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Abstract

We demonstrate that when the variables comprising a firm's investment opportunity set evolve in terms of a second order system of stochastic differential equations, then the present value of the cash flows the firm expects to earn will be stated in terms of the levels and the momentum of the affected variables. It is also shown that the market value of a firm's equity is comprised of the present value of the cash flows it expects to earn from operating under its existing investment opportunity set plus the value of the real options the firm possesses to modify or even completely change its existing investment opportunity set. Our empirical analysis shows that earnings momentum and the adaptation and growth options which are typically available to firms all appear to have a significant impact on the prices of stocks traded on the Shanghai Stock Exchange.

Key Words: book value; earnings; momentum; principal component; real option.

1. Introduction

There is now compelling evidence that equity prices bear a highly non-linear and generally convex relationship with their determining variables (Burgstahler and Dichev 1997, Ashton et al. 2003, Mak et al. 2011, Herath et al. 2015). Despite this, simple linear models of equity valuation continue their domination of the empirical work conducted in this area of the literature (Dechow et al. 1999, Myers 1999, Collins et al. 1999, Morel 2003, Gregory et al. 2005, Tsay et al. 2008, Khodadadi and Emami 2010, Lee et al. 2013). Yet, if as the empirical evidence suggests, a non-linear relationship exists between the market value of equity and its determining variables then in the very least these simple linear models will be afflicted by a correlated omitted variables problem. The consequences of this are well known - in particular, parameter estimation based on mis-specified linear modelling procedures will be inconsistent and inefficient (Greene 2012). Hence, parameters estimated from such models can only form a problematic basis for hypothesis testing and for any policy recommendations that might eventuate from them. The solution to this conundrum lays in the development of more refined equity valuation models which are compatible with the highly non-linear relationship which appears to exist between equity value and its determining variables. Yet, despite recurring pleas for the development of more realistic valuation models (Burgstahler and Dichev 1997, 212; Penman 2001, 692), the paucity of theoretical modelling that has long characterized this area of accounting research shows little sign of abatement.

Probably the best known and most widely applied model of the relationship between equity prices and their determining variables has been formulated by Ohlson (1995). The Ohlson (1995) model estimates equity values by discounting the future cash flows firms expect to earn. Unfortunately, both the empirical evidence (Dechow et al. 1999, Myers 1999, Collins et al. 1999, Morel 2003, Callen and Segal 2005, Khodadadi and Emami

2010; Lee et al. 2013) and developments in investment analysis (Dixit and Pindyck 1994 Trigeorgis 1996) show that it is highly unlikely the expected present value rule can provide a complete picture of the way equity prices evolve in practice. The principal difficulty with the present value rule is that it does not accommodate the possibility that at some future point in time the firm will modify or even completely abandon its existing investment opportunity set. Yet, a firm's ability to change or modify its investment opportunity set is a valuable option which has the potential to make a significant contribution to the overall market value of its equity and this will be in addition to the value emanating from the present value of the stream of future cash flows the firm expects to earn under its existing investment opportunity set. Moreover, the Ohlson (1995, 665-670) model assumes that a firm's cash flows evolve in terms a first order system of stochastic difference equations stated exclusively in terms of the levels of the affected variables. However, recent empirical evidence shows that the momentum of variables comprising a firm's investment opportunity set can also have a significant impact on the expected present value of the firm's future cash flows (Chordia and Shivakumar 2006, Fama and French 2012, Chen et al. 2014, Mao and Wei 2014).[1] Unfortunately, when an investment opportunity set is stated in terms of a first order system of stochastic difference equations as is the case with the Ohlson (1995) model, it cannot accommodate these momentum phenomena.

Our purpose here is to build momentum and real option phenomena into the Ohlson (1995) equity valuation model and then to assess the compatibility or otherwise of our

[1] Most studies in this area examine the association between stock price momentum and the momentum associated with specific firm attributes - as for example, the momentum associated with a firm's various revenue streams and its stock price momentum (Chen et al. 2014). This contrasts with the analysis conducted here which examines the relationship between the levels and the momentum of the variables comprising the firm's investment opportunity set and the market value of the firm's equity.

model against equity values and the information summarized in the published financial statements of firms listed on the Shanghai Stock Exchange. The Shanghai Stock Exchange was established in 1990 as part of the Chinese government's ambition of moving from a totally planned towards a mixed planned and market economy. Since its inception, the Shanghai Stock Exchange has experienced rapid development in terms of the number of companies listed on its trading boards, its trading volumes and its overall market capitalisation. Thus, whilst there were only eight companies listed on the Shanghai Stock Exchange on its first day of trading in 1990, by 2014 there were a total of 997 listed companies with a total market capitalisation of US$2,440 billion.[2] This means that in terms of total market capitalisation, the Shanghai Stock Exchange is now the largest stock exchange amongst developing nations and ranks as the third largest stock exchange in the world overall. Moreover, China is now the second largest economy in the world behind the United States in terms of Gross Domestic Product and so, the Shanghai Stock Exchange is of considerable importance to international investors, financial analysts, government policy makers and researchers alike.[3]

Our analysis begins in the next section with a formal statement of the fundamental proposition on which the Ohlson (1995) equity valuation model is based; namely, that the present value of the stream of future cash flows a firm expects to earn is determined by

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[2] Sourced from http://www.marketswiki.com/mwiki/Shanghai_Stock_Exchange and Shanghai Stock Exchange (2014, 5).

[3] The opening up of Chinese capital markets began with the Qualified Foreign Institutional Investor (QFII) measures which were introduced in November, 2002 by the China Securities Regulatory Commission (CSRC). The QFII allowed a small number of foreign investors to purchase A shares in domestic Chinese companies. However, the QFII provisions were radically extended and broadened by the CSRC in November, 2014 with the implementation of the Shanghai-Hong Kong Stock Connect cross-boundary investment channel. The Shanghai-Hong Kong Stock Connect measures allow all Hong Kong and overseas investors to trade the constituent stocks of the Shanghai Stock Exchange 180 Index and the Shanghai Stock Exchange 380 Index, as well as all Shanghai Stock Exchange listed A shares that are not included as constituent stocks of the relevant indices but which have corresponding H shares listed on the Hong Kong Stock Exchange.

summing the book value of its equity and the present value of its expected stream of abnormal earnings. We conduct our analysis in continuous time since this is both analytically convenient and provides a more realistic description of the way firms evolve in practice (Sprott 1997, 537).[4] We then determine the market value of a firm's equity based on the assumption that the variables comprising its investment opportunity set evolve in terms of a second order system of stochastic differential equations. We show in particular that stating a firm's investment opportunity set in terms of a second (rather than a first) order system of differential equations implies that the present value of the future cash flows a firm expects to earn will be stated in terms of the levels and the momentum of the variables comprising its investment opportunity set. In contrast, when a firm operates under a first order investment opportunity set momentum in the determining variables can have no impact on stock prices. The empirical analysis summarized in the pages which follow shows, however, that momentum in the determining variables of firms listed on the Shanghai Stock Exchange does have a significant impact on their stock prices. Thus, our modelling procedures provide an analytical justification for the emerging empirical work that documents a significant association between earnings momentum and the market value of a firm's equity (Chordia and Shivakumar 2006, Fama and French 2012, Chen et al. 2014, Mao and Wei 2014).

[4] Bergstrom (1990, 1) notes that for the financial and other aggregates controlled by large publicly listed firms "there will be thousands of small changes at random intervals of time on a single day, and the changes occur at any time during that day. A realistic aggregate model which, accurately, takes account of these microeconomic decision processes must, therefore, be formulated in continuous time". Moreover, Cox and Miller (1965, 235) note that a "… useful procedure … is one of using a diffusion process to study a discrete process. This procedure is useful because mathematical methods associated with the continuum (e.g. differential equations, integration) very often lend themselves more easily to analytical treatment than those associated with discrete coordinate axes." Similarly, Karlin and Taylor (1981, 356) note that a "… great advantage in the use of continuous stochastic differential equations versus discrete models in describing certain … economic processes is that explicit answers are frequently accessible in the continuous formulations. The dependence and sensitivity of the process on the parameters are therefore more easily accessible and interpretable. The process realisations (or expectation, variance and distributional quantities) for discrete time models rarely admit explicit representations and so their qualitative discussion is more formidable."

In Section 3 we demonstrate the significant impact which the option firms have to modify or change their investment opportunity sets can have on the market value of their equity securities. Our analysis shows in particular that there will be a convex and potentially, highly non-linear relationship between the market value of a firm's equity and the variables comprising its investment opportunity set. In this section we also examine the potential biases that are likely to arise from the simple linear models which characterize the empirical work conducted in this area of the literature. Our analysis shows that it is all but inevitable there will be problems with omitted variables when linear valuation models are applied in empirical work (Greene 2012). This, in turn, will mean that parameter estimates associated with these models will be both inconsistent and inefficient and can only form a problematic basis for hypothesis testing and any policy recommendations which might emerge from them.

Section 4 provides a short summary of data sources, a statistical summary of the data employed in our empirical analysis and a graphical summary of some of the key relationships on which our modelling procedures are based. We then move into section 5 which summarizes our empirical results under four main headings. The first of these is based on our Full-Sample data. We then divide the Full-Sample data into three sub-samples based on an ordering of the price to earnings ratios implied by our data. Our empirical analysis shows significant differences between the empirical results obtained for the three sub-samples and between the three sub-samples and the Full-Sample. The book value of equity appears to be the predominant determinant of stock prices for both the sub-sample with the lowest price to earnings ratios and the Full-Sample data whilst earnings (and the momentum in earnings) appears to be the most important determinant of stock prices for the sub-sample with the largest price to earnings ratios. Section 6 closes the paper with our summary conclusions.

2. Linear Information Dynamics

The Ohlson (1995) model determines the value of an equity security by discounting the stream of future cash flows it expects to earn whilst being constrained to operate within its existing investment opportunity set. This is often referred to as the recursion value of equity, $\eta(t)$, and may be determined from the following expression (Burgstahler and Dichev 1997, 188: Ostaszewski 2004, 302-303):

$$\eta(t) = b(t) + \int_t^\infty e^{-r(s - t)} E_t[a(s)]ds \qquad (1)$$

Here $b(t)$ is the book value of equity at time t, $a(t) = x(t) - rb(t)$ is the instantaneous abnormal (or residual) earnings, $x(t)$ is the instantaneous earnings reported on the firm's profit and loss (that is, income) statement, $E_t(\cdot)$ is the expectations operator taken at time t and $r > 0$ is the cost of capital applicable to equity.[5]

Now it is well known that a firm's accounting procedures invariably capture information relevant to the valuation of equity with a lag - it can take many years for the full economic impact of a newly developed drug, a newly discovered mining deposit or the expansion (contraction) of a firm's order book to filter through to the firm's accounting records (Beaver 2002, 457). Given this, we follow Ohlson (1995, 663-664) in introducing an "other information" variable, $\nu(t)$, which captures all information relevant to the valuation of equity which has not, as yet, found its way into the firm's accounting

[5] Hirshleifer (1970, 249-250) defines the cost of capital, r, in terms of a "risk class" which encompass "the same *proportionate* pattern of state [contingent] incomes" and which "reflect[s] an allowance for their futurity of as well as for their probability and scarcity". Hirshleifer (1970, 19-24) also demonstrates how r is determined within a general equilibrium economy.

records.[6] The Ohlson (1995) model assumes that the abnormal earnings and information variable jointly evolve in terms of a first order system of linear difference equations. However, there is now compelling empirical evidence which suggests that valuation models based on first order processes of the kind developed by Ohlson (1995) generally under-estimate equity values by around 20% (Dechow et al. 1999, Myers 1999, Collins et al. 1999, Morel 2003, Callen and Segal 2005, Khodadadi and Emami 2010, Lee et al. 2013). Moreover, first order processes cannot accommodate certain factors which empiricists have shown to have a significant association with equity returns. Probably the most important of these is earnings momentum (Chordia and Shivakumar 2006, Fama and French 2012, Chen et al. 2014, Mao and Wei 2014) which can only arise through an investment opportunity set defined in terms of a second (or higher) order system of differential (difference) equations. One can demonstrate the importance of this point by supposing the current increments in a firm's abnormal earnings and information variable hinge on the increments in these variables in previous periods. It then follows that the abnormal earnings and information variable will evolve in terms an investment opportunity set which is characterized by the following vector system of second order stochastic differential equations:[7]

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[6] Examples of the information variable found in the literature are any one or combinations of the expected additional profits arising from an expansion in a firm's order book, the expected additional profits arising from research and development expenditures, the expected additional profits arising from new patents secured by a firm, the expected additional profits arising from the regulatory approval of a new drug for a pharmaceutical company and the expected additional profits arising from new long lived contracts signed by a firm (Myers 1999, Kwon 2001, Sougiannis et al. 2005, Jan and Ou 2012). Other examples of the information variable are the current level of a firm's market penetration, a firm's longevity and the profitability and balance sheet implications of natural disasters, such as an earthquake or a prolonged period of drought (Amir and Lev 1996).

[7] The difference between the instantaneous increment in the abnormal earnings variable over the period from time s until time $(s + ds)$ and the instantaneous increment in the abnormal earnings variable over the period from time $(s - ds)$ until time s can be expressed as:

$$\{a(s + ds) - a(s)\} - \{a(s) - a(s - ds)\} = a(s + ds) - 2a(s) + a(s - ds)\}$$

However, here it will be recalled that:

$$\begin{pmatrix} \dfrac{d^2a(s)}{ds^2} \\ \dfrac{d^2v(s)}{ds^2} \end{pmatrix} =$$

$$\begin{pmatrix} h_{11} & h_{12} \\ h_{21} & h_{22} \end{pmatrix}\begin{pmatrix} \dfrac{da(s)}{ds} \\ \dfrac{dv(s)}{ds} \end{pmatrix} + \begin{pmatrix} c_{11} & c_{12} \\ c_{21} & c_{22} \end{pmatrix}\begin{pmatrix} a(s) \\ v(s) \end{pmatrix} + \sqrt{\eta(s)}\begin{pmatrix} k_1 & 0 \\ 0 & k_2 \end{pmatrix}\begin{pmatrix} \dfrac{dz_1(s)}{ds} \\ \dfrac{dz_2(s)}{ds} \end{pmatrix} \quad (2a)$$

or, in vector-matrix notation:

$$\underset{\sim}{u}''(s) = H\underset{\sim}{u}'(s) + C\underset{\sim}{u}(s) + \sqrt{\eta(s)}.K\underset{\sim}{z}'(s) \quad (2b)$$

Here $a'(s) = \dfrac{da(s)}{ds}$ is the instantaneous momentum and $a''(s) = \dfrac{d^2a(s)}{ds^2}$ is the acceleration in the abnormal earnings variable, $a(s)$, whilst $v'(s) = \dfrac{dv(s)}{ds}$ is the momentum and $v''(s) = \dfrac{d^2v(s)}{ds^2}$ is the instantaneous acceleration in the information variable, $v(s)$. Moreover, $\underset{\sim}{u}(s)$ is the vector comprised of the levels of the abnormal earnings and the information variable. Similarly, $\underset{\sim}{u}'(s)$ is the vector comprised of the first derivatives (or momentum) of these two variables whilst $\underset{\sim}{u}''(s)$ is the vector comprised of their second derivatives (or acceleration). The matrix H summarizes the structural coefficients (h_{11}, h_{12}, h_{21}, h_{22}) relating to the momentum in the abnormal earnings and information

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$$\frac{d^2a(s)}{ds^2} = \frac{a(s+ds) - 2a(s) + a(s-ds)}{ds^2}$$

where $\dfrac{d^2a(s)}{ds^2}$ is the second derivative (or acceleration) in the abnormal earnings variable at time s. Hence, stating the investment opportunity set in terms of changes in the momentum (that is, the instantaneous increments) of its determining variables is equivalent to formulating the investment opportunity set in terms of a system of second order stochastic differential equations. Hoel et al. (1986, 159-169) provide a detailed treatment of the analytical foundations of second (and higher) order stochastic differential equations.

variable whilst the matrix C summarizes the structural coefficients (c_{11}, c_{12}, c_{21}, c_{22}) relating to the levels of these variables. Moreover, K is a matrix whose diagonal elements are the "normalising" constants:

$$k_1 = \frac{[r^2 - (rh_{11} + c_{11})][r^2 - (rh_{22} + c_{22})] - (rh_{12} + c_{12})(rh_{21} + c_{21})}{[r^2 - (rh_{22} + c_{22})]}$$

and: (3)

$$k_2 = \frac{[r^2 - (rh_{11} + c_{11})][r^2 - (rh_{22} + c_{22})] - (rh_{12} + c_{12})(rh_{21} + c_{21})}{(rh_{12} + c_{12})}$$

and whose off-diagonal elements are all zero. Finally, $z_1'(s) = \frac{dz_1(s)}{ds}$ and $z_2'(s) = \frac{dz_2(s)}{ds}$ are uncorrelated white noise processes with variance parameters of σ_1^2 and σ_2^2, respectively.[8] Now here it will be recalled that the system of stochastic differential equations on which the equations (2) are based captures all the significant attributes affecting the evolution of the firm's bookkeeping and information variables. It is for this reason that this system of differential equations is often referred to as the firm's "investment opportunity set" (Ashton et al. 2004, 277). Moreover, in the Appendix (available from the authors on request) we demonstrate how one can substitute this system of differential equations into equation (1) and thereby show that the present value of the stream of future cash flows the firm expects to earn under its existing investment

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[8] Myers (1999, 7) notes that the persistence of monopoly rents will affect the evolution of the abnormal earnings variable, $a(t)$. He goes on to note that "although monopoly rents may persist for some time competition should force returns toward the cost of capital. Modelling abnormal earnings as an autoregressive process" as is the case under the second order structural model specified here, "captures this notion." Moreover, one could impose a correlation structure on the structural model by allowing the off-diagonal elements of the matrix K in equation (2) to take on non-zero values. Whilst doing this does not change the nature of the results we are about to report, it does increase the complexity of the algebra that underscores them.

opportunity set (that is, the recursion value, $\eta(t)$, of its equity) can be expressed as:

$$\eta(t) = b(t) + \int_t^{\infty} e^{-r(s-t)} E_t[a(s)]ds =$$

$$b(t) + \frac{\{(r - h_{11})[r^2 - (rh_{22} + c_{22})] - h_{21}(rh_{12} + c_{12})\}a(t)}{[r^2 - (rh_{11} + c_{11})][r^2 - (rh_{22} + c_{22})] - (rh_{12} + c_{12})(rh_{21} + c_{21})} + \frac{[r^2 - (rh_{22} + c_{22})]a'(t)}{[r^2 - (rh_{11} + c_{11})][r^2 - (rh_{22} + c_{22})] - (rh_{12} + c_{12})(rh_{21} + c_{21})} +$$

$$\frac{(rc_{12} - c_{12}h_{22} + c_{22}h_{12})v(t)}{[r^2 - (rh_{11} + c_{11})][r^2 - (rh_{22} + c_{22})] - (rh_{12} + c_{12})(rh_{21} + c_{21})} + \frac{(rh_{12} + c_{12})v'(t)}{[r^2 - (rh_{11} + c_{11})][r^2 - (rh_{22} + c_{22})] - (rh_{12} + c_{12})(rh_{21} + c_{21})} \quad (4)$$

Note how this result shows that the present value of the expected stream of future cash flows hinges on both the levels ($a(t)$ and $v(t)$) and momentum ($a'(t) = \frac{da(t)}{dt}$ and $v'(t) = \frac{dv(t)}{dt}$) of the variables comprising the firm's investment opportunity set. And here it needs to be emphasized that whilst various papers have established an empirical association between equity value and earnings persistence (Chordia and Shivakumar 2006, Fama and French 2012, Chen et al. 2014, Mao and Wei 2014), few have demonstrated that momentum in the variables comprising the firm's investment opportunity set can make a significant contribution to equity value at an analytical level.

In the Appendix we also demonstrate that one can differentiate through equation (4) and thereby show that the present value of the future cash flows, $\eta(t)$, the firm expects to earn under its existing investment opportunity set will evolve in terms of a continuous time branching process; namely (Feller 1951, 235-237; Cox and Ross 1976, 149):[9]

$$\frac{d\eta(t)}{dt} = (r\eta(t) - D(t)) + \sqrt{\eta(t)}.\frac{dq(t)}{dt} \qquad (5a)$$

where $D(t)$ is the instantaneous dividend payment at time t and $\frac{dq(t)}{dt} = \frac{dz_1(t)}{dt} + \frac{dz_2(t)}{dt}$ is a white noise process with variance parameter $\zeta^2 = \sigma_1^2 + \sigma_2^2$. Thus, if one makes the simple assumption that the firm's dividend rate is equal to a constant proportion, $\alpha < r$ of its recursion value (that is, $D(t) = \alpha.\eta(t)$) it will then follow that the recursion value of equity will evolve in accordance with the following differential equation:

$$\frac{d\eta(t)}{dt} = (r - \alpha)\eta(t) + \sqrt{\eta(t)}.\frac{dq(t)}{dt} \qquad (5b)$$

Note also that under both of the above interpretations the recursion value of equity (and hence, the present value of the future cash flows the firm expects to earn) will evolve as a first order differential equation even though the variables on which it is based evolve in terms of a second order system of stochastic differential equations.

[9] Note how this result implies that the expected rate of growth in recursion value, $\frac{E_t[d\eta(t)]}{\eta(t)} = (r - \frac{D(t)}{\eta(t)})dt$, hinges on the dividend policy invoked by the firm as captured by the function $D(t)$. In particular, higher dividend payouts will mean that recursion value grows more slowly. Moreover, the variance of instantaneous increments in recursion value will be $Var_t[\frac{d\eta(t)}{\eta(t)}] = \frac{\zeta^2}{\eta(t)}dt$. Consistent with the empirical evidence of Heston (1993) and Hull and White (1988) amongst others, this shows that the variance of instantaneous increments in the recursion value of equity will decline as recursion value grows in magnitude.

3. Real Option Component of Equity Value and Accounting Variables

Our analysis to date is based on the premise that the market value of a firm's equity is determined by discounting the stream of future cash flows it expects to earn whilst being indefinitely constrained to operate within its existing investment opportunity set. We have previously noted, however, that there is a second component of equity value; namely, the real option or adaptation value associated with a firm's ability to alter its existing investment opportunity set by (for example) fundamentally changing the nature of its operating activities (Burgstahler and Dichev 1997; 188; Mak et al. 2011, 1042; Herath et al. 2015, 3-4). Here, Ashton et al. (2004, 285) combine the proportionate dividends assumption as defined by equation (5b) with the arbitrage conditions on which the Ohlson (1995, 669) valuation model is based and thereby show that the value of the firm's equity, $P(\eta)$, will be described by the following expression (Davidson and Tippett 2012, 278):

$$P(\eta) = \eta + \frac{P(0)}{2}\int_{-1}^{1} exp(\frac{-2\theta\eta}{1+z}).\frac{[1 + \frac{\alpha}{\zeta^2}\eta + \frac{\alpha(2\alpha - r)}{3\zeta^4}\eta^2 + \_\_\_\_]}{[1 + \frac{\alpha}{\zeta^2}.\frac{2\eta}{(1+z)} + \frac{\alpha(2\alpha - r)}{3\zeta^4}.(\frac{2\eta}{1+z})^2 + \_\_\_\_]^2}.dz \quad (6)$$

where $\theta = \frac{2(r - \alpha)}{\zeta^2}$ is a measure of the relative stability with which the recursion value of equity grows over time (Ashton et al. 2004, 286).[10] The first term, η, on the right hand

[10] The probability of the recursion value falling away to zero on or before time t is given by (Cox and Miller 1965, 237):

$$Prob[\eta(t) = 0 \,/\, \eta(0)] = exp(\frac{-\theta\eta(0)}{1 - e^{-rt}})$$

This in turn means that the probability recursion value will fall away to zero at some point in the future is given by:

side of the above expression for $P(\eta)$ is the recursion value of the firm's equity as summarized by equation (4). The second term involving the integral expression is the adaptation value associated with a firm's ability to change its existing investment opportunity set. Note in particular that when the recursion value of equity falls away to zero (that is, $\eta(t) = 0$), the market value of the firm's equity will be completely comprised of its adaptation value, $P(0) \geq 0$.[11]

Now, here one can apply the Riesz Representation Theorem (MacCluer 2008, 21-23) using the Laguerre polynomials as an orthogonal set of basis functions and thereby obtain an infinite but convergent power series expansion for the value of the firm's equity, namely:[12]

$$\underset{t \to \infty}{Limit}\ Prob[\eta(t) = 0 \,/\, \eta(0)] = e^{-\theta\eta(0)}$$

[11] This follows from the fact that:

$$\underset{\eta \to 0}{Limit}\ \{\eta + \frac{P(0)}{2}\int_{-1}^{1} exp(\frac{-2\theta\eta}{1+z}).\frac{[1 + \frac{\alpha}{\zeta^2}\eta + \frac{\alpha(2\alpha - r)}{3\zeta^4}\eta^2 + \_\_\_]}{[1 + \frac{\alpha}{\zeta^2}.\frac{2\eta}{(1+z)} + \frac{\alpha(2\alpha - r)}{3\zeta^4}.(\frac{2\eta}{1+z})^2 + \_\_\_]^2}.dz\} = \frac{P(0)}{2}\int_{-1}^{1} dz = P(0) \geq 0$$

Burgstahler and Dichev (1997, 194) amongst others have argued that the book value of equity, $b(t)$, provides a good approximation for $P(0)$. However, about 2% of firms listed on the Shanghai Stock Exchange carry negative book values on their financial statements over the period from 2000 to 2014. The Shanghai Stock Exchange Listing Rules provide that these firms be issued with a "delisting risk warning" (Shanghai Stock Exchange Fact Book 2014, 79). Moreover, if the book value of equity remains negative in the following year the firm's shares are de-listed with immediate effect (Shanghai Stock Exchange Fact Book 2014, 80). These and other legal requirements mean that listed Chinese firms which carry a negative book value of equity on their financial statements will be severely restricted in their adaptation options. Given this, we set both the adaptation value, $P(0)$, and the book value, $b(t)$, of such firms to zero in all subsequent empirical analysis (Brown et al. 2008, Jan and Ou 2012).

[12] The series expansion is carried to order 3 in order to allow our subsequent regression procedures to differentiate between the non-linear real option effects of positive and negative earnings. Truncating the series expansion at order 2, as is occasionally done in the empirical research in this area of the literature, means that negative earnings would be squared and thus would be positive in our regression model. The regression model would not then be able to differentiate between the real option effects of positive and negative earnings.

$$P(\eta) = \delta_0 + \delta_1(1 - \eta) + \frac{\delta_2}{2}(\eta^2 - 4\eta + 2) + \frac{\delta_3}{6}(6 - 18\eta + 9\eta^2 - \eta^3) + \_\_\_\_ \qquad (7)$$

where the δ_j are known as the "Fourier-Laguerre" coefficients, $L_0(\eta) = 1$ is the Laguerre polynomial of order zero, $L_1(\eta) = (1 - \eta)$ is the Laguerre polynomial of order one, $L_2(\eta) = \frac{1}{2}(\eta^2 - 4\eta + 2)$ is the Laguerre polynomial of order two and so on.[13] Now one can substitute the expression for the recursion value of equity as given in equation (4) into the power series expansion for $P(\eta)$ as given in equation (7) and thereby obtain the following third order approximation formula for the value of the firm's equity:

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[13] Minimising a least squares norm leads to the following expression for the Fourier-Laguerre coefficient, δ_j, associated with the jth Laguerre polynomial, $L_j(\eta)$; namely:

$$\delta_j = \int_0^\infty e^{-\eta} P(\eta) L_j(\eta) d\eta$$

where $P(\eta)$ is the price of the equity stock as given by equation (6). Here we would note that the integral expression for δ_j will, in general, have to be evaluated numerically. Ataullah et al. (2009) summarize some important properties of the Laguerre polynomials and also provide examples of the computational procedures involved in determining the Fourier-Laguerre coefficients for non-dividend paying stocks.

$$P(t) = \beta_0 + \beta_1 b(t) + \beta_2 x(t) + \beta_3 x'(t) + \beta_4 [b(t)]^2 + \beta_5 [x(t)]^2 + \beta_6 [x'(t)]^2 + \beta_7 b(t)x(t) + \beta_8 b(t)x'(t) + \beta_9 x(t)x'(t) + \beta_{10}[b(t)]^3 + \beta_{11} x(t)[b(t)]^2 + \beta_{12} b(t)[x(t)]^2 + \beta_{13}[x(t)]^3 + \beta_{14}[x'(t)]b(t)]^2 + \beta_{15} b(t)x(t)x'(t) + \beta_{16} x'(t)[x(t)]^2 + \beta_{17} b(t)[x'(t)]^2 + \beta_{18} x(t)[x'(t)]^2 + \beta_{19}[x'(t)]^3 + e(t) \tag{8}$$

where, as previously, $b(t)$ is the book value of equity, $x(t) = a(t) + rb(t)$ is the instantaneous earnings attributable to equity at time t, $a(t)$ is the instantaneous abnormal earnings at time t, r is the cost of equity capital, $x'(t) = \frac{dx}{dt}$ is the first derivative (that is, the momentum) in the firm's instantaneous earnings at time t and the β_j are valuation coefficients determined by summing the Fourier-Laguerre coefficients, α_m, associated with the given determining variable in the power series expansion defined by equation (7).[14] Finally, $e(t)$ is an error term that captures all components of the power series expansion in equation (7) that have been excluded from the above third order approximation formula. The results summarized in this section have important implications for the simple linear equity valuation modelling procedures which have traditionally been applied in the empirical work summarized in the literature. If linear valuation models are used to estimate the complex non-linear relationships that exist between equity value and its determining variables, it is all but inevitable there will be problems with omitted variables (Greene 2012).

[14] Thus, β_1 is the sum of the Fourier-Laguerre coefficients in the power series expansion comprising equation (7) associated with the book value variable $b(t)$; β_8 is the sum of the Fourier-Laguerre coefficients in the power series expansion associated with the cross-product term $b(t)x'(t)$ and so on.

This in turn will mean that parameter estimates will be both inconsistent and inefficient and must therefore form a problematic basis for hypothesis testing and any policy recommendations that might eventuate from them. We now summarize the empirical evidence relating to the form and nature of the biases that arise under linear equity valuation models based on a large sample of stocks listed on the Shanghai Stock Exchange.

4. Sample Data and Descriptive Statistics

Our sample data are comprised of $N = 10{,}617$ firm-year observations drawn from the Shanghai Stock Exchange as stored on Datastream and covering the period from 2000 until 2014. The sample includes all available data from all industrial groupings listed on the Shanghai Stock Exchange over this period. For each firm-year, the market value of equity, $P(t)$, is defined as the stock price at the end of fiscal year t. The market value of equity is adjusted for capital issues such as stock splits and dividend payments during the year (Datastream code P). Moreover, all listed Chinese firms have the same fiscal year-end; namely, 31 December. Their annual financial statements must be published by 30 April of the following year. In order to capture the relationship between the accounting variables used in our regression analysis and the market value of equity, we assume that the closing stock price on 30 April each year fully reflects the market's reaction to the information summarized in the financial statements covering the fiscal year ended 31 December of the previous year.[15]

Our empirical analysis is based on three primary determining (that is, independent) variables. First, $x(t)$ is earnings per share and is profit after tax, minority interest and

[15] Previous literature notes that results are not sensitive to different timings of stock price dates (Fama and French 1992, Sloan 1996, Burgstahler and Dichev 1997, Ashton et al. 2003).

preferred dividends but before extraordinary items for the period from time *(t - 1)* until time *t* (Datastream code WC05201). Next, *b(t)* represents the book value (proportioned common equity divided by outstanding shares) at the company's fiscal year end, time *t* (Datastream code WC05476).[16] Here we should emphasize that consistent with prior empirical work in the area, our empirical analysis is implemented by lagging book value by one year (Burgstahler and Dichev 1997, 195; Ashton et al. 2003, 436). This means that whilst earnings are taken over the period from time *(t - 1)* until time *t*, book value is lagged by one year and is thus taken at time *(t - 1)*. Using book value at year *(t - 1)* is a more appropriate explanatory variable for the market value of equity since it does not include earnings for the period from time *(t - 1)* until time *t*. As such, it allows our regression model to distinguish more clearly between the impact that earnings and book value will separately have on the market value of equity. Finally, earnings momentum, *x′(t)*, is approximated by the difference in earnings per share over the period from time *(t - 1)* until time *t* and earnings per share over the period from time *(t - 2)* until time *(t - 1)* ; that is, $x'(t) \approx x(t) - x(t - 1)$.[17]

Table 1 provides summary statistical information relating to the distributional properties of the data on which our empirical analysis is based. This table shows that the mean and median of book value of equity across the *N = 10,617* firm-year observations comprising our sample are *2.21* Yuan and *1.86* Yuan per share, respectively. Likewise, the standard deviation of the book values across our sample data is *1.84*. Finally, the minimum book

[16] The Full-Sample of *N = 10,617* firm-year observations includes *239* firm-years where the book value of equity is negative. As discussed in Section 3, we set both the adaptation value, *P(0)*, and book value, *b(t)*, of these firm-years to zero in all subsequent empirical analysis.

[17] Firm-years encompassing capital issues were initially excluded from our empirical analysis in order to preserve the integrity of our momentum calculations. This involved around 100 observations (or less than 1% of our total sample of *N = 10,617* firm-year observations). However, since empirical results including firm-years with capital issues are virtually identical to empirical results excluding them, we summarize only the former in subsequent discussion.

TABLE ONE ABOUT HERE

value in our sample is zero whilst the maximum book value is *44.17* Yuan. The other statistics summarized in Table 1 are to be similarly interpreted. Figure 1 presents a summary graph of the relationship between the standardized stock price, standardized book value and standardized earnings across the $N = 10{,}617$ firm-year observations comprising the Full-Sample data. All determining variables are standardized in order to provide a graphical summary of the Full-Sample data which can be meaningfully fitted

FIGURE ONE ABOUT HERE

onto a single page. Thus, for each firm-year involving the vector of observations $[P(t), b(t), x(t)]$ a new set of standardized variables is calculated which takes the form:

$$[\frac{P(t) - \overline{P(t)}}{\sigma[P(t)]}, \frac{b(t) - \overline{b(t)}}{\sigma[b(t)]}, \frac{x(t) - \overline{x(t)}}{\sigma[x(t)]}]$$

where $\overline{P(t)}$, $\overline{b(t)}$ and $\overline{x(t)}$ are the average stock price, average book value and average earnings, respectively and $\sigma[P(t)]$, $\sigma[b(t)]$ and $\sigma[x(t)]$ are the standard deviation of the stock price, the standard deviation of book value and the standard deviation of earnings, respectively across the $N = 10{,}617$ firm-year observations comprising the Full-Sample data. Thus, from Table 1 standardized book values are defined by $\frac{b(t) - \overline{b(t)}}{\sigma[b(t)]} = \frac{b(t) - 2.21}{1.84}$ whilst standardized earnings are $\frac{x(t) - \overline{x(t)}}{\sigma[x(t)]} = \frac{x(t) - 0.17}{0.60}$.[18] Note in particular how Figure

[18] Many studies in this area of the literature scale data by the book value of equity, stock price, the book value of total assets or something similar before giving them graphical presentation (Burgstahler and Dichev 1997, 199; Ashton et al 2003, 429). However, Pearson (1897) demonstrates how this procedure

1 is characterized by a positive relationship between standardized stock price, standardized book value and standardized earnings. More important, however, is that there is a convex hull at the foot of the graph which when projected onto the standardized price-standardized earnings plane leads to the convex relationship between the market value of equity and earnings evident in several previous studies of the relationship between stock prices and earnings (Burgstahler and Dichev 1997, 199; Ashton et al. 2003, 429).

5. Empirical Analysis and Results

Full-sample Analysis

We begin our analysis of the Full-Sample data by detailing the correlation matrix pertaining to each of the nineteen determining variables summarized on the right hand side of equation (8). Thus, Table 2 shows that the product moment correlation coefficient between earnings, $x(t)$, and book value, $b(t)$, across the $N = 10{,}617$ firm-year observations comprising our sample is 0.173. Similarly, the product moment correlation coefficient between the squared earnings and earnings momentum cross product term,

TABLE TWO ABOUT HERE

$x'(t)[x(t)]^2$, and the cubed earnings term, $[x(t)]^3$, is 0.990. The latter of these two correlation coefficients (as well as several others summarized in the correlation matrix) suggests that co-linearity in the determining variables leading to numerically unstable matrix inversion procedures may be an issue for the correlation matrix associated with our Full-Sample data.

induces spurious correlation between the graphed variables. We avoid this outcome by presenting all graphs in terms of standardized (mean zero, unit variance) variables.

One can assess the scale of the potential instability issues caused by co-linear independent variables by determining the condition index for the Full-Sample correlation matrix. Here, Table 3 summarizes the nineteen eigenvalues for the correlation matrix based on our Full-Sample data. The largest of these eigenvalues is $\lambda_1 = 11.522$ whilst the smallest is $\lambda_{19} = 0.000$.[19] This leads to the following condition index for the Full-Sample correlation matrix (Greene 2012):

$$\sqrt{\frac{\lambda_1}{\lambda_{19}}} = \sqrt{\frac{11.522}{0.000}} = 356.43$$

Unfortunately, a condition index of this magnitude far exceeds the value of 15 at which the stability of the regression procedures are regarded as being seriously compromised

TABLE THREE ABOUT HERE

(Belsley et al. 1980, 100).[20] However, one can address this issue by applying an orthogonal transformation to the original Full-Sample data based on the eigenvectors of the correlation matrix as summarized in Table 3. Under this procedure the original Full-Sample data are converted into a new set of uncorrelated (that is, orthogonal) variables called principal components (Jolliffe 2002). Moreover, one can divide the eigenvalue, λ_j,

[19] All eigenvalues are stated to three decimal places. The smallest eigenvalue is in fact $\lambda_{19} = 0.000091$ when rounded to six decimal places.

[20] We would here emphasize that basing our empirical analysis on a more parsimonious second (rather than a third) order series expansion (and thereby omitting the term $\frac{\delta_3}{6}(6 - 18\eta + 9\eta^2 - \eta^3)$ from equation (7)) does not resolve the co-linearity issues which arise from the regression procedures applied in this area of the literature. The correlation matrix associated with the second order independent variables still exhibits a condition index which far exceeds the value of 15 at which the stability of the regression procedures are regarded as being seriously compromised. Moreover, we have previously noted how the second order approximation formula is incapable of differentiating between the real option effects of positive and negative earnings.

corresponding to a given principal component, $\underset{\sim}{PRIN}_j$, by the number of determining variables on which the analysis is based and thereby determine the proportionate variation in the original Full-Sample data which is accounted for by the given principal component. Similarly, summing the eigenvalues corresponding to a given set of principal components will also determine the proportionate variation in the original Full-Sample data which is accounted for by the given set of principal components. Hence, from Table 3 the first four principal components account for:

$$\frac{11.522 + 2.451 + 1.523 + 1.327}{19} = 88.55\%$$

of the variation in the original Full-Sample.[21] Furthermore, since these first four principal components account for a substantial majority of the variation in the original Full-Sample data, one can resolve the relationship between the market value of equity, $P(t)$, and its determining variables in terms of the following reduced form valuation model:

$$P(t) = \gamma_0 + \gamma_1.\underset{\sim}{PRIN}_1^T.\underset{\sim}{z(t)} + \gamma_2.\underset{\sim}{PRIN}_2^T.\underset{\sim}{z(t)} + \gamma_3.\underset{\sim}{PRIN}_3^T.\underset{\sim}{z(t)} + \gamma_4.\underset{\sim}{PRIN}_4^T.\underset{\sim}{z(t)} + \varepsilon(t) \qquad (9)$$

where $\underset{\sim}{PRIN}_j^T$ is the transpose of the relevant principal component as summarized in Table 3, and:

[21] We follow Kaiser (1970, 401) and others by implementing our empirical analysis using only principal components with eigenvalues that exceed unity. See Anderson (2003) for an introduction to the sampling theory (dealing with the empirical estimation of eigenvalues) that underscores this criterion.

$$\underset{\sim}{z(t)} = \begin{pmatrix} b(t) \\ x(t) \\ x'(t) \\ [b(t)]^2 \\ [x(t)]^2 \\ [x'(t)]^2 \\ b(t)x(t) \\ b(t)x'(t) \\ x(t)x'(t) \\ [b(t)]^3 \\ x(t)[b(t)]^2 \\ b(t)[x(t)]^2 \\ [x(t)]^3 \\ x'(t)[b(t)]^2 \\ b(t)x(t)x'(t) \\ x'(t)[x(t)]^2 \\ b(t)[x'(t)]^2 \\ x(t)[x'(t)]^2 \\ [x'(t)]^3 \end{pmatrix} \quad (10)$$

is the vector which summarizes the determining (that is, independent) variables for a particular firm-year. As previously, $x(t)$ is the earnings, $x'(t)$ is the momentum in earnings and $b(t)$ is the book value of equity for the particular firm-year. Finally, γ_j is the valuation coefficients associated with the principal component, $\underset{\sim}{PRIN}_j$, whilst $\varepsilon(t)$ is the stochastic error term. Recall that the nineteen principal components formed from the original Full-Sample data are all orthogonal and so, the regression specification given here resolves all instability issues arising in parameter estimation due to co-linear independent variables.[22]

[22] We have previously noted how many studies in this area scale variables on both sides of the regression equation by the book value of equity, stock price, the book value of total assets or something similar in order to reduce heteroscedasticity (Jones 1991, 212; Basu 1997, 10). However, Pearson (1897) demonstrates that this procedure leads to biased parameter estimates of the levels relationship and an R^2 statistic which is biased upwards due to the effects of spurious correlation.

Table 4 summarizes the parameter estimates and their associated t statistics for the Full-Sample data based on the above valuation model.[23] Note that only two of the

TABLE FOUR ABOUT HERE

four principal components return an estimated valuation coefficient which is significantly different from zero. The first of these is $\underset{\sim}{PRIN}_2$ which has an estimated valuation coefficient of $\gamma_2 = 1.87$ with a $t = 1.85$ score which is significant - but only weakly so at the 10% level. Moreover, $\underset{\sim}{PRIN}_2$ loads exclusively onto the book value related components $b(t)$, $[b(t)]^2$ and $[b(t)]^3$. This contrasts with $\underset{\sim}{PRIN}_4$ which returns an estimated valuation coefficient of $\gamma_4 = 2.56$ and an associated $t = 2.95$ score which is highly significant. Moreover, $\underset{\sim}{PRIN}_4$ loads heavily onto the book value component, $b(t)$, squared earnings, $[x(t)]^2$, squared momentum, $[x'(t)]^2$, and a number of cross product terms involving these components.

These factor loadings contrast with those for the principal components $\underset{\sim}{PRIN}_1$ and $\underset{\sim}{PRIN}_3$, both of which return insignificant valuation coefficients. Note that $\underset{\sim}{PRIN}_1$ loads heavily onto the earnings related components $x(t)$, $[x(t)]^2$ and $[x(t)]^3$ as well as several cross-product terms involving these components. It also loads less heavily onto the earnings momentum related components $x'(t)$, $[x'(t)]^2$ and $[x'(t)]^3$ and several cross-product terms involving these components. Similarly, $\underset{\sim}{PRIN}_3$ loads almost exclusively onto the earnings momentum related components $x'(t)$, $[x'(t)]^2$ and $[x'(t)]^3$. Thus, in summary, the

[23] All t values are calculated using the STATA cluster option in order to address issues of heteroscedasticity and correlated error terms across firms and/or across time (Petersen, 2009).

two principal components which return insignificant valuation coefficients load onto a combination of their earnings and/or their earnings momentum related components.

The overall tenor of the empirical results for the Full-Sample data is that there is a complex non-linear relationship between stock prices and their determining variables with book value occupying a more prominent role than earnings in the stock valuation process.[24] Moreover, the insignificant valuation coefficient associated with the principal component $\underset{\sim}{PRIN}_3$ means that earnings momentum does not appear to have a direct impact on stock prices comprising our Full-Sample firm-year data.

Efficiency Sub-Sample Analysis

A number of authors (Burgstahler and Dichev 1997, Ashton et al. 2003) have suggested that as a firm's accumulated losses grow in magnitude, market participants will gradually shift their focus away from earnings towards the firm's balance sheet (and the book value of equity in particular). This is based on the proposition that the book value of equity measures the firm's adaptation value when adverse financial circumstances force it into making fundamental changes to its investment opportunity set (Burgstahler and Dichev 1997, 194). We now seek to test this hypothesis by ordering our sample of $N = 10,617$ firm-year observations from the firm-year with the lowest price to earnings ratio, up to the firm-year with the highest price to earnings ratio (Siegel 2013). It is likely that firms with low price to earnings ratios are experiencing unfavorable trading conditions and

[24] The tender offer rules under the Chinese Takeover Measures, 2006, require that when an acquiring firm makes a takeover offer for a listed target firm it must submit separate offer prices for the target firm's "tradable shares" and its "non-tradable shares". The offer price for tradable shares is based on their market price on the stock exchange. The offer price for the non-tradable shares is based on the book value of the target firm's equity as summarized in its latest set of published financial statements. This will be a contributing factor to our observation that book value occupies a more prominent role than earnings in the pricing of Chinese equity stocks. However, we would expect this to moderate under the "Guquan Fenzhi Gaige" or Shareholder Structure Reforms that will gradually come into force in the years ahead due to the enabling legislation passed into law by the Chinese government in April, 2005.

therefore, have minimal growth potential. In contrast, it is likely that firms with high price to earnings ratios are experiencing favorable trading conditions with strong growth potential.[25] Given this, we divided the ordered sample of firm-year price to earnings ratios into three sub-samples comprised of *3,539* firm-years each. The first sub-sample is comprised of firm-years with the lowest price to earnings ratios and is dubbed the Low-Efficiency sample. Since the book value of a firm's equity measures the firm's adaptation value when adverse trading conditions require it to make modifications to its investment opportunity set (Burgstahler and Dichev 1997, 188), it follows that one would expect the book value of equity to play a more prominent role than earnings in the valuation of equity for the firm-year data comprising the Low-Efficiency sample. The second sub-sample, dubbed the Mid-Efficiency sample, is comprised of the firm-years corresponding to the middle set of *3,539* ordered price to earnings ratios. For these firms there is a non-trivial probability that in the immediate future they will either experience unfavorable trading conditions or a much higher rate of profitability because of the growth options which are available to them. Given this, one would expect both the adaptation and growth options available to these firms to have non-trivial values and this in turn will mean that earnings, earnings momentum and book value will all make a significant contribution to overall equity value for these firm-years. Finally, there is the High-Efficiency Sample which is comprised of firm-years with the highest set of *3,539* ordered price to earnings ratios. The firms comprising this sample will be experiencing relatively favorable trading conditions and there will only be a trivial probability that they will experience the adverse circumstances which will require them to exercise the

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[25] We also ordered our sample of $N = 10,617$ firm-year observations from the firm-year with the lowest earnings to book ratio, up to the firm-year with the highest earnings to book ratio and then replicated the efficiency analysis summarized in this section of the paper (Burgstahler and Dichev 1997, Burgstahler 1998). There are no significant differences between the efficiency analysis based on the earnings to book ratio and the efficiency analysis based on the price to earnings ratio summarized here.

adaptation options which are available to them. Their adaptation options will have a relatively small value because of this. For these firms one would expect earnings and the growth options associated with earnings to be the principal determinant of their equity values.

Low-Efficiency Sample Analysis

Table 5 provides summary statistical information relating to the distributional properties of the determining variables whilst Figure 2 presents a summary graph of the relationship between the standardized stock price, standardized book value and standardized earnings for the Low-Efficiency Sample of firm-year observations. Probably the most important

TABLE FIVE AND FIGURE 2 ABOUT HERE

characteristic displayed by Figure 2 is that there is a "V" shaped wedge in the distribution of the Low-Efficiency data. The left arm of this wedge is characterized by firm-year data which apart from stochastic perturbations, takes the form of a plane parameterised in terms of standardized book value and standardized stock price. This in turn means for the firm-years comprising this plane, earnings will have little impact on stock prices; that is, the standardized stock price and standardized earnings are orthogonal variables. Hence, for the firm-years comprising this arm of the wedge standardized book value is all that is needed to estimate the standardized stock price. This contrasts with the firm-years comprising the second arm of the wedge which tend to slope away from the standardized book value axis as standardized earnings increase in magnitude. This indicates that earnings have at least some (though as shall be seen in subsequent sections, minimal) impact on the stock price over the firm-years which characterize this segment of the wedge formation.

Table 6 summarizes the correlation matrix pertaining to each of the nineteen determining variables whilst Table 7 summarizes the nineteen eigenvalues and principal component vectors for the correlation matrix based on the Low-Efficiency sample data. These tables

TABLES SIX AND SEVEN ABOUT HERE

show very high correlation coefficients across several of the determining variables and lead to a condition index of *669.03 > 15* (Belsley et al. 1980, 100). Moreover, the first four principal components account for *90.30%* of the variation in the original Low-Efficiency sample data (Kaiser 1970, 401). This in turn means that one can resolve the relationship between the market value of equity, *P(t)*, and its determining variables in terms of the reduced form valuation model summarized in the discussion surrounding equations (9) and (10).

Panel A of Table 8 summarizes parameter estimates and their associated t statistics for the Low-Efficiency sample data based on the reduced form valuation model. Of particular note is that the results summarized in panel A of Table 8 for the Low-Efficiency sample are very similar to the results summarized in Table 4 for the Full-Sample reduced form valuation model. Thus, panel A of Table 8 shows that $\underset{\sim}{PRIN}_2$ has

TABLE EIGHT ABOUT HERE

an estimated valuation coefficient for the Low-Efficiency sample data of $\gamma_2 = 1.86$ with a $t = 1.81$ score which is significant - but only weakly so at the 10% level. This is very similar to the valuation coefficient for $\underset{\sim}{PRIN}_2$ of $\gamma_2 = 1.87$ with an associated $t = 1.85$ score for the Full-Sample data as summarized in Table 4. Moreover, in both the Full-

Sample and Low-Efficiency data sets $\underset{\sim}{PRIN}_2$ loads heavily onto the book value related elements $b(t)$, $[b(t)]^2$ and $[b(t)]^3$. Similarly, panel A of Table 8 shows that $\underset{\sim}{PRIN}_4$ has an estimated valuation coefficient for Low-Efficiency sample data of $\gamma_4 = 3.33$ with a $t = 3.38$ score which is highly significant. This is not dissimilar to the valuation coefficient for $\underset{\sim}{PRIN}_4$ of $\gamma_4 = 2.56$ with an associated $t = 2.95$ score for the Full-Sample data as summarized in Table 4. Furthermore, for both the Full-Sample and Low-Efficiency data sets $\underset{\sim}{PRIN}_4$ loads heavily onto the book value component, $b(t)$, squared earnings, $[x(t)]^2$, squared momentum, $[x'(t)]^2$, as well as a number of cross product terms involving these components.

Table 4 and panel A of Table 8 also show that $\underset{\sim}{PRIN}_1$ and $\underset{\sim}{PRIN}_3$ both return insignificant but similar valuation coefficients for the Full-Sample and Low-Efficiency data. Moreover, both data sets show that $\underset{\sim}{PRIN}_1$ loads heavily onto the earnings related components $x(t)$, $[x(t)]^2$ and $[x(t)]^3$ as well as several cross-product terms involving these components. Likewise, $\underset{\sim}{PRIN}_3$ loads almost exclusively onto the earnings momentum related components $x'(t)$, $[x'(t)]^2$ and $[x'(t)]^3$ for both data sets. Thus, the two principal components which return insignificant valuation coefficients load onto a combination of their earnings and/or their earnings momentum related components.

Bringing these results together shows that for Low-Efficiency sample data there is a complex non-linear relationship between stock prices and their determining variables with book value occupying a more prominent role than earnings in the stock valuation process. We have previously observed how book value measures a firm's adaptation value when there is a strong likelihood that adverse trading conditions will require it to make modifications to its investment opportunity set. Hence, one would expect book value to play a more prominent role than earnings in the valuation of the Low-Efficiency firm-year data on which our empirical analysis in this section is based. That book value plays a much more prominent role in the determination of Low-Efficiency stock prices when compared to the impact it has on Full-Sample stock prices is evident from Table 4 and Panel A of Table 8, respectively which show that the reduced form valuation model defined by equations (9) and (10) returns an $R^2 = 0.36$ for Low-Efficiency sample data compared with the much lower $R^2 = 0.21$ for the Full-Sample data. Finally, note also that the insignificant valuation coefficient associated with the principal component $\underset{\sim}{PRIN}_3$ shows how earnings momentum does not appear to have a direct impact on the stock prices comprising the Low-Efficiency data set.

Mid-Efficiency Sample Analysis

Table 9 provides summary statistical information relating to the distributional properties of the determining variables whilst Figure 3 presents a summary graph of the relationship between the standardized stock prices, standardized book value and standardized earnings for the Mid-Efficiency Sample of firm-year observations. Note how Figure 3 has several important distinguishing characteristics when compared with Figure 2, which is the equivalent graph for the Low-Efficiency sample data. First, amongst these is that Figure 3 does not exhibit the V shaped wedge property which characterizes the graph for the

TABLE NINE AND FIGURE THREE ABOUT HERE

Low-Efficiency sample data. Second, Figure 3 exhibits much more compact distributional properties than those displayed in Figure 2 for the Low-Efficiency data set. These first two properties arise from the fact that firms comprising the Mid-Efficiency sample will, in general, have a non-trivial probability of entering either the Low-Efficiency state or the High-Efficiency state at some point in the foreseeable future. This in turn will mean their growth and adaptation options will both possess significant value. Furthermore, if a firm in the Mid-Efficiency state gravitates towards the Low-Efficiency state (due, for example, to increasing levels of financial distress), then its growth options will decline in value. However, the affected firm will receive at least partial compensation for the falling value of its growth options through an increase in the value of its adaptation options. Similarly, if a firm that currently occupies the Mid-Efficiency state gravitates towards the High-Efficiency state (due, for example, to an increased rate of profitability), it will receive at least partial compensation for the declining value of its adaptation options by an increase in the value of its growth options. The complementary (that is, compensatory) nature of changes in the value of the growth and adaptation options available to firms comprising the Mid-Efficiency state has the important implication that variations in real option value across the firm-years comprising the Mid-Efficiency sample are likely to be relatively small. This in turn will mean that one can expect the Mid-Efficiency sample of firm-year observations to exhibit far more compact distributional properties than either the Low-Efficiency sample or the High Efficiency sample - both of which will lack this complementary (that is, compensating) attribute in their real option values.[26] And this is exactly what we see when we compare Figure 3 for Mid-Efficiency sample data with Figure 2 for Low-Efficiency sample data - and what we will also see at a later point for Figure 4 which provides a graphical summary of the High-Efficiency data set.

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[26] This follows from the fact that High-Efficiency firm-years will be characterized by trivial adaptation option values whilst Low-Efficiency firm-years will be characterized by trivial growth option values.

There is, however, a third crucially important property exhibited by Figure 3. And this is that as standardized earnings increase in magnitude, the scatter of firm-year data in Figure 3 slopes away from the standardized book value axis at a rate which far exceeds the rate at which the scatter slopes away from the book value axis for the Low-Efficiency firm-year data in Figure 2. This indicates that earnings have a far greater impact on stock prices for the firm-years comprising the Mid-Efficiency sample data in Figure 3 than is the case for the firm-years comprising the Low-Efficiency sample data in Figure 2.

Table 10 summarizes the correlation matrix pertaining to each of the nineteen determining variables whilst Table 11 summarizes the nineteen eigenvalues and principal component vectors for the correlation matrix based on the Mid-Efficiency sample data.

TABLES TEN AND ELEVEN ABOUT HERE

These tables show very high correlation coefficients across several of the determining variables and lead to a condition index of $425.81 > 15$ (Belsley et al. 1980, 100). Moreover, the first four principal components account for *90.49%* of the variation in the original Mid-Efficiency sample data (Kaiser 1970, 401).

Panel B of Table 8 summarizes parameter estimates and their associated t statistics for the Mid-Efficiency sample based on the reduced form valuation model summarized in the discussion surrounding equations (9) and (10). Thus, $\underset{\sim}{PRIN}_1$ returns an estimated valuation coefficient of $\gamma_1 = 4.97$ with a $t = 26.48$ score that is highly significant. Moreover, Table 11 shows that $\underset{\sim}{PRIN}_1$ loads heavily onto the earnings related components $x(t)$, $[x(t)]^2$ and $[x(t)]^3$ as well as several cross-product terms involving these components. Panel B of Table 8 also shows that $\underset{\sim}{PRIN}_2$ returns an estimated valuation coefficient of $\gamma_2 = -1.19$ with a $t = -5.36$ score which again, is highly significant. Furthermore, Table 11 shows that $\underset{\sim}{PRIN}_2$ loads heavily onto the book value related components $b(t)$, $[b(t)]^2$ and $[b(t)]^3$ as well as several cross-product terms involving these components. The third principal component, $\underset{\sim}{PRIN}_3$, returns a valuation coefficient of $\gamma_3 = -1.54$ with a $t = -4.11$ score which again, is highly significant. Moreover, $\underset{\sim}{PRIN}_3$ loads heavily onto the earnings momentum related components $x'(t)$ and $[x'(t)]^3$. It also loads less heavily onto the book value component $b(t)$. These results are similar to those for $\underset{\sim}{PRIN}_4$ which returns an estimated valuation coefficient of $\gamma_4 = 4.77$ with a $t = 14.10$ score which once again, is highly significant. Moreover, $\underset{\sim}{PRIN}_4$ loads onto similar components as $\underset{\sim}{PRIN}_3$ - most notably book value, $b(t)$, and earnings, $x(t)$. It also loads onto earnings momentum, $x'(t)$, and a number of cross product terms involving $x'(t)$. The results for $\underset{\sim}{PRIN}_3$ and $\underset{\sim}{PRIN}_4$ are particularly important because they show how earnings momentum appears to have a significant impact on the stock prices comprising the Mid-Efficiency data set. This contrasts with the Full-Sample and Low-Efficiency data sets considered earlier where earnings momentum appears to have little or no influence on stock prices.

Thus, the general tenor of the results obtained for the Mid-Efficiency sample is that there is again a complex non-linear relationship between stock prices and their determining variables with book value, and, more importantly, earnings and earnings momentum having a significant impact on stock prices. Moreover, these results are consistent with our previously stated proposition that earnings and book value will both have a significant impact on the stock prices classified into the Mid-Efficiency sample of firm-year observations.

High-Efficiency Sample Analysis

Table 12 provides summary statistical information relating to the distributional properties of the determining variables whilst Figure 4 presents a summary graph of the relationship between the standardized stock price, standardized book value and standardized earnings for the Mid-Efficiency Sample firm-year observations. We have previously observed

TABLE TWELVE AND FIGURE FOUR ABOUT HERE

how one would expect the Mid-Efficiency sample data summarized in Figure 3 to exhibit much more compact distributional properties than those displayed in Figure 4 for the High-Efficiency data set. This follows from the fact that the firm-years comprising the High-Efficiency data set will lack the complementary (that is, compensatory) nature of changes in real (growth and adaptation) option values which characterize the firm-years comprising the Mid-Efficiency data set. A cursory comparison of Figure 3 with Figure 4 shows how this is borne out by the data - the Mid-Efficiency sample data depicted in Figure 3 supports a much more compact distribution of scatter than is the case for the High-Efficiency data depicted in Figure 4. Moreover, Figure 4 shows that earnings plays a more prominent role in stock valuation as one moves rightward away from the left hand standardized book value axis across the scatter towards the standardized earnings axis.

Table 13 summarizes the correlation matrix pertaining to each of the nineteen determining variables whilst Table 14 summarizes the nineteen eigenvalues and principal component vectors for the correlation matrix based on the High-Efficiency sample data. These tables show very high correlation coefficients across several of the determining variables and lead to a condition index of $190.52 > 15$ (Belsley et al. 1980, 100).

Moreover, the first four principal components account for *87.88%* of the variation in the original High-Efficiency sample data (Kaiser 1970, 401). Panel C of Table 8

TABLES THIRTEEN AND FOURTEEN ABOUT HERE

summarizes the parameter estimates and their associated t statistics for the High-Efficiency sample data based on the reduced form valuation model summarized in the discussion surrounding equations (9) and (10). This shows that $\underset{\sim}{PRIN}_1$ has an estimated valuation coefficient of $\gamma_1 = 3.62$ with a $t = 12.05$ score which is highly significant. Moreover, Table 14 shows that $\underset{\sim}{PRIN}_1$ loads heavily onto the earnings related components $x(t)$, $[x(t)]^2$ and $[x(t)]^3$ as well as several cross-product terms involving these components. Panel C of Table 8 also shows that $\underset{\sim}{PRIN}_2$ returns an estimated valuation coefficient of $\gamma_2 = 0.67$ with a $t = 1.62$ score which is not significant. Furthermore, Table 14 shows that $\underset{\sim}{PRIN}_2$ loads heavily onto the book value related components $b(t)$, $[b(t)]^2$ and $[b(t)]^3$ as well as several cross-product terms involving these components. The third principal component, $\underset{\sim}{PRIN}_3$, returns a valuation coefficient of $\gamma_3 = 0.85$ with a $t = 5.90$ score which is again highly significant. Moreover, $\underset{\sim}{PRIN}_3$ represents an asymmetric interpretation of $\underset{\sim}{PRIN}_2$ in the sense that its primary loadings are onto the earnings momentum related components $x'(t)$, $[x'(t)]^2$ and $[x'(t)]^3$. It also has secondary loadings onto the book value components $b(t)$, $[b(t)]^2$ and $[b(t)]^3$ as well as several cross-product terms involving the book value and earnings momentum related components. These results are also similar to those for $\underset{\sim}{PRIN}_4$ which returns an estimated valuation coefficient of $\gamma_4 = 1.50$ with a $t = 3.36$ score that again, is highly significant. Moreover,

$PRIN_4$ loads onto book value, *b(t)*, earnings, *x(t)*, and a few cross-product terms involving these two components.

Hence, the overall tenor of our empirical analysis of the High-Efficiency data set is that there is again a complex non-linear relationship between stock prices and its determining variables with earnings occupying a much more prominent role than book value in the stock valuation process. The only principal component which loads primarily onto its book value related components is $PRIN_2$ which returns an estimated valuation coefficient which is not significant. In contrast, $PRIN_1$ loads heavily onto several of its earnings related components and returns a highly significant valuation coefficient. Moreover, $PRIN_3$ loads heavily onto its earnings momentum related components and also returns a highly significant valuation coefficient. These results are consistent with our previously stated proposition that earnings and the growth options associated with earnings will be the predominant determinants of the stock prices comprising the High-Efficiency sample of firm-year observations.

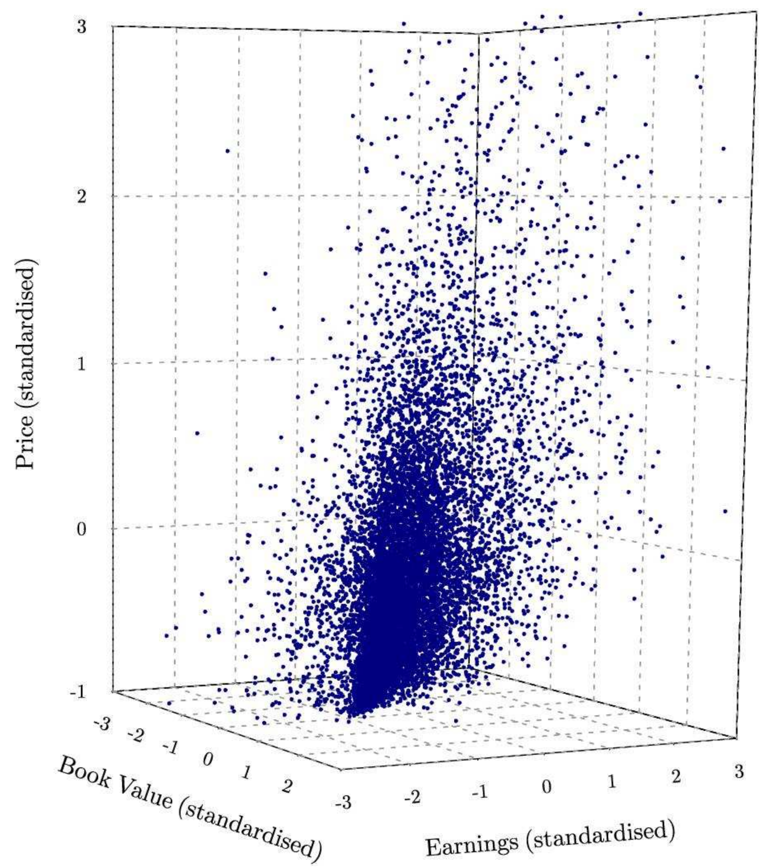
6. Summary Conclusions

A steadily growing volume of empirical evidence shows that the Ohlson (1995) equity valuation model provides at best, problematic estimates of actual stock prices (Dechow et al. 1999, Myers 1999, Collins et al. 1999, Morel 2003, Gregory et al. 2005, Tsay et al. 2008, Khodadadi and Emami 2010, Lee et al. 2013). Several reasons have been advanced for this. The first is that empirical researchers invariably use parsimonious systems of first order difference equations to model firm investment opportunity sets. It is unlikely that simple systems like these can capture the complex interrelationships which exist between the variables that determine stock prices. A second and perhaps more significant reason for the poor performance of the Ohlson (1995) model is that it is based on the assumption that firms are indefinitely constrained to operate within their existing investment opportunity sets.

We address the first of these issues by demonstrating that if one modifies the Ohlson (1995) model so that a firm's investment opportunity set evolves in terms of a second order system of stochastic differential equations, then the present value of the future cash flows the firm expects to earn will be stated in terms of both the levels and momentum (that is, first derivative) of the variables comprising its investment opportunity set. This provides an analytical justification for the emerging empirical work which documents a significant association between earnings momentum and stock prices (Chordia and Shivakumar 2006, Fama and French 2012, Chen et al. 2014, Mao and Wei 2014). Moreover, our empirical analysis of stocks listed on the Shanghai Stock Exchange shows how earnings momentum appears to have a significant impact on the stock prices of the Mid-Efficiency and High-Efficiency data sets comprising our sample.

We also demonstrate that if firms have the capacity to modify or change their investment opportunity sets then it is doubtful whether the expected present value rule on which the Ohlson (1995) model is founded can provide a complete description of the way stock prices are determined in practice. A firm's ability to modify or change its investment opportunity set is a valuable option which can make a significant contribution to the overall market value of equity; and this will be in addition to the value emanating from the present value of the stream of future cash flows the firm expects to earn. We illustrate the importance of this point by using basic no-arbitrage arguments to document the significant contribution which the option to modify (or abandon) a firm's investment opportunity set can make to overall equity value. Moreover, our empirical analysis of stocks listed on the Shanghai Stock Exchange is consistent with the hypothesis that there is a complex non-linear relationship between stock prices and their determining variables with book value or earnings occupying a more prominent role in the stock valuation process according to the efficiency level considered. These results are consistent with the hypothesis that the adaptation and growth options which are typically available to firms, have a significant role to play in the determination of the stock prices of the firms which are traded on the Shanghai Stock Exchange.

Figure 1
Shanghai Stock Exchange
Standardized Stock Price [*P(t)*] against Standardized Book Value [*b(t)*] and Standardized Earnings [*x(t)*] for Full-Sample Data
***N = 10,617* Firm-Years covering the period from 2000 until 2014**

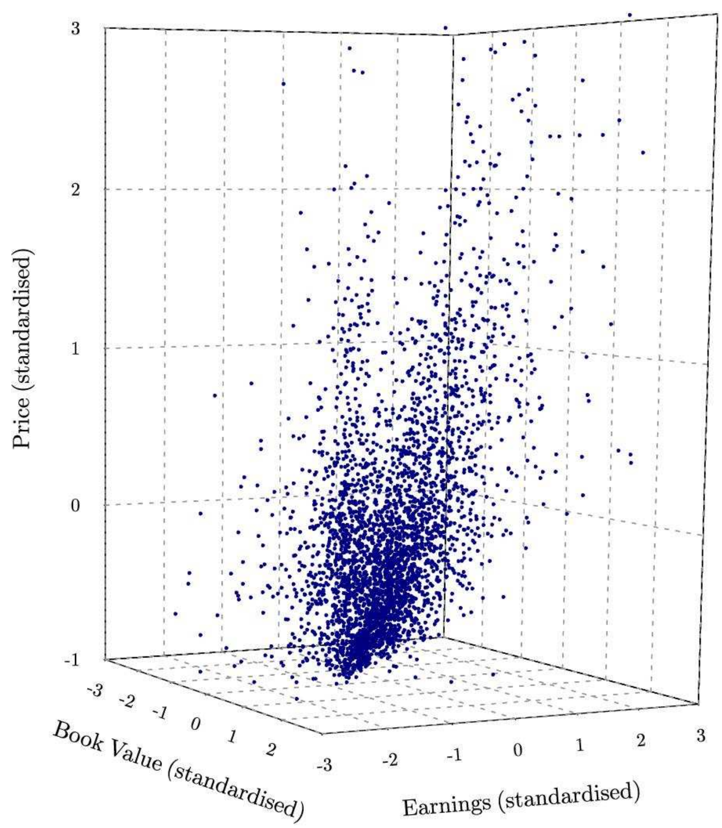


Each of the $N = 10,617$ firm-years of data, $[P(t),b(t),x(t)]$, covering the period from 2000 until 2014 was converted to the standardized form:

$$\left[\frac{P(t) - \overline{P(t)}}{\sigma[P(t)]}, \frac{b(t) - \overline{b(t)}}{\sigma[b(t)]}, \frac{x(t) - \overline{x(t)}}{\sigma[x(t)]}\right] = \left[\frac{P(t) - 7.93}{6.97}, \frac{b(t) - 2.21}{1.84}, \frac{x(t) - 0.17}{0.60}\right]$$

where $\overline{P(t)}$, $\overline{b(t)}$ and $\overline{x(t)}$ are the average stock price, average book value and average earnings and $\sigma[P(t)]$, $\sigma[b(t)]$ and $\sigma[x(t)]$ are the standard deviation of the stock price, book value and earnings, respectively calculated across the $N = 10,617$ firm-years of data. The standardized vectors are plotted in the above graph.

Figure 2
Shanghai Stock Exchange
Standardized Stock Price [*P(t)*] against Standardized Book Value [*b(t)*] and Standardized Earnings [*x(t)*] for Low-Efficiency Sample Data
$N_1 = 3{,}539$ Firm-Years covering the period from 2000 until 2014

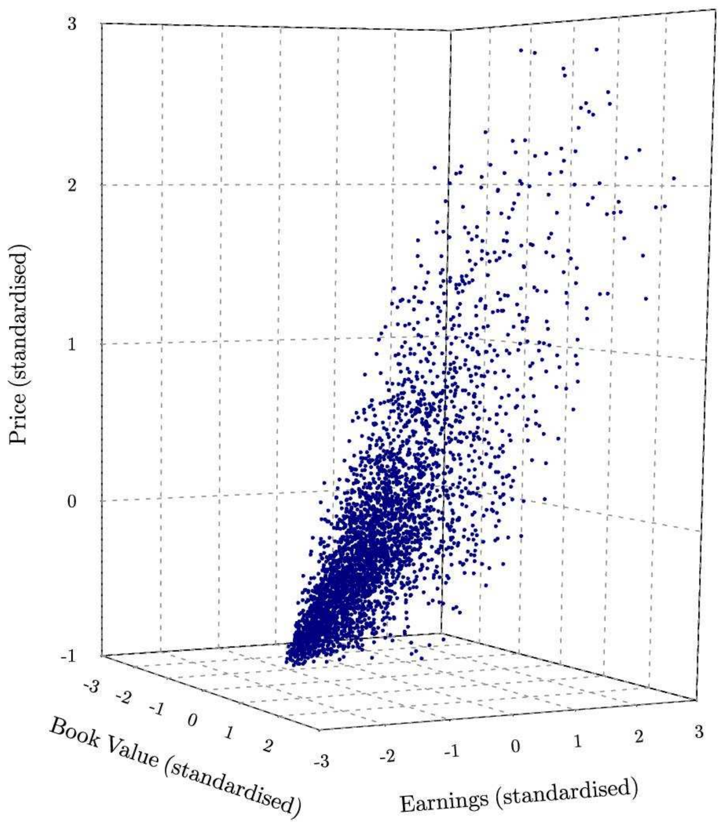


Each of the $N_1 = 3{,}539$ firm-years of data, $[P(t),b(t),x(t)]$, covering the period from 2000 until 2014 was converted to the standardized form:

$$\left[\frac{P(t)-\overline{P(t)}}{\sigma[P(t)]},\frac{b(t)-\overline{b(t)}}{\sigma[b(t)]},\frac{x(t)-\overline{x(t)}}{\sigma[x(t)]}\right]=\left[\frac{P(t)-7.05}{6.36},\frac{b(t)-2.53}{2.40},\frac{x(t)-0.18}{1.00}\right]$$

where $\overline{P(t)}$, $\overline{b(t)}$ and $\overline{x(t)}$ are the average stock price, average book value and average earnings and $\sigma[P(t)]$, $\sigma[b(t)]$ and $\sigma[x(t)]$ are the standard deviation of the stock price, book value and earnings, respectively calculated across the $N_1 = 3{,}539$ firm-years of data. The standardized vectors are plotted in the above graph.

Figure 3
Shanghai Stock Exchange
Standardized Stock Price [*P(t)*] against Standardized Book Value [*b(t)*] and Standardized Earnings [*x(t)*] for Mid-Efficiency Sample Data
N_2 = *3,539* Firm-Years covering the period from 2000 until 2014

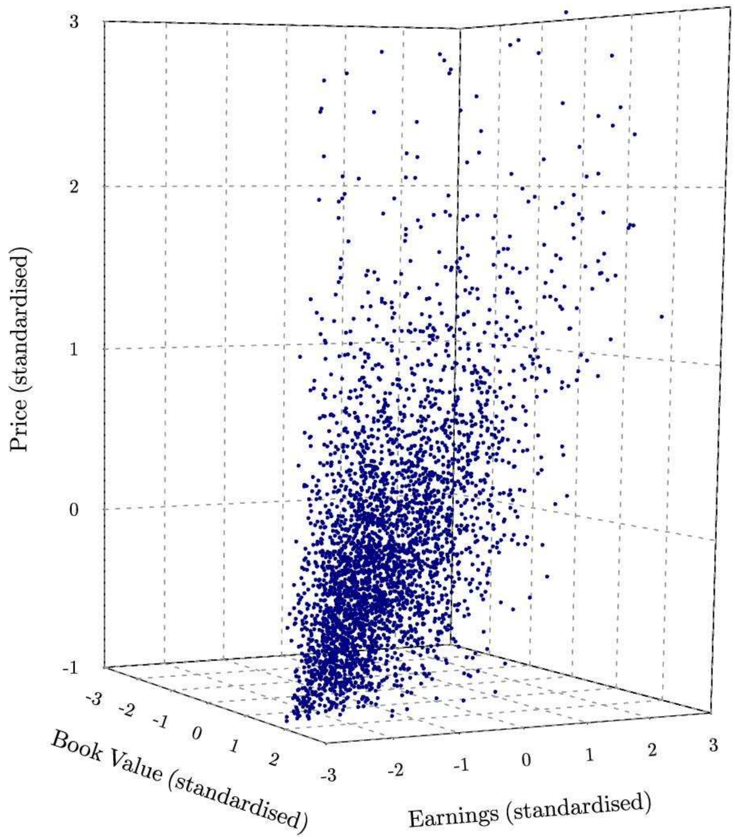


Each of the $N_2 = 3,539$ firm-years of data, $[P(t),b(t),x(t)]$, covering the period from 2000 until 2014 was converted to the standardized form:

$$\left[\frac{P(t) - \overline{P(t)}}{\sigma[P(t)]}, \frac{b(t) - \overline{b(t)}}{\sigma[b(t)]}, \frac{x(t) - \overline{x(t)}}{\sigma[x(t)]}\right] = \left[\frac{P(t) - 8.61}{8.19}, \frac{b(t) - 2.20}{1.61}, \frac{x(t) - 0.24}{0.26}\right]$$

where $\overline{P(t)}$, $\overline{b(t)}$ and $\overline{x(t)}$ are the average stock price, average book value and average earnings and $\sigma[P(t)]$, $\sigma[b(t)]$ and $\sigma[x(t)]$ are the standard deviation of the stock price, book value and earnings, respectively calculated across the $N_2 = 3,539$ firm-years of data. The standardized vectors are plotted in the above graph.

Figure 4
Shanghai Stock Exchange
Standardized Stock Price [*P(t)*] against Standardized Book Value [*b(t)*] and Standardized Earnings [*x(t)*] for High-Efficiency Sample Data
$N_3 = 3{,}539$ Firm-Years covering the period from 2000 until 2014



Each of the $N_3 = 3{,}539$ firm-years of data, $[P(t),b(t),x(t)]$, covering the period from 2000 until 2014 was converted to the standardized form:

$$\left[\frac{P(t) - \overline{P(t)}}{\sigma[P(t)]}, \frac{b(t) - \overline{b(t)}}{\sigma[b(t)]}, \frac{x(t) - \overline{x(t)}}{\sigma[x(t)]}\right] = \left[\frac{P(t) - 8.12}{6.07}, \frac{b(t) - 1.90}{1.27}, \frac{x(t) - 0.07}{0.09}\right]$$

where $\overline{P(t)}$, $\overline{b(t)}$ and $\overline{x(t)}$ are the average stock price, average book value and average earnings and $\sigma[P(t)]$, $\sigma[b(t)]$ and $\sigma[x(t)]$ are the standard deviation of the stock price, book value and earnings, respectively calculated across the $N_3 = 3{,}539$ firm-years of data. The standardized vectors are plotted in the above graph.

Table 1
Shanghai Stock Exchange
Distributional Properties of Full-Sample Data
***N = 10,617* Firm-Years covering the period from 2000 until 2014**

	$b(t)$	$x(t)$	$x'(t)$	$[b(t)]^2$	$[x(t)]^2$	$[x'(t)]^2$	$b(t)x(t)$	$b(t)x'(t)$	$x(t)x'(t)$	$[b(t)]^3$
Mean	2.21	0.17	0.01	8.26	0.39	0.40	0.56	-0.13	0.21	71.31
Median	1.86	0.12	0.01	3.46	0.02	0.00	0.19	0.01	0.00	6.43
Std. Deviation	1.84	0.60	0.63	39.75	9.44	8.87	11.17	8.63	7.49	1,520.94
Minimum	0.00	-28.09	-20.62	0.00	0.00	0.00	-953.34	-699.75	-126.20	0.00
Maximum	44.17	13.26	22.48	1,951.25	789.27	505.35	396.36	155.26	579.33	86,192.74

	$x(t)[b(t)]^2$	$b(t)[x(t)]^2$	$[x(t)]^3$	$x'(t)[b(t)]^2$	$b(t)x(t)x'(t)$	$x'(t)[x(t)]^2$	$b(t)[x'(t)]^2$	$x(t)[x'(t)]^2$	$[x'(t)]^3$
Mean	0.42	4.54	-2.63	-4.17	2.61	-2.33	2.65	-2.37	-0.06
Median	0.32	0.04	0.00	0.01	0.00	0.00	0.01	0.00	0.00
Std. Deviation	368.71	267.72	240.23	311.76	193.19	185.47	147.66	150.21	177.47
Minimum	-32,350.70	0.00	-22,173.83	-23,745.42	-720.74	-16,275.60	0.00	-11,946.29	-8,768.58
Maximum	11,852.48	26,783.18	2,328.84	6343.94	19,658.86	1,305.98	14,429.61	1,299.06	11,360.28

Variable Definitions: $b(t)$ = Book value of equity per share at end of fiscal year t computed as proportioned common equity divided by outstanding shares (Datastream code WC05476). $x(t)$ = Earnings per share for fiscal year t computed as profit after tax, minority interest and preferred dividends but before extraordinary items (Datastream code WC05201). $x'(t) \approx x(t) - x(t - 1)$ is earnings momentum for fiscal year t computed as the difference in earnings per share for fiscal year t less the earnings per share for fiscal year $(t - 1)$.

Table 2
Shanghai Stock Exchange
Correlation Matrix of Determining Variables for Full-Sample Data
***N = 10,617* Firm-Years covering the period from 2000 until 2014**

	$b(t)$	$x(t)$	$x'(t)$	$[b(t)]^2$	$[x(t)]^2$	$[x'(t)]^2$	$b(t)x(t)$	$b(t)x'(t)$	$x(t)x'(t)$	$[b(t)]^3$	$x(t)[b(t)]^2$	$b(t)[x(t)]^2$	$[x(t)]^3$	$x'(t)[b(t)]^2$	$b(t)x(t)x'(t)$	$x'(t)[x(t)]^2$	$b(t)[x'(t)]^2$	$x(t)[x'(t)]^2$	$[x'(t)]^3$
$b(t)$	1	0.173	-0.136	0.726	0.213	0.108	-0.039	-0.244	0.156	0.533	-0.156	0.234	-0.129	-0.263	0.217	-0.139	0.253	-0.136	-0.082
$x(t)$	0.173	1	0.552	-0.040	-0.476	-0.459	0.664	0.509	-0.526	-0.128	0.565	-0.394	0.622	0.447	-0.458	0.610	-0.489	0.628	0.346
$x'(t)$	-0.136	0.552	1	-0.169	-0.391	-0.011	0.369	0.486	-0.502	-0.167	0.356	-0.312	0.445	0.378	-0.352	0.480	-0.289	0.388	0.702
$[b(t)]^2$	0.726	-0.040	-0.169	1	0.325	0.202	-0.246	-0.463	0.272	0.959	-0.353	0.376	-0.227	-0.510	0.371	-0.241	0.444	-0.232	-0.152
$[x(t)]^2$	0.213	-0.476	-0.391	0.325	1	0.670	-0.596	-0.647	0.953	0.279	-0.630	0.856	-0.908	-0.611	0.835	-0.935	0.808	-0.922	-0.597
$[x'(t)]^2$	0.108	-0.459	-0.011	0.202	0.670	1	-0.435	-0.352	0.553	0.193	-0.430	0.474	-0.614	-0.389	0.465	-0.607	0.588	-0.760	0.036
$b(t)x(t)$	-0.039	0.664	0.369	-0.246	-0.596	-0.435	1	0.861	-0.631	-0.306	0.981	-0.734	0.807	0.826	-0.834	0.736	-0.853	0.673	0.402
$b(t)x'(t)$	-0.244	0.509	0.486	-0.463	-0.647	-0.352	0.861	1	-0.664	-0.483	0.904	-0.779	0.735	0.977	-0.844	0.705	-0.845	0.615	0.503
$x(t)x'(t)$	0.156	-0.526	-0.502	0.272	0.953	0.553	-0.631	-0.664	1	0.251	-0.651	0.759	-0.909	-0.601	0.778	-0.941	0.720	-0.888	-0.761
$[b(t)]^3$	0.533	-0.128	-0.167	0.959	0.279	0.193	-0.306	-0.483	0.251	1	-0.387	0.333	-0.210	-0.538	0.346	-0.220	0.432	-0.212	-0.144
$x(t)[b(t)]^2$	-0.156	0.565	0.356	-0.353	-0.630	-0.430	0.981	0.904	-0.651	-0.387	1	-0.781	0.809	0.885	-0.874	0.744	-0.892	0.674	0.420
$b(t)[x(t)]^2$	0.234	-0.394	-0.312	0.376	0.856	0.474	-0.734	-0.779	0.759	0.333	-0.781	1	-0.853	-0.746	0.983	-0.832	0.944	-0.762	-0.472
$[x(t)]^3$	-0.129	0.622	0.445	-0.227	-0.908	-0.614	0.807	0.735	-0.909	-0.210	0.809	-0.853	1	0.679	-0.890	0.990	-0.864	0.953	0.631
$x'(t)[b(t)]^2$	-0.263	0.447	0.378	-0.510	-0.611	-0.389	0.826	0.977	-0.601	-0.538	0.885	-0.746	0.679	1	-0.806	0.645	-0.845	0.587	0.394
$b(t)x(t)x'(t)$	0.217	-0.458	-0.352	0.371	0.835	0.465	-0.834	-0.844	0.778	0.346	-0.874	0.983	-0.890	-0.806	1	-0.856	0.964	-0.773	-0.512
$x'(t)[x(t)]^2$	-0.139	0.610	0.480	-0.241	-0.935	-0.607	0.736	0.705	-0.941	-0.220	0.744	-0.832	0.990	0.645	-0.856	1	-0.819	0.966	0.686
$b(t)[x'(t)]^2$	0.253	-0.489	-0.289	0.444	0.808	0.588	-0.853	-0.845	0.720	0.432	-0.892	0.944	-0.864	-0.845	0.964	-0.819	1	-0.791	-0.361
$x(t)[x'(t)]^2$	-0.136	0.628	0.388	-0.232	-0.922	-0.760	0.673	0.615	-0.888	-0.212	0.674	-0.762	0.953	0.587	-0.773	0.966	-0.791	1	0.522
$[x'(t)]^3$	-0.082	0.346	0.702	-0.152	-0.597	0.036	0.402	0.503	-0.761	-0.144	0.420	-0.472	0.631	0.394	-0.512	0.686	-0.361	0.522	1

Variable Definitions: $b(t)$ = Book value of equity per share at end of fiscal year t computed as proportioned common equity divided by outstanding shares (Datastream code WC05476). $x(t)$ = Earnings per share for fiscal year t computed as profit after tax, minority interest and preferred dividends but before extraordinary items (Datastream code WC05201). $x'(t) \approx x(t) - x(t-1)$ is earnings momentum for fiscal year t computed as the difference in earnings per share for fiscal year t less the earnings per share for fiscal year $(t - 1)$.

Table 3
Shanghai Stock Exchange
Principal Components ($PRIN_j$) of Determining Variables for Full-Sample Data
$N = 10{,}617$ Firm-Years covering the period from 2000 until 2014

	$PRIN_1$	$PRIN_2$	$PRIN_3$	$PRIN_4$	$PRIN_5$	$PRIN_6$	$PRIN_7$	$PRIN_8$	$PRIN_9$	$PRIN_{10}$	$PRIN_{11}$	$PRIN_{12}$	$PRIN_{13}$	$PRIN_{14}$	$PRIN_{15}$	$PRIN_{16}$	$PRIN_{17}$	$PRIN_{18}$	$PRIN_{19}$
$b(t)$	-0.245	0.734	-0.116	0.366	0.059	-0.474	-0.067	-0.119	0.073	0.018	0.005	0.009	0.011	-0.012	0.004	0.002	0.000	0.000	0.000
$x(t)$	0.622	0.354	0.071	0.208	0.602	0.039	-0.151	0.127	-0.190	-0.017	-0.016	-0.015	0.005	-0.002	-0.003	-0.002	0.000	0.000	0.000
$x'(t)$	0.497	0.132	0.729	0.040	0.275	0.214	-0.125	-0.205	0.154	-0.009	0.024	0.008	0.002	0.001	-0.003	0.002	0.000	0.000	0.000
$[b(t)]^2$	-0.433	0.854	-0.083	0.160	-0.155	0.137	0.056	-0.044	-0.011	-0.004	0.008	-0.014	-0.034	0.040	-0.019	-0.012	0.001	0.001	0.001
$[x(t)]^2$	-0.896	-0.131	0.051	0.372	0.079	0.076	0.038	0.105	0.062	0.076	-0.062	0.000	-0.006	-0.012	-0.017	0.006	-0.015	0.003	0.002
$[x'(t)]^2$	-0.589	-0.111	0.580	0.338	-0.359	-0.054	-0.120	0.159	-0.090	0.054	0.091	0.013	-0.002	-0.002	0.002	-0.001	0.000	0.000	0.000
$b(t)x(t)$	0.861	0.061	-0.103	0.434	0.043	0.052	0.074	0.179	0.083	-0.071	0.007	0.014	-0.034	0.013	0.020	0.019	0.001	-0.003	-0.001
$b(t)x'(t)$	0.880	-0.183	0.083	0.349	-0.046	0.031	0.130	-0.168	-0.087	0.021	-0.035	0.065	-0.023	-0.016	0.012	-0.017	-0.001	-0.001	0.001
$x(t)x'(t)$	-0.885	-0.203	-0.146	0.308	0.049	0.123	-0.123	0.009	0.054	0.138	-0.057	-0.010	0.008	0.014	0.015	-0.005	0.012	-0.003	-0.001
$[b(t)]^3$	-0.427	0.796	-0.073	0.017	-0.255	0.324	0.045	-0.037	-0.053	-0.009	-0.008	-0.003	0.027	-0.033	0.017	0.009	-0.001	0.000	-0.001
$x(t)[b(t)]^2$	0.888	-0.060	-0.095	0.387	-0.042	0.058	0.108	0.131	0.093	-0.054	0.022	-0.011	0.053	0.008	0.000	-0.018	0.001	0.004	0.001
$b(t)[x(t)]^2$	-0.901	0.035	0.123	0.014	0.301	-0.005	0.269	0.065	0.034	0.010	0.043	-0.013	-0.004	-0.025	-0.013	-0.008	0.003	-0.008	-0.003
$[x(t)]^3$	0.951	0.230	-0.035	-0.118	-0.045	0.024	0.018	0.122	0.046	0.070	-0.002	0.028	-0.008	-0.024	-0.024	0.007	0.013	0.002	0.004
$x'(t)[b(t)]^2$	0.844	-0.267	-0.023	0.354	-0.032	-0.004	0.171	-0.209	-0.094	0.073	0.024	-0.044	0.015	0.012	-0.013	0.018	0.002	0.001	0.000
$b(t)x(t)x'(t)$	-0.939	0.022	0.092	-0.088	0.261	-0.018	0.170	-0.007	-0.002	0.030	0.038	-0.013	-0.018	-0.001	0.025	0.000	0.004	0.012	0.001
$x'(t)[x(t)]^2$	0.938	0.237	0.030	-0.212	-0.028	-0.018	0.026	0.082	0.009	0.092	-0.006	0.030	0.000	0.003	-0.007	-0.001	-0.002	0.006	-0.007
$b(t)[x'(t)]^2$	-0.936	0.108	0.235	-0.105	0.116	-0.039	0.141	0.023	-0.047	-0.019	-0.027	0.076	0.036	0.035	-0.003	0.011	0.002	-0.001	0.001
$x(t)[x'(t)]^2$	0.890	0.242	-0.134	-0.300	0.116	0.011	0.040	0.042	0.024	0.147	0.047	-0.001	0.007	0.016	0.019	-0.003	-0.009	-0.006	0.003
$[x'(t)]^3$	0.603	0.211	0.690	-0.150	-0.184	-0.160	0.124	0.085	-0.007	0.002	-0.091	-0.051	-0.002	0.003	0.010	-0.002	0.002	-0.002	0.000
Eigenvalue (λ_j)	11.522	2.451	1.523	1.327	0.897	0.456	0.282	0.269	0.121	0.079	0.033	0.018	0.009	0.007	0.004	0.002	0.001	0.000	0.000

Variable Definitions: $b(t)$ = Book value of equity per share at end of fiscal year t computed as proportioned common equity divided by outstanding shares (Datastream code WC05476). $x(t)$ = Earnings per share for fiscal year t computed as profit after tax, minority interest and preferred dividends but before extraordinary items (Datastream code WC05201). $x'(t) \approx x(t) - x(t-1)$ is earnings momentum for fiscal year t computed as the difference in earnings per share for fiscal year t less the earnings per share for fiscal year $(t-1)$.

Table 4
Shanghai Stock Exchange
Coefficient Estimates for Full-Sample Principal Components Regression
***N = 10,617* Firm-Years covering the period from 2000 until 2014**

$$P(t) = \gamma_0 + \gamma_1 . \underset{\sim}{PRIN}_1^T . \underset{\sim}{z}(t) + \gamma_2 . \underset{\sim}{PRIN}_2^T . \underset{\sim}{z}(t) + \gamma_3 . \underset{\sim}{PRIN}_3^T . \underset{\sim}{z}(t) + \gamma_4 . \underset{\sim}{PRIN}_4^T . \underset{\sim}{z}(t) + \varepsilon(t)$$

Full-Sample		
Principal Components	*Coefficients*	*t-value*
γ_1	0.26	0.57
γ_2	1.87	1.85
γ_3	0.13	0.80
γ_4	2.56	2.95
Constant (γ_0)	7.93	11.59
Adj R^2	0.21	

Variable Definitions: $\underset{\sim}{z}(t)$ = Vector whose elements are the nineteen determining variables defined by equation (10). $\underset{\sim}{PRIN}_j^T$ = Transpose of the vector representing the jth principal component as summarized in Table 3. $P(t)$ = Stock price at end of fiscal year t adjusted for stock splits and dividend payments during the year. γ_j = Valuation coefficient corresponding to $\underset{\sim}{PRIN}_j^T$. $\varepsilon(t)$ = Stochastic error term.

Table 5
Shanghai Stock Exchange
Distributional Properties of Low-Efficiency Sample Data
$N_1 = 3{,}539$ Firm-Years covering the period from 2000 until 2014

	$b(t)$	$x(t)$	$x'(t)$	$[b(t)]^2$	$[x(t)]^2$	$[x'(t)]^2$	$b(t)x(t)$	$b(t)x'(t)$	$x(t)x'(t)$	$[b(t)]^3$
Mean	2.53	0.18	-0.03	12.12	1.02	1.04	0.77	-0.48	0.60	142.25
Median	2.11	0.23	0.01	4.44	0.12	0.02	0.34	0.00	0.03	9.34
Std. Deviation	2.40	1.00	1.02	60.66	16.29	15.18	19.16	14.61	12.97	2363.75
Minimum	0.00	-28.09	-20.62	0.00	0.00	0.00	-953.34	-699.75	-126.20	0.00
Maximum	44.17	13.26	22.48	1,951.25	789.27	505.35	396.36	128.38	579.33	86,192.74

	$x(t)[b(t)]^2$	$b(t)[x(t)]^2$	$[x(t)]^3$	$x'(t)[b(t)]^2$	$b(t)x(t)x'(t)$	$x'(t)[x(t)]^2$	$b(t)[x'(t)]^2$	$x(t)[x'(t)]^2$	$[x'(t)]^3$
Mean	-2.89	12.84	-8.15	-14.11	7.64	-7.07	7.37	-7.18	0.12
Median	0.52	0.22	0.01	0.00	0.03	0.00	0.03	0.00	0.00
Std. Deviation	637.55	463.32	416.00	528.90	334.51	321.20	255.49	260.13	306.60
Minimum	-32,350.70	0.00	-22,173.83	-23,745.42	-720.74	-16,275.60	0.00	-11,946.29	-8,768.58
Maximum	11,852.48	26,783.18	2,328.84	1907.02	19,658.86	1,305.98	14,429.61	1,299.06	11,360.28

Variable Definitions: $b(t)$ = Book value of equity per share at end of fiscal year t computed as proportioned common equity divided by outstanding shares (Datastream code WC05476). $x(t)$ = Earnings per share for fiscal year t computed as profit after tax, minority interest and preferred dividends but before extraordinary items (Datastream code WC05201). $x'(t) \approx x(t) - x(t-1)$ is earnings momentum for fiscal year t computed as the difference in earnings per share for fiscal year t less the earnings per share for fiscal year $(t - 1)$.

Table 6
Shanghai Stock Exchange
Correlation Matrix of Determining Variables for Low-Efficiency Sample Data
$N_1 = 3{,}539$ Firm-Years covering the period from 2000 until 2014

	$b(t)$	$x(t)$	$x'(t)$	$[b(t)]^2$	$[x(t)]^2$	$[x'(t)]^2$	$b(t)x(t)$	$b(t)x'(t)$	$x(t)x'(t)$	$[b(t)]^3$	$x(t)[b(t)]^2$	$b(t)[x(t)]^2$	$[x(t)]^3$	$x'(t)[b(t)]^2$	$b(t)x(t)x'(t)$	$x'(t)[x(t)]^2$	$b(t)[x'(t)]^2$	$x(t)[x'(t)]^2$	$[x'(t)]^3$
$b(t)$	1	0.132	-0.169	0.768	0.263	0.131	-0.105	-0.368	0.197	0.612	-0.222	0.302	-0.171	-0.407	0.283	-0.184	0.319	-0.178	-0.111
$x(t)$	0.132	1	0.602	-0.084	-0.514	-0.487	0.666	0.531	-0.556	-0.158	0.580	-0.418	0.647	0.472	-0.482	0.636	-0.514	0.655	0.361
$x'(t)$	-0.169	0.602	1	-0.223	-0.425	0.009	0.393	0.495	-0.543	-0.228	0.379	-0.337	0.477	0.397	-0.379	0.515	-0.312	0.416	0.742
$[b(t)]^2$	0.768	-0.084	-0.223	1	0.359	0.218	-0.306	-0.615	0.303	0.968	-0.412	0.422	-0.259	-0.682	0.418	-0.273	0.483	-0.262	-0.175
$[x(t)]^2$	0.263	-0.514	-0.425	0.359	1	0.677	-0.614	-0.666	0.954	0.308	-0.637	0.856	-0.912	-0.627	0.836	-0.938	0.810	-0.925	-0.601
$[x'(t)]^2$	0.131	-0.487	0.009	0.218	0.677	1	-0.447	-0.364	0.557	0.207	-0.436	0.479	-0.621	-0.404	0.469	-0.614	0.592	-0.768	0.045
$b(t)x(t)$	-0.105	0.666	0.393	-0.306	-0.614	-0.447	1	0.880	-0.643	-0.355	0.984	-0.747	0.813	0.847	-0.846	0.743	-0.865	0.679	0.407
$b(t)x'(t)$	-0.368	0.531	0.495	-0.615	-0.666	-0.364	0.880	1	-0.681	-0.636	0.920	-0.799	0.750	0.979	-0.864	0.719	-0.871	0.628	0.515
$x(t)x'(t)$	0.197	-0.556	-0.543	0.303	0.954	0.557	-0.643	-0.681	1	0.277	-0.655	0.759	-0.911	-0.615	0.778	-0.942	0.721	-0.888	-0.764
$[b(t)]^3$	0.612	-0.158	-0.228	0.968	0.308	0.207	-0.355	-0.636	0.277	1	-0.438	0.369	-0.235	-0.710	0.383	-0.245	0.462	-0.236	-0.163
$x(t)[b(t)]^2$	-0.222	0.580	0.379	-0.412	-0.637	-0.436	0.984	0.920	-0.655	-0.438	1	-0.785	0.810	0.902	-0.877	0.744	-0.895	0.675	0.422
$b(t)[x(t)]^2$	0.302	-0.418	-0.337	0.422	0.856	0.479	-0.747	-0.799	0.759	0.369	-0.785	1	-0.855	-0.763	0.983	-0.833	0.945	-0.763	-0.474
$[x(t)]^3$	-0.171	0.647	0.477	-0.259	-0.912	-0.621	0.813	0.750	-0.911	-0.235	0.810	-0.855	1	0.692	-0.891	0.990	-0.865	0.953	0.633
$x'(t)[b(t)]^2$	-0.407	0.472	0.397	-0.682	-0.627	-0.404	0.847	0.979	-0.615	-0.710	0.902	-0.763	0.692	1	-0.824	0.658	-0.871	0.599	0.403
$b(t)x(t)x'(t)$	0.283	-0.482	-0.379	0.418	0.836	0.469	-0.846	-0.864	0.778	0.383	-0.877	0.983	-0.891	-0.824	1	-0.856	0.964	-0.774	-0.514
$x'(t)[x(t)]^2$	-0.184	0.636	0.515	-0.273	-0.938	-0.614	0.743	0.719	-0.942	-0.245	0.744	-0.833	0.990	0.658	-0.856	1	-0.820	0.966	0.688
$b(t)[x'(t)]^2$	0.319	-0.514	-0.312	0.483	0.810	0.592	-0.865	-0.871	0.721	0.462	-0.895	0.945	-0.865	-0.871	0.964	-0.820	1	-0.792	-0.362
$x(t)[x'(t)]^2$	-0.178	0.655	0.416	-0.262	-0.925	-0.768	0.679	0.628	-0.888	-0.236	0.675	-0.763	0.953	0.599	-0.774	0.966	-0.792	1	0.524
$[x'(t)]^3$	-0.111	0.361	0.742	-0.175	-0.601	0.045	0.407	0.515	-0.764	-0.163	0.422	-0.474	0.633	0.403	-0.514	0.688	-0.362	0.524	1

Variable Definitions: $b(t)$ = Book value of equity per share at end of fiscal year t computed as proportioned common equity divided by outstanding shares (Datastream code WC05476). $x(t)$ = Earnings per share for fiscal year t computed as profit after tax, minority interest and preferred dividends but before extraordinary items (Datastream code WC05201). $x'(t) \approx x(t) - x(t-1)$ is earnings momentum for fiscal year t computed as the difference in earnings per share for fiscal year t less the earnings per share for fiscal year $(t - 1)$.

Table 7

Shanghai Stock Exchange
Principal Components ($PRIN_j$) of Determining Variables for Low-Efficiency Sample Data
$N_1 = 3{,}539$ Firm-Years covering the period from 2000 until 2014

	$PRIN_1$	$PRIN_2$	$PRIN_3$	$PRIN_4$	$PRIN_5$	$PRIN_6$	$PRIN_7$	$PRIN_8$	$PRIN_9$	$PRIN_{10}$	$PRIN_{11}$	$PRIN_{12}$	$PRIN_{13}$	$PRIN_{14}$	$PRIN_{15}$	$PRIN_{16}$	$PRIN_{17}$	$PRIN_{18}$	$PRIN_{19}$
$b(t)$	-0.328	0.716	-0.086	0.410	0.048	-0.420	-0.143	-0.034	0.063	-0.021	-0.001	0.006	0.007	-0.011	0.005	0.001	0.000	0.000	0.000
$x(t)$	0.641	0.356	0.080	0.251	0.578	0.091	-0.111	0.150	-0.120	0.045	-0.002	-0.016	0.004	-0.001	-0.002	-0.001	0.000	0.000	0.000
$x'(t)$	0.526	0.130	0.733	0.035	0.268	0.203	-0.134	-0.160	0.091	-0.056	0.006	0.012	0.001	-0.002	-0.002	0.001	0.000	0.000	0.000
$[b(t)]^2$	-0.505	0.815	-0.072	0.177	-0.147	0.107	0.054	-0.069	-0.014	0.032	0.013	0.000	-0.022	0.035	-0.022	-0.008	0.000	0.002	0.000
$[x(t)]^2$	-0.896	-0.186	0.056	0.357	0.060	0.078	0.090	0.057	0.083	0.025	-0.052	-0.012	-0.011	-0.013	-0.012	0.008	-0.012	0.004	0.000
$[x'(t)]^2$	-0.588	-0.162	0.605	0.306	-0.366	0.009	-0.060	0.153	-0.015	0.024	0.076	0.027	0.000	-0.002	0.001	-0.001	0.000	0.000	0.000
$b(t)x(t)$	0.866	0.044	-0.101	0.447	0.003	0.053	0.153	0.035	-0.007	-0.091	-0.001	0.009	-0.028	0.021	0.017	0.011	0.002	-0.004	0.000
$b(t)x'(t)$	0.905	-0.262	0.079	0.276	-0.028	-0.042	0.040	-0.104	-0.047	0.095	-0.041	0.048	-0.019	-0.008	0.015	-0.011	-0.003	0.000	0.000
$x(t)x'(t)$	-0.882	-0.252	-0.145	0.286	0.035	0.146	-0.085	0.055	0.129	0.058	-0.039	-0.013	0.012	0.015	0.011	-0.006	0.010	-0.003	0.000
$[b(t)]^3$	-0.492	0.782	-0.076	0.034	-0.242	0.260	0.055	-0.062	-0.045	0.044	-0.002	-0.007	0.020	-0.028	0.019	0.007	0.000	-0.002	0.000
$x(t)[b(t)]^2$	0.890	-0.071	-0.093	0.388	-0.064	0.051	0.169	0.003	0.008	-0.074	0.011	-0.006	0.050	-0.003	-0.003	-0.011	0.000	0.005	0.000
$b(t)[x(t)]^2$	-0.901	0.011	0.126	0.019	0.311	-0.054	0.264	-0.022	0.018	0.000	0.038	-0.005	-0.010	-0.023	-0.008	-0.009	0.001	-0.007	-0.001
$[x(t)]^3$	0.945	0.273	-0.038	-0.083	-0.054	0.034	0.072	0.086	0.070	0.002	-0.013	0.019	-0.021	-0.027	-0.013	0.001	0.011	0.002	0.002
$x'(t)[b(t)]^2$	0.871	-0.363	-0.021	0.265	0.006	-0.080	0.049	-0.119	0.001	0.114	0.042	-0.022	0.015	0.004	-0.015	0.013	0.004	-0.001	0.000
$b(t)x(t)x'(t)$	-0.938	0.003	0.094	-0.090	0.275	-0.055	0.141	-0.027	0.017	0.024	0.041	-0.003	-0.011	0.009	0.023	0.003	0.005	0.010	0.000
$x'(t)[x(t)]^2$	0.933	0.283	0.027	-0.182	-0.029	-0.011	0.053	0.078	0.065	0.040	-0.013	0.026	0.001	-0.001	-0.006	0.003	0.001	0.004	-0.004
$b(t)[x'(t)]^2$	-0.937	0.084	0.239	-0.108	0.133	-0.071	0.119	0.014	-0.049	0.002	-0.053	0.059	0.035	0.017	-0.008	0.007	0.003	-0.002	0.001
$x(t)[x'(t)]^2$	0.884	0.294	-0.140	-0.267	0.122	0.008	0.053	0.064	0.118	0.056	0.045	0.013	0.016	0.016	0.011	-0.001	-0.010	-0.004	0.001
$[x'(t)]^3$	0.602	0.232	0.693	-0.141	-0.185	-0.159	0.123	0.038	-0.006	0.024	-0.053	-0.058	0.001	0.010	0.008	-0.003	0.001	-0.001	0.000
***Eigenvalue* (λ_j)**	11.814	2.565	1.562	1.215	0.875	0.384	0.261	0.134	0.081	0.055	0.025	0.013	0.007	0.005	0.003	0.001	0.001	0.000	0.000

Variable Definitions: $b(t)$ = Book value of equity per share at end of fiscal year t computed as proportioned common equity divided by outstanding shares (Datastream code WC05476). $x(t)$ = Earnings per share for fiscal year t computed as profit after tax, minority interest and preferred dividends but before extraordinary items (Datastream code WC05201). $x'(t) \approx x(t) - x(t-1)$ is earnings momentum for fiscal year t computed as the difference in earnings per share for fiscal year t less the earnings per share for fiscal year $(t-1)$.

Table 8
Shanghai Stock Exchange
Coefficient Estimates for Efficiency Groups Principal Components Regression covering the period from 2000 until 2014

$$P(t) = \gamma_0 + \gamma_1.\underset{\sim}{PRIN}_1^T.\underset{\sim}{z}(t) + \gamma_2.\underset{\sim}{PRIN}_2^T.\underset{\sim}{z}(t) + \gamma_3.\underset{\sim}{PRIN}_3^T.\underset{\sim}{z}(t) + \gamma_4.\underset{\sim}{PRIN}_4^T.\underset{\sim}{z}(t) + \varepsilon(t)$$

Panel A Low-Efficiency: $N_1 = 3{,}539$		
Variables	*Coefficients*	*t-value*
γ_1	0.26	0.48
γ_2	1.86	1.81
γ_3	0.18	0.95
γ_4	3.33	3.38
Constant (γ_0)	7.05	11.26
Adj R^2	0.36	
Panel B Mid-Efficiency: $N_2 = 3{,}539$		
Variables	*Coefficients*	*t-value*
γ_1	4.97	26.48
γ_2	-1.19	-5.36
γ_3	-1.54	-4.11
γ_4	4.77	14.10
Constant (γ_0)	8.61	23.35
Adj R^2	0.76	
Panel C High-Efficiency: $N_3 = 3{,}539$		
Variables	*Coefficients*	*t-value*
γ_1	3.62	12.05
γ_2	0.67	1.62
γ_3	0.85	5.90
γ_4	1.50	3.36
Constant (γ_0)	8.12	15.36
Adj R^2	0.45	

Variable Definitions: $\underset{\sim}{z}(t)$ = Vector whose elements are the nineteen determining variables defined by equation (10). $\underset{\sim}{PRIN}_j^T$ = Transpose of the vector representing the jth principal component as summarized in Table 7, Table 11 and Table 14, for each efficiency group, respectively. $P(t)$ = Stock price at end of fiscal year t adjusted for stock splits and dividend payments during the year. γ_j = Valuation coefficient corresponding to $\underset{\sim}{PRIN}_j^T$. $\varepsilon(t)$ = Stochastic error term.

Table 9
Shanghai Stock Exchange
Distributional Properties of Mid-Efficiency Sample Data
N_2 = *3,539* Firm-Years covering the period from 2000 until 2014

	b(t)	*x(t)*	*x'(t)*	*[b(t)]²*	*[x(t)]²*	*[x'(t)]²*	*b(t)x(t)*	*b(t)x'(t)*	*x(t)x'(t)*	*[b(t)]³*
Mean	2.20	0.24	0.03	7.43	0.13	0.06	0.74	0.09	0.03	50.56
Median	1.90	0.19	0.02	3.59	0.04	0.00	0.36	0.02	0.00	6.82
Std. Deviation	1.61	0.26	0.25	30.49	1.12	0.81	2.66	2.92	0.45	1,153.21
Minimum	0.00	0.01	-4.76	0.00	0.00	0.00	0.00	-33.57	-3.21	0.00
Maximum	40.86	7.67	5.80	1,669.46	58.87	33.67	123.62	155.26	24.95	68,212.38

	x(t)[b(t)]²	*b(t)[x(t)]²*	*[x(t)]³*	*x'(t)[b(t)]²*	*b(t)x(t)x'(t)*	*x'(t)[x(t)]²*	*b(t)[x'(t)]²*	*x(t)[x'(t)]²*	*[x'(t)]³*
Mean	3.65	0.76	0.25	2.03	0.19	0.08	0.37	0.05	0.04
Median	0.68	0.07	0.01	0.03	0.00	0.00	0.00	0.00	0.00
Std. Deviation	37.74	16.80	7.83	107.89	6.89	3.24	10.61	1.40	4.06
Minimum	0.00	0.00	0.00	-281.83	-26.92	-2.57	0.00	0.00	-107.71
Maximum	1,991.64	948.53	451.75	6,343.94	402.01	191.46	590.00	81.15	195.41

Variable Definitions: *b(t)* = Book value of equity per share at end of fiscal year *t* computed as proportioned common equity divided by outstanding shares (Datastream code WC05476). *x(t)* = Earnings per share for fiscal year *t* computed as profit after tax, minority interest and preferred dividends but before extraordinary items (Datastream code WC05201). *x'(t)* ≈ *x(t) - x(t - 1)* is earnings momentum for fiscal year *t* computed as the difference in earnings per share for fiscal year *t* less the earnings per share for fiscal year *(t - 1)*.

Table 10
Shanghai Stock Exchange
Correlation Matrix of Determining Variables for Mid-Efficiency Sample Data
$N_2 = 3{,}539$ Firm-Years covering the period from 2000 until 2014

	$b(t)$	$x(t)$	$x'(t)$	$[b(t)]^2$	$[x(t)]^2$	$[x'(t)]^2$	$b(t)x(t)$	$b(t)x'(t)$	$x(t)x'(t)$	$[b(t)]^3$	$x(t)[b(t)]^2$	$b(t)[x(t)]^2$	$[x(t)]^3$	$x'(t)[b(t)]^2$	$b(t)x(t)x'(t)$	$x'(t)[x(t)]^2$	$b(t)[x'(t)]^2$	$x(t)[x'(t)]^2$	$[x'(t)]^3$
$b(t)$	1	0.486	0.051	0.698	0.268	0.181	0.473	0.390	0.184	0.472	0.376	0.220	0.190	0.417	0.201	0.166	0.452	0.184	0.082
$x(t)$	0.486	1	0.282	0.233	0.749	0.160	0.842	0.222	0.627	0.062	0.691	0.634	0.596	0.077	0.556	0.541	0.157	0.524	0.059
$x'(t)$	0.051	0.282	1	0.236	0.269	0.199	0.250	0.512	0.432	0.262	0.269	0.242	0.238	0.316	0.301	0.247	0.233	0.202	0.654
$[b(t)]^2$	0.698	0.233	0.236	1	0.196	0.326	0.312	0.855	0.180	0.952	0.361	0.182	0.165	0.924	0.224	0.152	0.914	0.184	0.218
$[x(t)]^2$	0.268	0.749	0.269	0.196	1	0.214	0.956	0.314	0.936	0.072	0.970	0.980	0.966	0.127	0.930	0.926	0.251	0.890	0.126
$[x'(t)]^2$	0.181	0.160	0.199	0.326	0.214	1	0.220	0.263	0.194	0.315	0.261	0.218	0.218	0.310	0.223	0.218	0.444	0.389	0.371
$b(t)x(t)$	0.473	0.842	0.250	0.312	0.956	0.220	1	0.332	0.853	0.132	0.958	0.912	0.880	0.164	0.842	0.826	0.282	0.800	0.114
$b(t)x'(t)$	0.390	0.222	0.512	0.855	0.314	0.263	0.332	1	0.397	0.906	0.437	0.316	0.313	0.946	0.408	0.318	0.879	0.306	0.324
$x(t)x'(t)$	0.184	0.627	0.432	0.180	0.936	0.194	0.853	0.397	1	0.091	0.916	0.950	0.956	0.169	0.976	0.963	0.262	0.918	0.244
$[b(t)]^3$	0.472	0.062	0.262	0.952	0.072	0.315	0.132	0.906	0.091	1	0.227	0.072	0.067	0.990	0.140	0.064	0.950	0.097	0.232
$x(t)[b(t)]^2$	0.376	0.691	0.269	0.361	0.970	0.261	0.958	0.437	0.916	0.227	1	0.973	0.955	0.274	0.937	0.920	0.396	0.895	0.156
$b(t)[x(t)]^2$	0.220	0.634	0.242	0.182	0.980	0.218	0.912	0.316	0.950	0.072	0.973	1	0.996	0.134	0.972	0.973	0.265	0.939	0.136
$[x(t)]^3$	0.190	0.596	0.238	0.165	0.966	0.218	0.880	0.313	0.956	0.067	0.955	0.996	1	0.133	0.982	0.988	0.266	0.955	0.139
$x'(t)[b(t)]^2$	0.417	0.077	0.316	0.924	0.127	0.310	0.164	0.946	0.169	0.990	0.274	0.134	0.133	1	0.215	0.136	0.951	0.159	0.257
$b(t)x(t)x'(t)$	0.201	0.556	0.301	0.224	0.930	0.223	0.842	0.408	0.976	0.140	0.937	0.972	0.982	0.215	1	0.993	0.329	0.961	0.181
$x'(t)[x(t)]^2$	0.166	0.541	0.247	0.152	0.926	0.218	0.826	0.318	0.963	0.064	0.920	0.973	0.988	0.136	0.993	1	0.270	0.974	0.149
$b(t)[x'(t)]^2$	0.452	0.157	0.233	0.914	0.251	0.444	0.282	0.879	0.262	0.950	0.396	0.265	0.266	0.951	0.329	0.270	1	0.339	0.181
$x(t)[x'(t)]^2$	0.184	0.524	0.202	0.184	0.890	0.389	0.800	0.306	0.918	0.097	0.895	0.939	0.955	0.159	0.961	0.974	0.339	1	0.126
$[x'(t)]^3$	0.082	0.059	0.654	0.218	0.126	0.371	0.114	0.324	0.244	0.232	0.156	0.136	0.139	0.257	0.181	0.149	0.181	0.126	1

Variable Definitions: $b(t)$ = Book value of equity per share at end of fiscal year t computed as proportioned common equity divided by outstanding shares (Datastream code WC05476). $x(t)$ = Earnings per share for fiscal year t computed as profit after tax, minority interest and preferred dividends but before extraordinary items (Datastream code WC05201). $x'(t) \approx x(t) - x(t-1)$ is earnings momentum for fiscal year t computed as the difference in earnings per share for fiscal year t less the earnings per share for fiscal year $(t-1)$.

Table 11
Shanghai Stock Exchange
Principal Components ($PRIN_j$) of Determining Variables for Mid-Efficiency Sample Data
$N_2 = 3{,}539$ Firm-Years covering the period from 2000 until 2014

	$PRIN_1$	$PRIN_2$	$PRIN_3$	$PRIN_4$	$PRIN_5$	$PRIN_6$	$PRIN_7$	$PRIN_8$	$PRIN_9$	$PRIN_{10}$	$PRIN_{11}$	$PRIN_{12}$	$PRIN_{13}$	$PRIN_{14}$	$PRIN_{15}$	$PRIN_{16}$	$PRIN_{17}$	$PRIN_{18}$	$PRIN_{19}$
$b(t)$	0.414	0.407	-0.438	0.562	0.129	0.300	0.217	0.010	-0.021	0.033	-0.013	-0.018	-0.005	0.001	0.001	0.001	0.001	0.000	0.000
$x(t)$	0.685	-0.174	-0.187	0.563	-0.008	-0.322	-0.127	0.170	0.010	0.006	0.002	0.024	-0.007	-0.003	0.000	0.000	0.000	0.000	0.000
$x'(t)$	0.392	0.228	0.723	0.291	-0.289	-0.202	0.230	-0.080	0.063	0.012	0.001	0.010	0.001	0.002	-0.001	0.001	0.000	0.000	0.000
$[b(t)]^2$	0.478	0.838	-0.212	0.081	0.002	0.084	0.001	-0.044	0.032	-0.052	0.062	0.037	0.012	-0.012	-0.004	-0.001	-0.004	-0.001	0.001
$[x(t)]^2$	0.934	-0.312	-0.055	0.046	-0.025	-0.057	-0.102	-0.067	0.001	0.043	0.039	-0.052	0.017	-0.008	-0.003	0.009	0.002	-0.002	0.000
$[x'(t)]^2$	0.353	0.277	0.272	-0.038	0.825	-0.187	0.055	-0.041	-0.056	0.005	0.011	0.003	-0.002	0.002	-0.002	-0.001	0.000	0.000	0.000
$b(t)x(t)$	0.911	-0.215	-0.171	0.256	0.010	-0.043	-0.097	-0.117	-0.005	-0.046	-0.038	-0.013	0.025	0.015	-0.001	-0.005	-0.001	0.002	0.000
$b(t)x'(t)$	0.585	0.739	0.089	-0.110	-0.244	-0.089	0.012	0.007	-0.147	0.006	-0.042	-0.002	0.008	-0.016	0.001	-0.004	0.002	0.000	0.000
$x(t)x'(t)$	0.930	-0.274	0.141	-0.053	-0.125	0.003	0.079	0.066	-0.053	-0.055	0.051	-0.058	-0.017	0.005	0.006	-0.004	-0.001	0.000	0.000
$[b(t)]^3$	0.372	0.911	-0.088	-0.116	-0.057	-0.015	-0.065	0.001	0.021	0.008	0.035	0.015	-0.002	0.010	0.004	0.000	0.008	0.006	-0.001
$x(t)[b(t)]^2$	0.969	-0.158	-0.095	0.011	-0.007	0.032	-0.068	-0.134	0.010	-0.034	-0.027	0.026	-0.029	-0.004	0.007	0.004	0.003	-0.004	-0.001
$b(t)[x(t)]^2$	0.937	-0.321	-0.026	-0.088	-0.015	0.042	-0.044	-0.068	0.011	0.043	0.000	0.012	-0.016	-0.003	0.000	-0.004	-0.002	0.004	0.005
$[x(t)]^3$	0.930	-0.326	-0.005	-0.140	-0.014	0.061	-0.014	-0.019	0.017	0.060	0.017	0.017	0.001	-0.004	0.001	-0.007	-0.004	0.001	-0.005
$x'(t)[b(t)]^2$	0.425	0.878	-0.031	-0.166	-0.104	-0.039	-0.062	0.028	-0.033	0.032	-0.007	0.000	-0.003	0.018	0.008	0.006	-0.007	-0.002	0.000
$b(t)x(t)x'(t)$	0.941	-0.246	0.043	-0.177	-0.059	0.079	0.062	0.057	-0.044	-0.020	-0.011	0.022	-0.006	0.006	-0.022	0.007	-0.001	0.003	-0.001
$x'(t)[x(t)]^2$	0.915	-0.320	0.030	-0.196	-0.017	0.094	0.067	0.077	0.009	0.015	0.008	0.030	0.016	0.010	0.000	-0.005	0.005	-0.007	0.002
$b(t)[x'(t)]^2$	0.534	0.787	-0.117	-0.221	0.071	-0.069	-0.016	0.042	0.132	-0.002	-0.039	-0.048	-0.008	-0.004	-0.010	-0.004	0.000	-0.002	0.000
$x(t)[x'(t)]^2$	0.903	-0.270	0.013	-0.230	0.169	0.031	0.116	0.096	0.058	-0.024	-0.030	0.007	0.015	-0.009	0.015	0.006	-0.001	0.004	0.000
$[x'(t)]^3$	0.260	0.255	0.789	0.261	0.100	0.343	-0.213	0.060	0.009	-0.004	-0.010	-0.004	0.001	-0.002	0.000	0.000	0.000	0.000	0.000
Eigenvalue (λ_j)	9.945	4.548	1.586	1.114	0.919	0.436	0.227	0.109	0.058	0.020	0.016	0.014	0.003	0.001	0.001	0.000	0.000	0.000	0.000

Variable Definitions: $b(t)$ = Book value of equity per share at end of fiscal year t computed as proportioned common equity divided by outstanding shares (Datastream code WC05476). $x(t)$ = Earnings per share for fiscal year t computed as profit after tax, minority interest and preferred dividends but before extraordinary items (Datastream code WC05201). $x'(t) \approx x(t) - x(t-1)$ is earnings momentum for fiscal year t computed as the difference in earnings per share for fiscal year t less the earnings per share for fiscal year $(t - 1)$.

Table 12
Shanghai Stock Exchange
Distributional Properties of High-Efficiency Sample Data
$N_3 = 3{,}539$ Firm-Years covering the period from 2000 until 2014

	$b(t)$	$x(t)$	$x'(t)$	$[b(t)]^2$	$[x(t)]^2$	$[x'(t)]^2$	$b(t)x(t)$	$b(t)x'(t)$	$x(t)x'(t)$	$[b(t)]^3$
Mean	1.90	0.07	0.03	5.23	0.01	0.10	0.16	-0.01	0.00	21.12
Median	1.64	0.05	0.00	2.70	0.00	0.00	0.08	0.00	0.00	4.43
Std. Deviation	1.27	0.09	0.32	10.31	0.11	2.04	0.34	0.99	0.05	125.95
Minimum	0.00	0.00	-10.94	0.00	0.00	0.00	0.00	-32.17	-0.31	0.00
Maximum	17.97	2.48	2.90	322.81	6.15	119.57	12.80	8.28	2.89	5,799.98

	$x(t)[b(t)]^2$	$b(t)[x(t)]^2$	$[x(t)]^3$	$x'(t)[b(t)]^2$	$b(t)x(t)x'(t)$	$x'(t)[x(t)]^2$	$b(t)[x'(t)]^2$	$x(t)[x'(t)]^2$	$[x'(t)]^3$
Mean	0.50	0.04	0.01	-0.42	0.01	0.00	0.19	0.01	-0.33
Median	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Std. Deviation	1.90	0.56	0.26	10.66	0.27	0.12	2.25	0.07	21.99
Minimum	0.00	0.00	0.00	-402.59	-2.16	-0.09	0.00	0.00	-1,307.54
Maximum	66.11	31.74	15.23	84.70	14.91	7.16	87.41	3.36	24.29

Variable Definitions: $b(t)$ = Book value of equity per share at end of fiscal year t computed as proportioned common equity divided by outstanding shares (Datastream code WC05476). $x(t)$ = Earnings per share for fiscal year t computed as profit after tax, minority interest and preferred dividends but before extraordinary items (Datastream code WC05201). $x'(t) \approx x(t) - x(t-1)$ is earnings momentum for fiscal year t computed as the difference in earnings per share for fiscal year t less the earnings per share for fiscal year $(t - 1)$.

Table 13
Shanghai Stock Exchange
Correlation Matrix of Determining Variables for High-Efficiency Sample Data
$N_3 = 3{,}539$ Firm-Years covering the period from 2000 until 2014

	$b(t)$	$x(t)$	$x'(t)$	$[b(t)]^2$	$[x(t)]^2$	$[x'(t)]^2$	$b(t)x(t)$	$b(t)x'(t)$	$x(t)x'(t)$	$[b(t)]^3$	$x(t)[b(t)]^2$	$b(t)[x(t)]^2$	$[x(t)]^3$	$x'(t)[b(t)]^2$	$b(t)x(t)x'(t)$	$x'(t)[x(t)]^2$	$b(t)[x'(t)]^2$	$x(t)[x'(t)]^2$	$[x'(t)]^3$
$b(t)$	1	0.216	-0.163	0.853	0.092	0.000	0.444	-0.317	-0.003	0.584	0.501	0.101	0.054	-0.334	-0.009	0.047	0.213	0.070	0.012
$x(t)$	0.216	1	0.056	0.135	0.699	-0.010	0.865	0.087	0.555	0.057	0.646	0.617	0.537	0.043	0.518	0.512	0.015	0.439	0.012
$x'(t)$	-0.163	0.056	1	-0.173	0.072	-0.510	0.019	0.613	0.321	-0.148	-0.007	0.066	0.065	0.292	0.194	0.076	-0.424	-0.095	0.602
$[b(t)]^2$	0.853	0.135	-0.173	1	0.066	0.021	0.373	-0.516	-0.016	0.904	0.568	0.083	0.042	-0.620	-0.065	0.037	0.358	0.088	0.002
$[x(t)]^2$	0.092	0.699	0.072	0.066	1	0.008	0.798	0.117	0.907	0.029	0.691	0.988	0.969	0.056	0.913	0.954	0.047	0.792	0.003
$[x'(t)]^2$	0.000	-0.010	-0.510	0.021	0.008	1	0.001	-0.147	-0.020	0.028	0.011	0.009	0.010	-0.055	0.002	0.011	0.724	0.492	-0.979
$b(t)x(t)$	0.444	0.865	0.019	0.373	0.798	0.001	1	0.034	0.648	0.240	0.910	0.773	0.684	-0.022	0.654	0.660	0.079	0.571	0.007
$b(t)x'(t)$	-0.317	0.087	0.613	-0.516	0.117	-0.147	0.034	1	0.313	-0.564	-0.075	0.113	0.109	0.884	0.342	0.119	-0.558	0.029	0.154
$x(t)x'(t)$	-0.003	0.555	0.321	-0.016	0.907	-0.020	0.648	0.313	1	-0.032	0.577	0.908	0.910	0.160	0.955	0.920	0.010	0.779	0.058
$[b(t)]^3$	0.584	0.057	-0.148	0.904	0.029	0.028	0.240	-0.564	-0.032	1	0.496	0.044	0.018	-0.746	-0.112	0.016	0.387	0.075	-0.003
$x(t)[b(t)]^2$	0.501	0.646	-0.007	0.568	0.691	0.011	0.910	-0.075	0.577	0.496	1	0.704	0.624	-0.171	0.589	0.608	0.155	0.548	0.004
$b(t)[x(t)]^2$	0.101	0.617	0.066	0.083	0.988	0.009	0.773	0.113	0.908	0.044	0.704	1	0.988	0.054	0.933	0.977	0.053	0.812	0.002
$[x(t)]^3$	0.054	0.537	0.065	0.042	0.969	0.010	0.684	0.109	0.910	0.018	0.624	0.988	1	0.052	0.936	0.997	0.051	0.827	0.002
$x'(t)[b(t)]^2$	-0.334	0.043	0.292	-0.620	0.056	-0.055	-0.022	0.884	0.160	-0.746	-0.171	0.054	0.052	1	0.264	0.058	-0.610	-0.018	0.021
$b(t)x(t)x'(t)$	-0.009	0.518	0.194	-0.065	0.913	0.002	0.654	0.342	0.955	-0.112	0.589	0.933	0.936	0.264	1	0.943	-0.027	0.783	0.012
$x'(t)[x(t)]^2$	0.047	0.512	0.076	0.037	0.954	0.011	0.660	0.119	0.920	0.016	0.608	0.977	0.997	0.058	0.943	1	0.051	0.833	0.002
$b(t)[x'(t)]^2$	0.213	0.015	-0.424	0.358	0.047	0.724	0.079	-0.558	0.010	0.387	0.155	0.053	0.051	-0.610	-0.027	0.051	1	0.455	-0.655
$x(t)[x'(t)]^2$	0.070	0.439	-0.095	0.088	0.792	0.492	0.571	0.029	0.779	0.075	0.548	0.812	0.827	-0.018	0.783	0.833	0.455	1	-0.433
$[x'(t)]^3$	0.012	0.012	0.602	0.002	0.003	-0.979	0.007	0.154	0.058	-0.003	0.004	0.002	0.002	0.021	0.012	0.002	-0.655	-0.433	1

Variable Definitions: $b(t)$ = Book value of equity per share at end of fiscal year t computed as proportioned common equity divided by outstanding shares (Datastream code WC05476). $x(t)$ = Earnings per share for fiscal year t computed as profit after tax, minority interest and preferred dividends but before extraordinary items (Datastream code WC05201). $x'(t) \approx x(t) - x(t-1)$ is earnings momentum for fiscal year t computed as the difference in earnings per share for fiscal year t less the earnings per share for fiscal year $(t-1)$.

Table 14
Shanghai Stock Exchange
Principal Components ($PRIN_j$) of Determining Variables for High-Efficiency Sample Data
$N_3 = 3{,}539$ Firm-Years covering the period from 2000 until 2014

	$PRIN_1$	$PRIN_2$	$PRIN_3$	$PRIN_4$	$PRIN_5$	$PRIN_6$	$PRIN_7$	$PRIN_8$	$PRIN_9$	$PRIN_{10}$	$PRIN_{11}$	$PRIN_{12}$	$PRIN_{13}$	$PRIN_{14}$	$PRIN_{15}$	$PRIN_{16}$	$PRIN_{17}$	$PRIN_{18}$	$PRIN_{19}$
$b(t)$	0.205	0.606	0.444	0.412	0.102	-0.291	0.353	0.027	-0.015	-0.024	0.002	-0.044	-0.002	0.013	0.023	0.004	-0.006	-0.001	0.000
$x(t)$	0.702	0.013	0.138	0.349	-0.363	0.439	0.060	0.180	0.033	0.058	0.001	0.008	-0.030	-0.009	0.017	-0.002	0.005	-0.005	0.000
$x'(t)$	0.084	-0.583	0.447	-0.025	0.552	0.351	0.084	-0.005	-0.109	-0.061	-0.023	0.029	-0.028	0.007	0.005	-0.002	-0.007	0.001	0.000
$[b(t)]^2$	0.186	0.791	0.482	0.162	0.210	-0.149	-0.017	0.065	0.018	0.018	-0.009	0.080	0.001	-0.031	-0.031	-0.017	0.019	0.000	0.000
$[x(t)]^2$	0.975	-0.089	-0.015	-0.096	-0.118	0.007	0.012	0.056	-0.026	-0.054	0.054	0.037	0.066	0.013	0.023	-0.018	-0.001	0.022	0.000
$[x'(t)]^2$	0.073	0.433	-0.839	0.248	0.168	0.052	-0.034	0.041	-0.057	-0.038	-0.025	0.015	0.007	0.025	0.006	0.031	0.030	0.003	0.000
$b(t)x(t)$	0.850	0.157	0.225	0.348	-0.200	0.152	-0.006	-0.111	-0.030	-0.036	0.002	-0.016	0.013	0.020	-0.057	0.014	-0.013	0.005	-0.001
$b(t)x'(t)$	0.121	-0.821	-0.056	0.411	0.332	-0.011	-0.078	0.025	0.063	0.018	0.116	-0.059	0.016	-0.014	-0.010	-0.008	0.014	0.000	0.000
$x(t)x'(t)$	0.918	-0.243	-0.023	-0.136	0.188	0.039	0.037	0.070	0.124	-0.041	-0.123	-0.028	0.056	-0.026	-0.003	0.011	-0.003	-0.006	-0.001
$[b(t)]^3$	0.127	0.785	0.428	-0.066	0.247	0.005	-0.306	0.143	0.029	0.033	0.037	-0.014	0.005	0.026	0.010	0.018	-0.020	-0.001	0.000
$x(t)[b(t)]^2$	0.786	0.323	0.299	0.262	-0.010	0.026	-0.234	-0.244	-0.018	-0.005	-0.040	-0.016	-0.009	-0.021	0.037	-0.006	0.008	0.000	0.000
$b(t)[x(t)]^2$	0.977	-0.081	-0.020	-0.132	-0.065	-0.079	-0.009	-0.016	-0.045	-0.050	0.056	0.023	0.016	0.016	-0.001	-0.003	0.002	-0.028	0.007
$[x(t)]^3$	0.952	-0.107	-0.060	-0.223	-0.028	-0.135	0.012	0.031	-0.057	-0.018	0.054	0.005	-0.023	-0.018	0.003	0.011	0.002	-0.008	-0.011
$x'(t)[b(t)]^2$	0.034	-0.811	-0.220	0.478	0.019	-0.226	-0.031	-0.016	0.007	0.064	-0.018	0.081	0.010	-0.005	0.011	0.018	-0.022	-0.001	0.000
$b(t)x(t)x'(t)$	0.923	-0.275	-0.089	-0.085	0.091	-0.120	0.007	-0.035	0.159	0.004	-0.024	0.019	-0.061	0.054	-0.002	-0.013	0.006	0.004	-0.001
$x'(t)[x(t)]^2$	0.946	-0.116	-0.067	-0.238	0.003	-0.150	0.015	0.036	-0.033	0.006	0.019	-0.017	-0.052	-0.039	-0.006	0.024	-0.002	0.015	0.007
$b(t)[x'(t)]^2$	0.125	0.743	-0.475	-0.130	0.209	0.262	0.182	-0.151	0.109	0.038	0.081	0.029	0.009	-0.017	0.006	0.008	-0.012	-0.001	0.000
$x(t)[x'(t)]^2$	0.841	0.141	-0.427	-0.081	0.189	-0.012	0.041	0.001	-0.120	0.170	-0.043	-0.030	0.016	0.012	-0.009	-0.021	-0.003	-0.001	0.000
$[x'(t)]^3$	-0.050	-0.419	0.846	-0.273	-0.058	0.027	0.090	-0.076	0.011	0.103	0.014	0.012	0.032	0.018	0.004	0.029	0.022	0.001	0.000
Eigenvalue (λ_j)	8.081	4.519	2.868	1.228	0.876	0.633	0.337	0.173	0.097	0.065	0.052	0.026	0.019	0.010	0.008	0.005	0.003	0.002	0.000

Variable Definitions: $b(t)$ = Book value of equity per share at end of fiscal year t computed as proportioned common equity divided by outstanding shares (Datastream code WC05476). $x(t)$ = Earnings per share for fiscal year t computed as profit after tax, minority interest and preferred dividends but before extraordinary items (Datastream code WC05201). $x'(t) \approx x(t) - x(t-1)$ is earnings momentum for fiscal year t computed as the difference in earnings per share for fiscal year t less the earnings per share for fiscal year $(t-1)$.

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