculated using 30 days duration and return Rt is also calculated with the same duration.

## Table 3: Covariance Analysis of Bad Governance companies

| Event | | 30-30 | 40-20 | 20-40 | 50-10 | 10-50 |
|---|---|---|---|---|---|---|
| | | | Bad Governance Companies | | | |
| **Sale of Assets** | *Cov (Rt-3, Rt)* | -79.65 (-1.53) | -62.78 (-1.45) | -79.65 (-1.27) | -79.65 (-1.53) | -79.80 (-4.56)** |
| | *Cov (Rt-2, Rt)* | 33.23 (-1.17) | 94.28 (-0.68) | 14.66 (-1.35) | -32.39 (-0.78) | 21.81 (-4.33)** |
| | *Cov (Rt-1, Rt)* | 21.29 (-0.55) | 58.42 (0.47) | 57.05 (-1.50) | 44.32 (-0.45) | 69.01 (-3.61)** |
| **Mergers and Acquisitions** | *Cov (Rt-3, Rt)* | -180.04 (-0.54) | -2.60 (-.60) | -2.60 (-0.87) | -2.59 (-0.60) | -2.60 (-3.61)** |
| | *Cov (Rt-2, Rt)* | -474.94 (-2.02)* | -95.01 (-0.93) | -228.49 (-0.76) | -48.95 (-0.27) | -179.54 (-3.88)** |
| | *Cov (Rt-1, Rt)* | 0.94 (-0.49) | -259.53 (-2.02)* | -171.06 (-0.60) | -223.20 (-1.82) | -207.74 (3.44)** |
| **Preferential allotment** | *Cov (Rt-3, Rt)* | -15.23 (-0.11) | -9.66 (-0.50) | -14.17 (-1.68) | -14.17 (-0.09) | -14.17 (5.72)** |
| | *Cov (Rt-2, Rt)* | 3.28 (-0.09) | 6.48 (-0.40) | 0.99 (-1.59) | 23.20 (-0.40) | 2.21 (-5.61)** |
| | *Cov (Rt-1, Rt)* | -4.52 (-0.91) | -0.57 (-0.13) | -4.62 (-1.78) | -5.32 (-0.83) | -17.93 (-5.39)** |
| **Dividends** | *Cov (Rt-3, Rt)* | -9.20 (-1.65) | -10.42 (-1.98)* | -10.42 (-2.11)* | -10.42 (-1.82) | -10.42 (-4.24)** |
| | *Cov (Rt-2, Rt)* | -33.70 (-0.97) | -56.42 (-1.30) | -22.61 (-1.13) | -101.19 (-0.26) | -0.48 (-4.24)** |
| | *Cov (Rt-1, Rt)* | 3.02 (-1.19) | 3.66 (-0.27) | 1.01 (-1.94)* | 5.37 (-0.43) | 34.94 (4.23)** |

Note: Values in the parentheses are z-values using Mann-Whitney test. * and ** indicate significance at 5% and 1% level respectively. The table provides results of return auto-covariance between two return series with different window durations. For instance, Cov (Rt-3, Rt) with 30-30 window represents return Rt-3 is calculated using 30 days duration and return Rt is also calculated with the same duration.

## Table 4: Mispricing Ratios of Good Governance Companies

| Event | Good Governance Companies | | | | | |
|---|---|---|---|---|---|---|
| | 30-30 | 40-20 | 20-40 | 50-10 | 10-50 | |
| | MP | MP | MP | MP | MP | AMP |
| **Sale of Assets** | 6.53 (-0.59) | 1.19 (-0.09) | 0.73 (-1.95)* | 1.57 (-0.88) | 7.62 (-3.64)** | 1.23 |
| **Mergers and Acquisitions** | 2.59 (-0.62) | 1.78 (-1.55) | 2.14 (-0.81) | 4.57 (-0.85) | 2.52 (-3.84)** | 1.20 |
| **Preferential allotment** | 2.61 (-0.98) | 7.91 (-0.42) | 0.65 (-1.42) | 0.82 (0.11) | 16.02 (-2.49)* | 1.19 |
| **Dividends** | 1.58 (-0.43) | 2.61 (-1.18) | 1.63 (-0.55) | 0.99 (-0.72) | 2.93 (-2.23)* | 1.30 |

Note: MP represents mispricing ratio. AMP represents Average mispricing of all stocks in each group for the period between year 1996-2003. Mispricing is calculated using: $g = 1 - \{Cov(R_{t-2}, R_t)/Cov(R_{t-1}, R_t)\}$. Where "$g$" is the ratio of mispricing. $g = 1$ represents no mispricing. Value of $g > 1$ and $< 1$ indicates mispricing. Values in the parentheses are z-values using Mann-Whitney test. * and ** indicate significance at 5% and 1% level respectively. The table provides results of return auto-covariance between two return series with different window durations. For instance, $Cov(R_{t-3}, R_t)$ with 30-30 window represents return $R_{t-3}$ is calculated using 30 days duration and return $R_t$ is also calculated with the same duration.

## Table 5: Mispricing Ratios of Bad Governance Companies

| Event | Bad Governance Companies | | | | | |
|---|---|---|---|---|---|---|
| | **30-30** | **40-20** | **20-40** | **50-10** | **10-50** | |
| | **MP** | **MP** | **MP** | **MP** | **MP** | **AMP** |
| **Sale of Assets** | 0.08 (-0.59) | 0.47 (-0.09) | 0.74 (-1.95)* | 2.08 (-0.88) | 0.46 (-3.64)** | 3.17 |
| **Mergers and Acquisitions** | 2.41 (-0.62) | 1.41 (-1.55) | 42.9 (-0.81) | 3.17 (-0.85) | 1.34 (-3.84)** | 1.10 |
| **Preferential allotment** | 0.58 (-0.98) | 1.68 (-0.42) | 1.23 (-1.42) | 4.80 (0.11) | 0.72 (-2.49)* | 3.32 |
| **Dividends** | 2.18 (-0.43) | 2.41 (-1.18) | 1.91 (-0.55) | 2.94 (-0.72) | 2.91 (-2.23)* | 1.28 |

Note: MP represents mispricing ratio. AMP represents Average mispricing of all stocks in each group for the period between year 1996-2003. Mispricing is calculated using: $g = 1 - \{Cov(R_{t-2}, R_t)/Cov(R_{t-1}, R_t)\}$. Where "g" is the ratio of mispricing. $g = 1$ represents no mispricing. Value of $g > 1$ and $< 1$ indicates mispricing. Values in the parentheses are z-values using Mann-Whitney test. * and ** indicate significance at 5% and 1% level respectively. The table provides results of return auto-covariance between two return series with different window durations. For instance, $Cov(R_{t-3}, R_t)$ with 30-30 window represents return $R_{t-3}$ is calculated using 30 days duration and return $R_t$ is also calculated with the same duration.

# Table 6: Excess Volatility Ratios of Good Governance Companies

| Event | Good Governance Companies | | | | |
|---|---|---|---|---|---|
| | **30-30** | **40-20** | **20-40** | **50-10** | **10-50** |
| | EV | EV | EV | EV | EV |
| **Sale of Assets** | 0.42 (-0.37) | 0.33 (-0.81) | 0.67 (-0.16) | 0.26 (-0.01) | 6.91 (-0.21) |
| **Mergers and Acquisitions** | 0.12 (-0.10) | 4.07 (-0.23) | 1.49 (-0.07) | 0.30 (-0.01) | 2.23 (-0.54) |
| **Preferential allotment** | 2.53 (-1.78) | 0.18 (-1.69) | .10 (-1.15) | 0.04 (0.65) | 14.62 (-2.19)* |
| **Dividends** | 1.02 (-1.30) | 0.78 (-0.31) | 0.72 (-0.49) | 0.39 (-2.11)* | 2.61 (-0.31) |

Note: EV represents excess volatility ratio. Excess Volatility ratio is calculated using: $V_t^{EP} = Var\,(Pt\text{-}1 - Pt\text{-}2) - Var_R\,(Pt - Pt\text{-}1)/\,Var_R\,(Pt - Pt\text{-}1)$. Values in the parentheses are z-values using Mann-Whitney test. * and ** indicate significance at 5% and 1% level respectively. The table provides results of return auto-covariance between two return series with different window durations. For instance, Cov (Rt-3, Rt) with 30-30 window represents return Rt-3 is calculated using 30 days duration and return Rt is also calculated with the same duration.

**Table 7: Excess Volatility Ratios of Bad Governance Companies**

| | Bad Governance Companies | | | | |
|---|---|---|---|---|---|
| Event | 30-30 | 40-20 | 20-40 | 50-10 | 10-50 |
| | EV | EV | EV | EV | EV |
| Sale of Assets | 0.14 (-0.37) | 0.17 (-0.81) | .01 (-0.16) | 0.03 (-0.01) | 0.79 (-0.21) |
| Mergers and Acquisitions | 0.57 (-0.10) | 0.08 (-0.23) | 0.11 (-0.07) | 0.26 (-0.01) | 0.27 (-0.54) |
| Preferential allotment | 0.03 (-1.78) | 1.17 (-1.69) | .47 (-1.15) | 0.14 (0.65) | 1.06 (-2.19)* |
| Dividends | 10.79 (-1.30) | 5.80 (-0.31) | 11.37 (-0.49) | 8.75 (-2.11)* | 8.41 (-0.31) |

Note: EV represents excess volatility ratio. Excess Volatility ratio is calculated using: $V_t^{EP} = Var (Pt-1 - Pt-2) - Var_R (Pt - Pt-1)/ Var_R (Pt - Pt-1)$. Values in the parentheses are z-values using Mann-Whitney test.  * and ** indicate significance at 5% and 1% level respectively. The table provides results of return auto-covariance between two return series with different window durations. For instance, Cov (Rt-3, Rt) with 30-30 window represents return Rt-3 is calculated using 30 days duration and return Rt is also calculated with the same duration.

**Appendix 1: S&P list of attributes for measuring transparency disclosure[9]:**

**Ownership Structure and Investor Relations**

1 number of issued and outstanding ordinary shares disclosed?
2 number of issued and outstanding other shares disclosed
3 par value of each ordinary share disclosed?
4 par value of each other shares disclosed (preferred, non-voting)?
5 number of authorised but unissued & outstanding ordinary shares disclosed?
6 number of authorised but unissued & outstanding other shares disclosed?
7 par value of authorised but unissued & outstanding ordinary Shares disclosed?
8 par value of authorised but unissued & outstanding other shares disclosed?
9 top 1 shareholder?
10 top 3 shareholders?
11 top 5 shareholders?
12 top 10 shareholders?
13 description of share classes provided?
14 review of shareholders by type?
15 number and identity of shareholders holding more than 3%?
16 number and identity of shareholders holding more than 5%?
17 number and identity of shareholders holding more than 10%?
18 percentage of cross-ownership?
19 existence of a Corporate Governance Charter or Code of Best Practice?
20 Corporate Governance Charter / Code of Best Practice itself?
21 details about its Articles of Association. (e.g. changes)?
22 voting rights for each voting or non-voting share?
23 way that shareholders nominate directors to board?
24 way shareholders convene an EGM?
25 procedure for putting inquiry rights to the board?
26 procedure for putting proposals at shareholders meetings?

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[9] **Source:** www.standardandpoors.com

27 review of last shareholders meeting? (e.g. minutes)
28 calendar of important shareholders dates?

## Financial Transparency & Information Disclosure

1 its accounting policy?
2 the accounting standards it uses for its accounts?
3 accounts according to the local accounting standards?
4 accounts according to an internationally recognized accounting standard (IAS/US GAAP)?
5 its balance sheet according to international accounting standard (IAS/US GAAP)?
6 its income statement according to international accounting standard (IAS/US GAAP)?
7 its cash flow statement according to international accounting standard (IAS/US GAAP)?
8 a basic earnings forecast of any kind?
9 a detailed earnings forecast?
10 financial information on a quarterly basis?
11 a segment analysis (broken down by business line)?
12 the name of its auditing firm?
13 a reproduction of the auditors' report?
14 how much it pays in audit fees to the auditor?
15 any non-audit fees paid to auditor?
16 consolidated financial statements (or only the parent/holding co)?
17 methods of asset valuation?
18 information on method of fixed assets depreciation?
19 a list of affiliates in which it holds a minority stake?
20 a reconciliation of its domestic accounting standards to IAS/US GAAP?
21 the ownership structure of affiliates?
22 details of the kind of business it is in?
23 details of the products or services produced/provided?
24 output in physical terms? (number of users etc.)
25 characteristics of assets employed?
26 efficiency indicators (ROA ROE etc.)
27 any industry-specific ratios?
28 a discussion of corporate strategy?
29 any plans for investment in the coming year(s)?

30 detailed information about investment plans in the coming year(s)?
31 an output forecast of any kind?
32 an overview of trends in its industry?
33 its market share for any or all of its businesses?
34 a list/register of related party transactions?
35 a list/register of group transactions?

**Board and Management Structure and Process**

1 a list of board members (names)?
2 details about directors (other than name/title)?
3 details about current employment/position of directors provided?
4 details about previous employment/positions provided?
5 when each of the directors joined the board?
6 classification of directors as an executive or an outside director?
7 a named chairman listed?
8 detail about the chairman (other than name/title)?
9 details about role of the board of directors at the company?
10 a list of matters reserved for the board?
11 a list of board committees?
12 the existance of an audit committee?
13 the names on the audit committee?
14 the existance of a remuneration/compensation committee?
15 the names on the remuneration/compensation committee)?
16 existance of a nomination committee?
17 the names on the nomination committee?
18 the existance of other internal audit functions besides the Audit Committee?
19 the existance of a strategy/investment/finance committee?
20 the number of shares in the company held by directors?
21 a review of the last board meeting? (e.g. minutes)
22 whether they provide director training?
23 the decision-making process of directors' pay?
24 the specifics of directors' pay (e.g. the salary levels etc.)?
25 the form of directors' salaries (e.g. cash, shares, etc.)?

26 the specifics on performance-related pay for directors?
27 the decision-making of managers' (not Board) pay?
28 the specifics of managers' (not on Board) pay (e.g. salary levels etc.)?
29 the form of managers' (not on Board) pay?
30 the specifics on performance-related pay for managers?
31 the list of the senior managers (not on the Board of Directors)?
32 the backgrounds of senior managers disclosed?
33 the details of the CEO's contract disclosed?
34 the number of shares held by the senior managers disclosed?
35 the number of shares held in other affiliated companies?

Appendix 2:

$$(P_t - P_{t-1}) = g\,(V_t - P_{t-1}) + u_t \qquad\qquad -1$$

Where $P_t$ is the current price and $P_{t-1}$ is the price lagged by one period. $V_t$ is the intrinsic value and $U_t$ is the noise. $g$ is the coefficient that measures price adjustment with the information flow between $t-1$ and $t$ period.

From equation 1 $P_t$ can also be interpreted as

$$P_t = (1-g)\,P_{t-1} + g\,V_t + u_t \qquad\qquad -2$$

Then by induction approach we have,

$$P_t = (1-g)^t \Sigma^{\,t}_{s=-\infty} (1-g)^{-s} \,(g\,V_s + u_s)$$

$$P_t = \Sigma^{\,t}_{s=-\infty} (1-g)^{t-s} \,(g\,V_s + u_s)$$

$$P_t = \Sigma^{+\infty}_{i=o} (1-g)^i \,(g\,V_{t-i} + u_{t-i}) \qquad \text{where } i = t\text{-}s, \text{ then,}$$

$$P_t = g\Sigma^{+\infty}_{i=o} (1-g)^i \,V_{t-i} + g\Sigma^{+\infty}_{i=o} (1-g)^i \,u_{t-i} \quad -3$$

If $R_t$ is the return of security at time $t$ then

$$R_t = P_t - P_{t-1} \qquad - \qquad 4$$

By substituting the value $P_t$ from equation 3 we have

$$R_t = g\Sigma^{+\infty}_{i=o} (1-g)^i \,(V_{t-i} - V_{t-1-i}) + \Sigma^{+\infty}_{i=o} (1-g)^i \,(u_{t-i} - u_{t-1-i}) \quad -5$$

If security value follows a random walk with a drift then

$$V_t = V_{t-i} + e_t + m \qquad\qquad\qquad\qquad -6$$

Where $m$ represents the value return and $e_t$ represents the valuation error.

Substituting $V_t$ from equation 6 in equation 5 we have

$$R_t = g\Sigma^{+\infty}_{i=o} (1-g)^i \,(e_{t-i} + m) + \Sigma^{+\infty}_{i=o} (1-g)^i \,(u_{t-i} - u_{t-1-i}), \text{ then}$$

$$R_t = mg\Sigma^{+\infty}_{i=o} (1-g)^i + g\Sigma^{+\infty}_{i=o} (1-g)^i \,(e_{t-i} - u_{t-1-i}) + \Sigma^{+\infty}_{i=o} (1-g)^i \,(u_{t-i} - u_{t-1-i} + gu_{t-1-i})$$

$$R_t = m + g\Sigma^{+\infty}_{i=o} (1-g)^i \,(e_{t-i} - u_{t-1-i}) + \Sigma^{+\infty}_{i=o} (1-g)^i \,u_{t-i} - \Sigma^{+\infty}_{i=o} (1-g)^{i+1} \,u_{t-1-i}$$

$$R_t = m + g\Sigma^{+\infty}_{i=o} (1-g)^i \,(e_{t-i} - u_{t-1-i}) + \Sigma^{+\infty}_{i=o} (1-g)^i \,u_{t-i} - \Sigma^{+\infty}_{i=o} (1-g)^j \,u_{t-j}, \text{ where } j = i+1,$$

$$R_t = m + g\Sigma^{+\infty}_{i=o} (1-g)^i \,(e_{t-i} - u_{t-1-i}) + u_t, \text{, therefore,}$$

$R_t = m + w_t + u_t$            - 7

where, $w_t = g \sum_{i=0}^{+\infty} (1-g)^i (e_{t-i} - u_{t-1-i})$

Note: $e_t$ and $u_t$ are independent

From equation 7 it is clear that the observed return $R_t$ is composed of the value return m, error due to incorrect valuations $w_t$ and the remaining errors reflected on the observed price $u_t$.

From equation 7 one can arrive at the variance, auto covariance and auto correlation of the observed return $R_t$.

**Variance of $R_t$ :**

From equation 7 variance of $R_t$ is

$\mathrm{Var}(R_t) = g^2 \mathrm{Var}(w_t) + \mathrm{Var}(u_t) + 2g\mathrm{Cov}(w_t, u_t)$

$\mathrm{Var}(R_t) = g^2 \sum_{i=0}^{+\infty} (1-g)^{2i} (v^2 + \sigma^2) + \sigma^2$

Where $v^2$ represents the variance due to valuation error $e_t$ and $s^2$ is the variance due to other errors reflected on the observed price. Then,

$\mathrm{Var}(R_t) = g^2 (v^2 + \sigma^2) \, 1/1 - (1-g)^2 + \sigma^2$

$\mathrm{Var}(R_t) = g^2 (v^2 + \sigma^2) \, 1/g - (2-g) + \sigma^2$

$\mathrm{Var}(R_t) = (g/(2-g)) v^2 + (g/(2-g) + 1)\sigma^2$

$\mathrm{Var}(R_t) = (g/(2-g)) v^2 + (2/(2-g))\sigma^2$         - 8

Amihud and Mendelson (1986) showed that variance in the observed return has two components ($v^2$, $\sigma^2$) as discussed above. If $g = 1$ then equation 8 will be

$\mathrm{Var}(R_t) = v^2 + 2\sigma^2$         - 9

**Auto-Covariance of $R_t$:**

$\mathrm{Cov}(R_t, R_{t-1}) = \mathrm{Cov}(gw_t + u_t, gw_{t-1} + u_{t-1})$ where $w_t$ and $u_{t-1}$ are independent, then

$\mathrm{Cov}(R_t, R_{t-1}) = g^2 \mathrm{Cov}(w_t, w_{t-1}) + g \mathrm{Cov}(w_t, u_{t-1})$

$\mathrm{Cov}(R_t, R_{t-1}) = g^2 \sum_{i=0}^{+\infty} \sum_{j=0}^{+\infty} (1-g)^i (1-g)^j \mathrm{Cov}(e_{t-i} - u_{t-1-i}, e_{t-j-1} - u_{t-2-j}) - g\mathrm{Var}(u_{t-1})$

$\mathrm{Cov}(R_t, R_{t-1}) = g^2 \sum_{i=0}^{+\infty} \sum_{j=0}^{+\infty} (1-g)^i (1-g)^j [\mathrm{Cov}(e_{t-i}, e_{t-j}) + \mathrm{Cov}(u_{t-1-i} - u_{t-2-j})] - g\sigma^2$

$\text{Cov}(R_t, R_{t-1}) = g^2 \sum_{j=0}^{+\infty} (1-g)^{2j+1} (v^2 + \sigma^2) - g\sigma^2$

$\text{Cov}(R_t, R_{t-1}) = g(1-g)/(2-g)(v^2 + \sigma^2) - g\sigma^2$

$\text{Cov}(R_t, R_{t-1}) = g/(2-g)[(1-g)(v^2 + \sigma^2) - (2-g)\sigma^2]$

$\text{Cov}(R_t, R_{t-1}) = g/(2-g)[(1-g)v^2 - \sigma^2]$ \hfill - 10

## Auto- Correlation of $R_t$:

Note: Correlation = Covariance/ Variance i.e., equation 7/ equation 8

$\text{Corr}(R_t, R_{t-1}) = g/(2-g)[(1-g)(v^2 + \sigma^2) - (2-g)\sigma^2] / (g/(2-g))v^2 + (g/(2-g) + 1)\sigma^2$

$\text{Corr}(R_t, R_{t-1}) = [g(1-g)v^2 - g\sigma^2]/[g v^2 + 2\sigma^2]$ \hfill - 11

## Second order auto-covariance of $R_t$

$\text{Cov}(R_t, R_{t-2}) = g^2 \text{Cov}(w_t, w_{t-2}) + g \text{Cov}(w_t, u_{t-2}) + g \text{Cov}(u_t, w_{t-2}) + \text{Cov}(u_t, u_{t-2})$ - 12

We know that $u_t$ has zero mean and finate variance and $u_t$ and $w_t$ are independent, then

$g \text{Cov}(u_t, w_{t-2}) = 0$ and $\text{Cov}(u_t, u_{t-2}) = 0$, then

$\text{Cov}(R_t, R_{t-2}) = g^2 \text{Cov}(w_t, w_{t-2}) + g \text{Cov}(w_t, u_{t-2})$

$\text{Cov}(R_t, R_{t-2}) = g^2 \sum_{i=0}^{+\infty} \sum_{j=0}^{+\infty} (1-g)^i (1-g)^j \text{Cov}(e_{t-i}, e_{t-2j}) + \text{Cov}(u_{t-1-i} - u_{t-3-j})$

$\qquad - g(1-g)\sigma^2$ \hfill - 13

$\text{Cov}(R_t, R_{t-2}) = g^2 \sum_{j=0}^{+\infty} (1-g)^{2j+2}(v^2 + \sigma^2) - g(1-g)\sigma^2$

$\text{Cov}(R_t, R_{t-2}) = g^2 (1-g)^2(v^2 + \sigma^2)(1/1-(1-g)^2) - g(1-g)\sigma^2$

$\text{Cov}(R_t, R_{t-2}) = g^2 (1-g)^2(v^2 + \sigma^2)(1/g(2-g)) - g(1-g)\sigma^2$

$\text{Cov}(R_t, R_{t-2}) = g^2 (1-g)^2/ g(2-g)(v^2 + \sigma^2) - g(1-g)\sigma^2$

We know that $g(1-g)/(2-g)(v^2 + \sigma^2) - g(1-g)\sigma^2 = \text{Cov}(R_t - R_{t-1})$, then

$g \qquad = 1 - \text{Cov}(R_t, R_{t-2})/\text{Cov}(R_t, R_{t-1})$ \hfill - 14