The Persistent Measurement Biases

Stockholm School of Economics

MSc. Accounting and Financial Management

Abstract: Despite recent advancements in the field of accounting-based valuation, the challenges in linking forecasts of residual income levels to past financial statements; and simultaneously considering the effects of conservatism in the accounting, remain. This paper describes the exploration of an equity valuation model that adheres to a linear information model as conceptualised by Ohlson (1995), and Feltham and Ohlson (1995) in the forecasts of earnings, which is parsimonious and individual for each firm. I find that such a model, that uses the bias estimates (PMBs) of equity as defined by Runsten (1998) for the Swedish market while not permitting short selling; can achieve positive abnormal returns (AR) for the sample period between 2003 to 2015. The observed AR levels were independent of the market cap, and the P/E or B/M – ratio when controlled for their quintile levels. Furthermore, correct assessments of "under or over"-valuation states were in a 12 months forward-looking period in excess of 50 percent, independent from the benchmark performance, the quintile levels of market cap, and the P/E or B/M – ratio. The findings warrant further research towards the nature and cause of observed AR levels, as well as towards whether the model merely tracks the expected cost of capital or captures short-term mispricings of the Swedish markets.

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Forecasting future residual income levels based on financial statement numbers has been made popular with the prominence of the Residual-Income Valuation (RIV) model (Ohlson, 2005, p. 323). The issue of explicitly linking forecasts of residual income levels to past financial statements, however, were first made prominent by Ohlson (1995), and Feltham and Ohlson (1995) with their linear model for the information dynamics in earnings. Despite the advancements in the research of accounting-based valuation, the past challenges that were present then, are still relevant today: the linking of future residual incomes to past financial statements; and the effects that conservative accounting has on the forecasts of residual income.[1]

Premises for not considering the effects of conservative accounting in equity valuations are generally rooted in the view that "fair-value-based standards" - such as the International Financial Reporting Standard (IFRS) – require all assets and liabilities to be measured at fair value. Such confusion in the meaning of IFRS can lead to misinterpreted conclusions. As Cairns (2006) showed: fair value use is not extensive within IFRS; moreover, such use outside of property valuation settings has been shown to be low[2] (Cairns, 2006, pp. 5-6; Christensen & Nikolaev, 2013, p. 736). In fact, when comparing intrinsic value estimates to market values, researchers such as Choi et al. (2006, p. 76) have attributed the persistent undervaluation by the RIV model to the model's inability to capture the effects of conservative accounting.

Adjustments to the original RIV model to better capture the effects of conservative accounting have been introduced. These methods range from the adjustment of current financial statement numbers by the capitalisation of previously expensed costs (see Cheng, 2005), to the extension of the Feltham and Ohlson (1995) model to include a "conservatism-correction term" for analyst forecasts of future residual income levels (see Choi et al., 2006). Many of such modifications, however, do not utilise the information dynamics conceptualised in Ohlson

[1] See for example working paper by Anesten, Möller, and Skogsvik (2015, p. 12); Choi, O'Hanlon, and Pope (2006, pp. 73, 76)

[2] In a study of the United Kingdom and German market, Christensen & Nikolaev found that only 3% of sample firms used fair-value accounting for at least one asset class following the IFRS adoption (Christensen & Nikolaev, 2013, p. 736) .

(1995), and Feltham and Ohlson (1995) for their forecasts of profitability. Moreover, the results of the empirical attempts, have usually been disappointing.[3]

An explanation for these "empirical disappointments" lies in the issue of tailoring the information dynamic to each specific firm, and its accounting system (Kin & Lys, 2000, p. 360). This paper proposes an equity valuation model that is a new independent and parsimonious model, adhering to a linear information dynamic for earnings specific to each firm. This model, hereafter referred to as the linear-information equity valuation (LIEV) model, is an exploration of the feasibility of a valuation model with the key characteristics as follows:

a. Non-dependent on analyst forecasts of profitability;
b. Anchors forecasts of residual income on the empirical research of Runsten (1998);
c. Express forecasts of residual income in a linear model of profitability and growth.

I have focused on the exploration of two issues: first, the assessment of whether such a model can achieve abnormal returns; second, to what degree such a model correctly predicts the direction of future stock movements from the valuation time point after a holding period of 12 months has passed.

By utilising the research of Runsten (1998) in the formulation of a linear model for the information dynamic, and merging with the RIV model, I find that abnormal returns indeed can be achieved by such a proposed LIEV model. The findings are limited to securities listed on the Swedish NASDAQ stock exchange between the periods of Dec. 30 - 2002 to Feb. 28 - 2017, with two portfolios formed for each sample year and the full sample period: (a) where long and short positions were allowed, abbreviated as [C. L&S]; and (b) where only long positions were allowed, abbreviated as [C. L].

In a full sample analysis, the average abnormal returns (μ_{AR}) were (statistical) significant for being less than zero in [C. L&S] (one-sided t-test, $t = -3.6$, $p < 0.025$), and significantly greater than zero in [C. L] (one-sided t-test, $t = 3.7$, $p < 0.025$). When controlled for the industry and quintile levels of market cap; Price-to-Earnings (P/E) and Book-to-Market (B/M) – ratio, formed yearly at portfolio formation in the last trading day of February, I found no statistical support for the μ_{AR} levels to differ from one another in [C. L] (one-way ANOVA, $p > 0.025$).

[3] For example, Myers (1998, p. 1) found that the linear information models of Ohlson (1995), and Feltham and Ohlson (1995) provided value estimates no better than book value alone.

However, the same tests were significant for the quintile levels of P/E and B/M – ratios in [C. L&S] (one-way ANOVA, $p < 0.025$).

For individual sample years, those years that showed statistical significance were almost exclusively for [C. L&S] significantly less than zero (one-sided t-test, $p < 0.025$), and predominantly significantly greater than zero in [C. L] (one-sided t-test, $p < 0.025$). On a size (market cap) based level over the sample years, the larger firms (belonging to the 60'th to 100'th percentiles of market cap) of [C. L] significantly outperform their smaller contemporaries (0'th to 40'th market cap percentiles) with a cumulative μ_{AR} (CAAR) difference averaging 43.1 *percentage units* from 2007 to 2015. The CAAR at the sample end of 2015 was 24.7 percent for the larger firms, and -37.9 percent for the smaller firms.

The propensity for the LIEV model to correctly predict subsequent stock movements 12 months from portfolio formation in the last trading day of February, were for the full sample period significantly higher than 50 percent in [C. L&S] and [C. L], irrespectively of the benchmark returns for the same period (binomial test, $p < 0.025$). These results were further found to be stable when controlled for the individual quintile levels of market cap, P/E and B/M – ratios. Invariably, the LIEV model seems to be a good gauge for the assessment of whether a security is over or under-valued in a 12 months forward-looking period.

Such overwhelming capacity in predicting valuation states should stem from an inherent capacity of the LIEV model in capturing short-term mispricings in the market; the mechanisms and source of this capacity are however yet to be identified. For the model's ability in capturing positive abnormal returns, I am more careful; those abnormal returns may merely be the reflection of bad-model errors in the chosen capital asset pricing model (Fama, 1998, pp. 284, 304). For those subsets that are undoubtedly positive such as the larger firms in [C. L], their abnormal returns seem to stem from a time-specific anomaly after the year 2007 and may merely reflect the momentary under or over-reaction as captured by the LIEV model. However, for the observer who is willing to accept the results at "face-value", the LIEV model succeeds in its capabilities for capturing positive abnormal returns; both in the majority of years for [C. L], and in its full sample.

This paper first introduces the previous research and presents an overview of accounting-based valuation. Second, the LIEV model specifications and research design are presented, followed by the findings and a concluding remark of the study.

Ohlson (1995) and the linear information dynamic

In an influential paper, Ohlson (1995) introduced a variation of the RIV model where the behaviour of future abnormal returns are expressed in a simple linear model consisting of the past period's abnormal return, and a υ variable capturing "other information" yet to affect the financial statements. This concept of expressing abnormal returns defined by Ohlson as the "linear information dynamic" (LID), provides a link between present financial statement data and future abnormal return (and residual income) levels. In contrast, the traditional RIV model without a LID component for the expression of abnormal returns is in its entirety based on forecasts, and not on the accruals in the financial statements. (Lee, 1999, pp. 416-417; Myers, 1999, p. 1; Ohlson, 1995, pp. 667-668).

The Ohlson (1995) LID model

$\{\widetilde{x_t^a}\}$ *is assumed to* satisfy the stochastic process

$$\widetilde{x_{t+1}^a} = \omega x_t^a + v_t + \tilde{\varepsilon}_{1\,t+1}$$

$$\widetilde{v_{t+1}} = \gamma v_t + \tilde{\varepsilon}_{2\,t+1}$$

where

$x_t^a = abnormal\ earnings$

$v_t = information\ other\ than\ abnormal\ earnings$

$\tilde{\varepsilon}_1\ and\ \tilde{\varepsilon}_2, for\ t \geq 1\ are\ unpredictable\ zero-mean\ variables$

$\omega\ and\ y\ are\ known, fixed\ and\ restricted\ to\ be\ non-negative$

$and\ less\ than\ one$

(Ohlson, 1995, pp. 667 - 668)

The LID proposed by Ohlson assume the unconditional mean of abnormal earnings (x_t^a) and the "other information" variable υ to be zero. Thus, Ohlson does not account for conservatism (bias) in the accounting but operates under a presumption of unbiased (perfect) accounting. Biased (conservative) accounting in a LID for the expression of future earnings was instead introduced in Feltham and Ohlson (1995).

Feltham and Ohlson (1995) – a linear information model

In contrast to Ohlson (1995) with considerations for the effects from economic rents and conservatism in the accounting variables, Feltham and Ohlson (1995) introduce a model for the assessment of a firm's market value through its accounting data.

In Feltham and Ohlson's LID for earnings, three parameters in a linear model describe the future abnormal operating earnings ($o\tilde{x}_t^a$):

- current abnormal operating earnings (ox_t^a);
- current operating assets ($o\tilde{a}_t^a$);
- "other information" (υ) similar to that introduced by Ohlson (1995).

Together, these parameters accommodate the modelling of growth in book values under conservative accounting; and the presence of a persistent, abnormal level in (operating) earnings due to either economic rents or conservatism in the accounting, or a combination of both (Feltham & Ohlson, 1995, pp. 689, 701-702).

Feltham and Ohlson's analysis demonstrates the importance of considering for conservatism in the accounting when valuing a firm's equity. A firm whose operating assets are expected to grow will on average have a large variation in its market value relative to the earnings if there is conservatism in the accounting; thus, growth and conservatism in the accounting have synergies. Moreover, assuming a full dividend payout-ratio and positive growth when the accounting is conservative leads to earnings increasing without an upper bound into perpetuity, whereas if growth is equal to zero, the earnings will reach a finite bound that is time-constant (Feltham & Ohlson, 1995, pp. 692-693).

The Feltham & Ohlson (1995) LID model

$$
\begin{aligned}
o\tilde{x}_{t+1}^a &= \omega_{11} ox_t^a + \omega_{12} oa_t + \upsilon_{1t} + \tilde{\varepsilon}_{1t+1} \\
o\tilde{a}_{t+1}^a &= \qquad\qquad\;\; + \omega_{22} oa_t + \upsilon_{2t} + \tilde{\varepsilon}_{2t+1} \\
\tilde{\upsilon}_{1t+1} &= \qquad\qquad\qquad\qquad\;\; \gamma_1 \upsilon_{2t} + \tilde{\varepsilon}_{3t+1} \\
\tilde{\upsilon}_{2t+1} &= \qquad\qquad\qquad\qquad\;\; \gamma_2 \upsilon_{2t} + \tilde{\varepsilon}_{4t+1}
\end{aligned}
$$

where

$$| \gamma_h | < 1, h = 1, 2$$

$$0 < \omega_{11} < 1$$

$0 < \omega_{11} < 1$

$0 < \omega_{22} < R_F$

$\omega_{12} \geq 0$

$R_F = risk - free\ interest\ rate$

$oa_t = operating\ assets, net\ of\ operating\ liabilities\ at, date\ t$

$ox_t = operating\ earnings\ for\ period\ (t-1, t)$

(Feltham & Ohlson, 1995, pp. 694, 702-703)

Empirical tests of the Ohlson (1995), and Feltham and Ohlson (1995) models have produced estimates of firm value no better than using book values alone (Myers, 1999, p. 1); or only minor improvements over a simple PVED-model that capitalized short-term earnings forecasts into perpetuity (Dechow, Hutton, & Sloan, 1999, pp. 1, 32).

It is important in the light of these results to recognize the limitations of the LID models formulated by Ohlson (1995), and Feltham and Ohlson (1995). The underlying equations that express the behaviours of earnings in the LID models are *assumptions*, and not derivations from the valuation models itself (Feltham & Ohlson, 1995, p. 702; Lee, 1999, p. 418; Ohlson, 1995, p. 668).

In response to the weak empirical results of Ohlson (1995), and Feltham and Ohlson (1995) which often produced negative biases between the firm-value estimates and their market value (Choi et al., 2006, p. 73), a variation of the Feltham and Ohlson (1995) model by Choi et al. (2006) included a "conservatism-correction term".[4] This term was defined as the past realisations of residual income and a "other information" variable defined as analyst forecasts for residual income. Choi et al. showed that such an addition could substantially reduce the mean of signed valuation errors between the value estimates and the stock prices observed in the market. However, when measured as an absolute metric the mean valuation errors did not improve meaningfully (Choi et al., 2006, pp. 82, 97).

[4] Choi et al. (2006) builds on the work of Ohlson (1995); Feltham and Ohlson (1995) and Dechow et al. (1999).

Runsten (1998) and the PMB estimates

Runsten (1998) estimated the *relative* permanent measurement bias (PMB) between biased and unbiased equity for firms in the Swedish stock market, given no abnormal return.[5] The training data used by Runsten was composed of all firms listed on the Stockholm stock exchange between the years of 1966 and 1993 where data were available, this corresponded to more than 75 percent of the total population by firm-years for the training period (Runsten, 1998, pp. 31, 36, 109, 112).

Instead of directly capitalising previously expensed costs like Cheng (2005), the PMB is estimated through a set of accounting items that Runsten found to be commonly affected by conservative accounting. These items were then scaled based on their relative importance between each other, and for each firm: first on total reported assets, then re-scaled against the book value of equity. Subsequently, Runsten summed the measurement bias "factors" after estimating their relative proportion in each of his 16 industry classifications (Runsten, 1998, pp. 68-70, 141).

These industry classifications were based on an already existing classification schema at the time: the Affärsvärlden's industry classification. For the PMB estimates on an industry group level to be time-constant, Runsten made estimates of the mean annual inflation rate, after-tax cost of debt and real economic growth, and applied these in his calculations where applicable (Runsten, 1998, pp. 141, 315). The partial PMB estimates and their summed estimates are presented next, as is the formulation connecting the difference in market-value and book-value of equity to the PMB estimate.

Given no abnormal return

$$\frac{V_T}{B_T} - 1 = PMB\ (permanent\ measurement\ bias)$$

where

$$V_T = market\ value\ of\ equity\ given\ no\ abnormal\ returns$$

$$B_T = book\ value\ of\ equity\ given\ no\ abnormal\ returns$$

[5] Defined as no abnormal profits from economic rents being present. Note that abnormal returns can still persist due to conservatism in the accounting.

given cost of equity (r_e) > growth (g), and no abnormal returns:

$$V_T = B_T * \frac{E(ROE-g)}{r_e-E(g)}$$

$$\frac{V_T}{B_T} - 1 = \frac{ROE-g}{r_e-g} - \frac{r_e-g}{r_e-g}$$

$$\frac{V_T}{B_T} - 1 = \frac{ROE-r_e}{r_e-g}$$

$$= PMB$$

(Runsten, 1998, p. 36)

Table 1. [Excerpt] - Shows the partial PMB estimates for each industry as classified by Runsten

MES (= machinery, equipment and ships)

Table 5.2 Summary of the estimated partial *PMBs* per industry. The industries have been ranked in descending *PMB* order.

Estimated partial *PMBs* due to different measurement problems for different industries	MES	Buildings	Trading property	Land	Investment in shares	R&D expenses	Personnel develop. expenses	Marketing expenses	Deferred taxes	= **Total *PMB***
Pharmaceutical	0.06	0.09				1.08			0.51	**1.74**
Capital-intensive service*	0.23	0.15		**	0.06				0.33	**0.76**
Consumer goods	0.15	0.11			0.01			0.25	0.20	**0.72**
Investment companies					0.53				0.16	**0.68**
Pulp and paper*	0.23	0.08		0.07	0.01				0.27	**0.67**
Shipping	0.47	0.02			0.02				0.14	**0.65**
Other service	0.03	0.04			0.02		0.40		0.14	**0.62**
Consultants & computer*	0.03				0.01		0.40		0.15	**0.59**
Real estate		0.31	0.12	0.01	0.01				0.10	**0.56**
Mixed build. and real est.	0.02	0.02	0.35	0.01	0.01				0.12	**0.55**
Trading and retail	0.03	0.21							0.23	**0.47**
Chemical industry*	0.10	0.12			0.01				0.21	**0.44**
Building and construction	0.03	0.03	0.12	0.01	0.02				0.16	**0.38**
Engineering*	0.07	0.10			0.01				0.15	**0.33**
Other production*	0.07	0.10			0.01				0.13	**0.31**
Conglom. & mix. inv. *	0.04	0.08			0.08				0.09	**0.28**

* Industries that contain particular companies with an estimated bias related to R&D.
** Two electrical utility companies have partial *PMBs* amounting to approximately 0.30.

Source: "Summary of estimated partial PMB's per industry" Runsten (1998, p. 151)

Significant items for the calculation of the PMB (Runsten, 1998) estimates

Tangible assets: Runsten emphasises the importance of inflation and the annual growth rate for this marginal measurement bias; firms with newer assets will have a relatively lower bias compared to the firms whose asset portfolio would be more balanced (Runsten, 1998, pp. 71-75).

Runsten made the following assumptions in his calculation of the marginal measurement biases attributable to tangible assets:

- The units have uniform economic lives, uniform rates of depreciation, the same cost of acquisition in real terms and the same number of units are replaced each year;
- The historical rate of inflation has been constant since the first of the existing units was acquired;
- The same rate of inflation will continue.

(Runsten, 1998, p. 72) [6]

Intangible assets: Runsten counted R&D and advertisement expenses into this category, essentially encompassing the capitalisation method of previously expensed costs as by Cheng (2005) but with added modes of complexity. Expenditures in intangible assets were presumed to generate “fair but late returns” with an “average investment-to-harvest timelag” variable. Runsten emphasised that for this marginal measurement bias, the marginal effects of a higher “average investment-to-harvest timelag”, could be substantial.[7] He particularly pointed out the pharmaceutical industry; with their very long timelags (10 – 20 years) between early research and product launches. Consequently, their marginal measurement bias for intangible assets will be large (Runsten, 1998, pp. 78-80).

Deferred taxes: Runsten assumed that all deferred taxes are to be repaid at a single point in the future, emphasising that only a large deferred tax liability with a long life expectancy would generate a marginal measurement bias in excess of 0.5 (Runsten, 1998, pp. 81-83). Overall, the issue of quantifying the marginal measurement bias for deferred taxes can be summarised to be secondary to those for tangible and intangible assets.

Comparing Runsten to Fruhan (1979)

A brief comparison between the method of Runsten (1998) and the method used by Fruhan (1979) to quantify measurement biases for the US market is highlighted here for those contents that are of interest to this study. Runsten made this comparison by himself, and of significance are the differences in measurement biases between those estimates of Fruhan and those made by Runsten for the equivalent industry.

[6] These assumptions were originally suggested by Johansson and Östman (1995, p. 137).

[7] Runsten (1998) provides an example where he assumed a 50% reported solidity, 30% tax rate, discount rate and annual growth rate of 5% and 0%, respectively. Under such conditions, and with an investment-to-harvest timelag of 5 years, the PMB estimate is approximately equivalent to if a 10 to 11 years economic life with linear depreciation is used. Another example is given, where a two-year timelag and 15% annual expenditures (intangible assets expense / total assets) generates a marginal PMB of 0.43 (Runsten, 1998, pp. 79-80).

"The [Fruhan (1979)] manufacturing sector included 'high-tech' firms such as IBM, Xerox … which can be expected to have invested heavily in both R&D and marketing. The average estimated bias was still as low as 0.11 for this group."

"The R&D intensive group of pharmaceuticals had on average a bias of 0.28 caused by the capitalization of R&D and advertising expenditure. A similar measurement bias is consistent with, for example, a four-year investment-to-harvest timelag and annual R&D expenditures amounting to 5% in relation to total assets [assuming 50% solidity and 30% tax rate]"

(Runsten, 1998, p. 86)

Evidently, estimations of the measurement bias can be highly unstable. In this regard, Runsten explicitly states that any interpretation of the PMB estimate must be made with the utmost caution, as "*some of the operationalizations rest on weak or simplified ground*" (Runsten, 1998, p. 150).

<u>*Key assumptions of Runsten*</u>

Presenting all the assumptions made by Runsten in the derivation of the PMB estimates would be infeasible as they are too numerous, but I will here present the key assumptions that underpin the PMB estimates.

First, by assuming a *constant relative bias*, the growth rate of the unbiased and biased equity must be equal, as a constant relative rate otherwise cannot be achieved (Runsten, 1998, p. 31). Second, the derivation of the RIV model is dependent on the satisfaction of consistency between the balance sheet items and reported income in the income statement: in short, the "clean surplus relationship of accounting" must apply (Runsten, 1998, p. 23). Third, the notion of a constant relative measurement bias is in itself an assumption introduced by Johansson and Östman (1995). Runsten explains in the following quote why such a notion is attractive:

"An analysis of the size and development of different measurement biases assuming more realistic conditions quickly becomes extremely complex. Simplifications must therefore be made. … In this study the valuation equation will only be expanded to allow for a constant relative measurement bias."

(Runsten, 1998, p. 31)

A recent application of Runsten

Recent research presented in a working paper of Anesten et al. (2015) has employed the PMB estimates in the examination of valuation accuracies of equity valuation models for the Scandinavian markets. Anesten et al. (2015, p. 2) examined the valuation accuracy for parsimonious variations of each of the following models: PVED (present-value expected dividends); RIV and the AEG (abnormal-earnings growth). The PMB estimates of Runsten were used in the RIV model for calculating a truncation value in the forecasts of residual income.

Among the tested models, only the RIV model did not benefit from the inclusion of bankruptcy risk; and when extending the forecast period of the parsimonious models, the RIV model showed a higher improvement over the other models (Anesten et al., 2015, pp. 12, 19).

Cheng (2005) – estimating conservatism in the presence of economic rents

Investigating the determinants of abnormal return on equity (ROE); economic rents and accounting conservatism, Cheng (2005, p. 86) proposed a "conservative accounting factor" (CAF) for capturing the impact of conservatism in the accounting. The CAF is estimated through the capitalisation of previously expensed R&D and marketing expenses and combined with a second component for capturing the economic rents to yield the abnormal ROE.[8]

Cheng (2005) presents the following formula

$$ROE_t^a = CAF_t + ROE_t^{a'} \left(1 + \frac{ER_{t-1}}{BV_{t-1}}\right)$$

$$CAF_t = \frac{(1 + r)\, ER_{t-1} - ER_t}{BV_{t-1}}$$

where

unbiased accounting numbers are denoted with " ′ "

$$X_t' - X_t = ER_t - ER_{t-1} \tag{1}$$

$$ROE_t^a = abnormal\ ROE\ under\ conservative\ accounting$$

[8] Abnormal ROE was defined as the difference between ROE and the cost of equity, and measured as the net income before extraordinary items available for common equity, deflated by the beginning-of-period book value of equity. The industry cost of equity is the sum of the annualised one-month T-bill yield and the conditional three-factor model by Fama and French (1997) (Cheng, 2005, p. 91).

$$BV_t^{'} = BV_{t-1}^{'} + X_t^{'} - d_t \quad (2)$$

$$BV_t = BV_{t-1} + X_t - d_t \quad (3)$$

$$BV_t = conservative\ (accounting)\ book\ value\ of\ owner's\ equity$$

$$ER_t = estimated\ reserve = BV_t^{'} - BV_t \quad (4)$$

$$d_t = net\ dividends$$

$$X_t = conservative\ (accounting)\ net\ income$$

The estimated reserve (1) assumes a clean surplus relationship (2, 3) for unbiased and biased accounting numbers, respectively. By not assuming economic rents to be zero when estimating the CAF, the abnormal ROE estimate (and by extension the residual income) aims at capturing both the effects from economic rents and conservatism in the accounting. However, this method is not without its problems, as accruals of the estimated reserve are the differences in net income when comparing unbiased to biased accounting (4). Cheng writes the following:

> *"The difference in book value of equity between unbiased and conservative accounting is defined as the estimated reserve [ER]. ... Thus, the estimated reserve is positive under conservative accounting and the higher the estimated reserve, the more conservative the accounting system. ... Net income under conservative accounting is lower than that under unbiased accounting if the estimated reserve [ER] increases, and vice versa. ... Economic rents and conservative accounting effects might be related. For example, successful R&D investments can affect abnormal ROE through both economic rents and conservative accounting factors."*

(Cheng, 2005, pp. 88-89, 92)

Albeit intuitive, it bears additional reflection; for how can one reliably separate the effects from each other, when both forces converge in the net income? Also, the composition of each force varies across time and circumstance and may be interlinked. It is such inter-connectivity between the effects of economic rents and conservative accounting, that leads to certain difficulties in assessing and separating one effect from the other.

The determining forces converge

In my brief contemplation of Runsten (1998) and Cheng (2005), the inter-connectivity of the determinants for abnormal ROE (residual income) in the net income seems to call for the disarmament in one of its sources: either in eliminating the effects arising from economic rents; or those from conservative accounting.

One approach to this problem is to assume the equalization in the rates of returns that the notion of "mean reversion" provides; by the neutralisation of economic rent profits over time in any industry due to competitive forces, one is eventually left only with the abnormal profit due to conservatism in the accounting. Runsten inexplicitly favours this approach in his consideration for an efficient market in the calculation of the PMB estimates (Runsten, 1998, p. 32). Such an approach leaves the issue of how those years where economic rents are still present should be forecasted. In this predicament, Cheng (2005) offers a solution in the separation of residual income streams through the CAF and economic rent proxies.

Behaviours of profitability

A discussion of the behaviours of residual income in the context of forecasting profitability is here warranted. The reasons are not limited to the previous discussions on the separation of determinants for the abnormal ROE (economic rent vs conservative accounting), but because after all, half of what is forecasted in the RIV model is profitability.

In the economic literature, the notion of "mean reversion" in profitability has existed for long: specifically, the rate of returns should converge towards equality in all industries over time as unprofitable ventures are abandoned, and profitable ventures become more fiercely competed for (Fama & French, 2000, p. 161). This notion of "mean reversion", present both in fortune and misfortune for each firm and industry, is a historical concept that has even been the definition of what competition constitutes. For most contemporaries, however, the proposition of "mean reversion" is the end-result of competitive competition. A counter-argument to the notion of "mean reversion" is the idea that unexpected events; such as those of a new consumer taste or habits, will alter the allocation of resources within the economy and disturb this "equalisation process of profitability" (Joseph Stigler, 1963, p. 55).

There are variations of these counter-arguments against the presence of "mean reversion" in profitability, and they have over the time of history found mixed support.[9] Mueller (1977, p.

[9] In the times of Joseph Stigler (1963), it was believed that such disturbances as arising from, for example shifting consumer tastes, could occur so frequently and have such an impact that the proposed equality in rates of return would never materialise. Joseph Stigler (1963) did however not agree, claiming that large unexpected events were not that common to explain how fast competition equalises the rates of returns, and presumed that smaller disturbance events would cancel each other out (Joseph Stigler, 1963, p. 56).

373) for example found strong rejection for what he called a “competitive environment hypothesis” in the US data spanning 24 years of data from the year 1949. However, a more recent analysis by Fama and French (2000) on US data spanning between 1964 and 1995 holds profitability (measured as earnings before interest to total book assets) to be mean reverting; and especially, when far from its mean or when profitability is below the historical mean for the firm (Fama & French, 2000, pp. 163 - 164).

Runsten (1998, p. 21) cited several sources for the empirical observations of the same mean reversion properties for ROE, which he defines as his central performance variable. Logically, profitability ratios that extend upon the definition set by Fama and French (2000); such as ROE used by Runsten, should arguably also exhibit mean reversion properties like their higher-order equivalents. I take the stance to assume such a relationship in this paper.

Historically, forecasting economic profits through the use of accounting numbers such as the use of the RIV model was cautioned against, nowadays, such models have however become prominent, especially the RIV model (Ohlson, 2005, p. 323; Peasnell, 1982, p. 361).

The role of accounting numbers in valuations

The choice of valuation model is often a matter of personal preference, and not seldom when forecasting the future (residual income), steeped in imprecise estimates. A more parsimonious variation of a valuation model may prove more narrow in its estimates than a more complex one (see Myers, 1999); valuation is thus akin to an interdisciplinary art.

Accounting systems help in providing a language for the forecasting of earnings: more specifically, the principles of "revenue recognition" and "matching" in the accounting provide a consistent measurement of earnings over time, which also applies in the comparison of forecasts to actually realized outcomes (Lee, 1999, p. 414). This notion of forecasting "flows" of earnings in determining intrinsic value stem from the neoclassical economic theory, that any firm or project's intrinsic value is equal to their capitalised and expected future cash flows. It is from this neoclassical notion that we subsequently arrive at the well-known present-value expected dividend (PVED) model.

The development of the RIV model

The PVED model requires only the assumption of equal timing in the cash flows at the end of each period[10] and can be used to value any asset or security (Peasnell, 1982, pp. 362 - 363). However, its rudimentary form does not accommodate well for the properties of accounting systems: a link between observable accounting data and firm value is missing. Extending on the PVED model, and through the explicit linking of earnings to book value of equity through the "clean surplus relationship", one can show that the RIV model is equivalent to the PVED model (Kin & Lys, 2000, p. 341). In its essence, the "clean surplus" relationship and assumption within the context of the RIV model is *only* needed to link earnings to book value of equity. The RIV model is not dependent on any accounting system, so the "clean surplus" could in practice link any two income/balance sheet items as long as the accounting system remains consistent (i.e. no "dirty surplus" is introduced) (Kin & Lys, 2000, p. 341).

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[10] This can be specified to days, months or years at the analyst's discretion.

The PVED model

$$V_0 = \sum_{t}^{T} \frac{Div_t}{r_t}$$

where

V_0 = *present value*

Div_t = *dividend at time t*

r_t = *discount rate at time t*

The RIV model

$$V_0 = B_0 + \sum_{t}^{\infty} \frac{E\,(ROE_t - r_e) * B_{t-1}}{(1 + r_e)^t} \tag{1}$$

$$= B_0 + \sum_{t}^{T} \frac{E\,(ROE_t - r_e) * B_{t-1}}{(1 + r_e)^t} + \frac{V_T - B_T}{(1 + r_e)^T} \tag{2}$$

The "clean surplus relationship"

$$B_t = B_{t-1} + NI_t - Div_t$$

where (in addition to previous definitions)

B_t = *book value of owner's equity at time t*

NI_t = *net income at time t*

r_e = *discount rate for owner's equity at time t*

ROE_t = *return on equity at time t*

V_T = *market value of book value of owner's equity at time T*

B_T = *book value of owner's equity at time T*

Forecasting RIV estimates in a two-period setting

It is customary within valuation contexts to separate the valuation process into two time-periods, one period in which the firm enjoys economic rents and another when these effects have been competed away. The first is commonly referred to as the "explicit forecasting period", and the second the "steady-state", whose values are commonly inherited by the last time-period in the explicit forecasting period to ease the present value calculation of the steady-state. Such a separation yields the second (2) formula above, and is presented on the next page as part (a) being the explicit forecasting period, commonly forecasted by the analyst; and part

(b) being the steady-state where economic rents are assumed to have been competed away, commonly represented by a truncation value.

The RIV model with explicit forecasting (a) and a steady-state (b)

(a) (b)

$$V_0 = B_0 + \sum_{t}^{T} \frac{E\,(ROE_t - r_e) \, * \, B_{t-1}}{(1 + r_e)^t} + \frac{V_T - B_T}{(1 + r_e)^T}$$

where in steady-state

- No excess profit is assumed (all firms earn the cost of capital).
- Only zero net present value (NPV) business activities are pursued.

Merging the PMB (Runsten, 1998) estimates and the RIV model

Separating the explicit and steady-state profitability generates a more structured forecast, the remaining issue is then the conceptual tasks that Ohlson (1995), and Feltham and Ohlson (1995) dealt with: linking past financial statements to forecasts of future earnings (residual incomes).

By substituting a function of the PMB estimates for the steady-state truncation value of [V_T - B_T] in the RIV model, a linear information dynamic (LID) can be generated for the expression of future profitability and growth (and thus earnings) if their explicit forecast values are linked to their steady-state values. However, such a linear-information model (LIM) is dependent on the estimation of the steady-state values of the residual income determinants; ROE, growth rate and cost of equity (r_e) to be already known when the forecasting begins in the explicit forecasting period.

Given that the levels of r_e and growth in the steady-state (g_{ss}) are known (or assumed), rearranging the PMB estimate formula allows for a steady-state level of ROE to be estimated. It is then possible to satisfy the LIM condition of knowing the steady-state values for the determinants of residual income before forecasting commences.

The steady state (ss) expressions of the ROE and PMB estimate

conditioned on: $r_{e,ss} > E(g_{ss})$

then

$$V_T = B_T * \frac{E(ROE_{ss} - g_{ss})}{r_{e,ss} - E(g_{ss})}$$

$$\frac{V_T}{B_T} - 1 = \frac{ROE_{ss} - g_{ss}}{r_{e,ss} - g_{ss}} - \frac{r_{e,ss} - g_{ss}}{r_{e,ss} - g_{ss}}$$

$$\frac{V_T}{B_T} - 1 = \frac{ROE_{ss} - r_{e,ss}}{r_{e,ss} - g_{ss}} = PMB\ estimate$$

(rearranging)

$$ROE_{ss} = r_{e,ss} + PMB\ estimate * (r_{e,ss} - g_{ss})$$

$$V_T = (PMB\ estimate + 1) * B_T$$

$$V_T - B_T = PMB\ estimate * B_T$$

In this section, I first introduce the model specifications of the LIEV model with a particular attention on the estimation methods for the return on equity (ROE) and equity growth (g_{equity}) levels. Subsequently, the solution to match modern industry classifications to those used by Runsten in 1998 is dealt with; followed by the estimation method for the cost of equity (r_e) and the assumptions of the LIEV model.

Forecasting the return on equity and equity growth

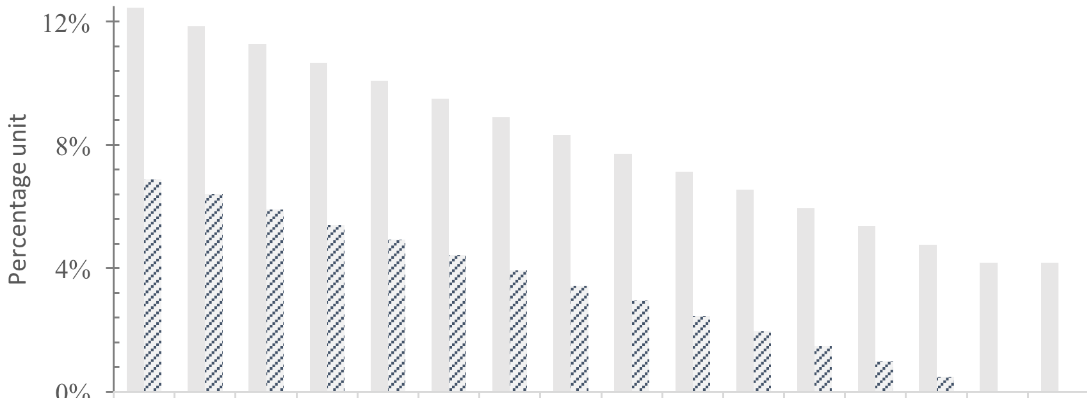
The residual income is the ROE for the period deducted by a capital charge (r_e), multiplied by the closing book-value of equity (B) in the previous period. If no abnormal return is to persist in the steady-state, the value of the steady-state period should be the difference in book-value to market-value for the equity, essentially the PMB estimate multiplied by the book-value of equity at the steady-state. This formulation yields the value of residual income for the steady-state which has been presented algebraically in the previous section (see page 19 - 20).

To equally satisfy the condition of $r_{e,ss} > E(g_{ss})$ for all securities and thus avoid unfeasible valuation computations, the g_{equity} in the steady-state is assumed to be equal to zero for all securities. Although such an assumption is practically unrealistic, a growth rate of zero in the steady-state does not affect the intrinsic value estimate; and when assuming a full pay-out ratio of 100 percent in the steady-state, earnings will increase to a finite bound that is time-constant when there is conservatism in the accounting. This state is more manageable and intuitive compared to its alternative when there are growth and conservatism in the accounting; the earnings then increase into perpetuity (Feltham & Ohlson, 1995, pp. 692-693).

During the explicit forecast period, fifteen years are allowed to pass before the onset of the steady-state. In order for the forecasts not to start at an extreme level, the estimate for ROE and g_{equity} in the first explicit forecast year is assumed to be their arithmetic mean of the past five years; observations that were greater than 1.5 (150 percent) or smaller than minus 1 (-100 percent) were considered as extreme outlier values (and excluded in the subsequent analysis). Those year-observations that were missing or removed are replaced by observations for years before the five-year period; and if a vector of five historical years cannot be retrieved in either the ROE or g_{equity}, then no valuation is performed for the firm at that particular year.

Following the first explicit forecast year, the remaining fourteen explicit forecasts follow an incrementally linear increase or decrease of their ROE and g_{equity} levels towards their steady-state levels.[11] In the remaining determinants of residual income (B, r_e), the B is assumed to grow with the forecasts of g_{equity}, leaving the pay-out ratio up until the steady-state (where it is 100 percent) as a residual. The estimated r_e levels are assumed to be time-constant in the forecasts of residual income, but unique for each firm and year of valuation.

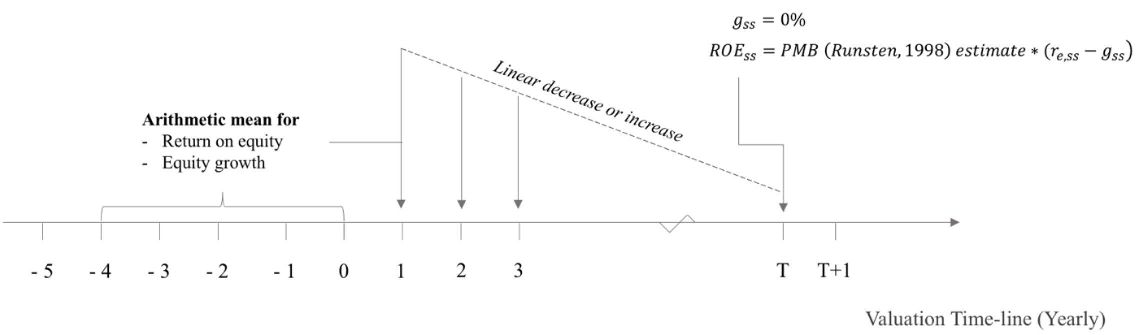
Graph 1. [Example] - Forecasts of ROE and g_{equity} for Ericsson at February 2011



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
ROE	12%	12%	11%	11%	10%	9%	9%	8%	8%	7%	7%	6%	5%	5%	4%	4%
Equity growth	7%	6%	6%	5%	5%	4%	4%	3%	3%	2%	2%	1%	1%	0%	0%	0%

Comment: Both the ROE and g_{equity} decline linearly towards their steady-state (T+1) values, 0 percent for the g_{equity} and 4 percent for the ROE.

Graph 2. [Illustration] - Simplification of forecasting method



Comment: The long-term profitability level is first determined, with forecasts of the immediate future anchored on the long-term estimates.

[11] Deducted through the formula: $ROE_{ss} = r_{e,ss} + PMB\ estimate * (r_{e,ss} - g_{ss})$

The LIEV model

$$V_0 = B_0 + \sum_{t}^{T} \frac{E\ (ROE_t - r_e)\ *\ B_{t-1}}{(1 + r_e)^t} + \frac{B_T * PMB(Runsten, 1998)\ estimate}{(1 + r_e)^T}$$

where the ROE and g_{equity} for t = 1:

$$ROE_{t=1}, g_{equity,t=1} = \frac{\sum_{t=-4}^{t=0}\ (five)\ past\ values}{5}\ \ with\ replacement\ for\ missing\ values$$

and where the ROE and g_{equity} follows a linear model for T ≥ t ≥ 2:

$$ROE_t = ROE_{t-1} + \frac{ROE_T - ROE_{t=1}}{N. of\ explicit\ forecast\ years\ (T) - 1}$$

$$g_{equity,t} = g_{equity,t-1} + \frac{g_{equity,T} - g_{equity,t=1}}{N. of\ explicit\ forecast\ years\ (T) - 1}$$

and where:

$$B_t = B_{t-1} * (1 + g_{equity,t})$$

$$r_{e_t} = r_{e,t=1}, r_{e,t=2}, r_{e,t=3} \dots r_{e,T}$$

$$g_{equity,T} = 0\%$$

$$ROE_T = r_e + PMB\ estimate * \left(r_e - g_{equity,T}\right)$$

Matching industry classifications by Runsten in 1998

Runsten (1998) estimates the PMB for sixteen industries. In contrast, my data source classifies industries after the Global Industry Classification Standard (GICS); a 4-tier hierarchical classification system with increasing levels of detail for each tier (MSCI, 2017). To resolve this, the descriptions for the 68 GICS industry sectors, the third most detailed hierarchy, were matched against the appropriate industry under the classifications used by Runsten.

This process results in that each GICS industry sector is classified by their 6-digit identification code and belongs to one of the sixteen industry groups that Runsten used. Two industry groups of Runsten, the “other service” and “other production” stand out among the rest due to the high number of GICS classifications assigned to them (Appendix Table W). As the industry of the firm determines the PMB estimate, many sectors that previously were separately considered will now share a joint industry group although their industries should in principle claim a unique

PMB estimate. These inaccuracies add another layer of caution to the conclusions drawn from the empirical use of the PMB estimates.

Estimating the cost of equity

The cost of equity is estimated with the capital asset pricing model (CAPM) of Sharpe (1964) and Lintner (1965). Initially built on the assumptions formulated by Markowitz (1952, p. 77) of investor risk aversion and their expectation to maximise the expected return to variance ratio in portfolio selection, Sharpe and Lintner then added two assumptions in the formulation of the CAPM. First, the complete agreement of asset return distributions among investors; second, that unlimited funds can be borrowed or lent at the risk-free rate (Fama & French, 2004, p. 26; Lintner, 1965, pp. 14, 16; Sharpe, 1964, pp. 433-434). Black (1972, pp. 449-450, 455) later introduced a CAPM model with relaxations for the assumption of unlimited borrowing and lending where the expected return still was a linear function of the β – variable, however, this model requires the estimation of a zero-β portfolio in the absence of a risk-free asset.

With a similar agreement of the return distributions and risk-free borrowing and lending, it holds that all investors would hold the same portfolio: a combination of the risk-free asset and the “mean-variance” efficient portfolio for risky assets. This portfolio, the “market portfolio”, represents the value-weighted portfolio of all risky assets and is not limited to financial assets alone. The difference of its expected return and that of the risk-free asset is referred to as the market risk-premium.

The capital asset pricing model (CAPM)

$$E(R_t) = R_f + \beta_i(E(R_M) - R_f)$$

$$\beta_i = \frac{Cov(R_M, R_i)}{Var(R_M)}$$

where

$$E(R_t) = expected\ cost\ of\ equity\ for\ stock\ i\ at\ time\ t$$

$$E(R_M) = expected\ return\ of\ market\ portfolio$$

$$R_f = risk - free\ rate\ at\ time\ t$$

$$\beta_i = Beta\ value\ for\ stock\ i\ at\ time\ t$$

$$E(R_M) - R_f = market\ risk - premium$$

PwC's annual risk-premium survey

PricewaterhouseCoopers (PwC) conducts yearly a survey among the Swedish finance industry for their risk-premium estimates of the Swedish market. The survey reports the risk-premium estimates, the benchmark used for the estimate of the risk-free rate, and any potential market cap based risk-additions that are added to the CAPM estimates. For the risk-free rate, the Swedish 10-year government bond is consistently referred to as the benchmark; and for the market cap based risk-additions PwC presents four "ranges" representing the aggregated average of respondent's risk additions.

Table 2. [Excerpt] - The PwC risk-premium report for market cap based risk-additions

Storleksrelaterad riskpremie – PwC:s riskpremiestudie

Storlek	Feb 2007	Feb 2008	Feb 2009	Mars 2010	Mars 2011	Mars 2012	Mars 2013
Börsvärde 5 000 MSEK	1,0%	0,6%	1,2%	0,7%	0,8%	0,7%	0,5%
Börsvärde 2 000 MSEK	1,3%	1,3%	1,6%	1,2%	1,4%	1,4%	1,2%
Börsvärde 500 MSEK	2,0%	2,5%	2,6%	2,2%	2,6%	2,6%	2,4%
Börsvärde 100 MSEK	3,1%	3,9%	3,9%	3,8%	3,8%	3,9%	3,7%

Source: PwC (2013) – "Riskpremien på den svenska aktiemarknaden"

The risk-premium for the Swedish market is in this paper assumed to be an average of all PwC survey results for the years between 1998 and 2016. This rate is 5 percent when rounded to the nearest full-digit and is assumed to be time-constant for all firm-years. Again, the benchmark used for the risk-free rate is the Swedish 10-year government bond.

A market cap based risk-addition is also added to the CAPM estimates, the average risk-additions for each market cap "range" for the years between 2003 and 2016 are extended in either direction so that between the ranges nine new values separate each original value in equal increments. Also, ten new observations extend the first and last ranges. This new range (see appendix table on p. 62) is continuous and generates a 4.9 percent risk-addition for the smallest market cap range of 0 - 10 million Swedish Krona (MSEK), and a 0.06 percent risk-addition for the largest market cap range of 7 700 - 7 400 MSEK.

Estimating the Beta (β) and risk-free rate

Each risky asset's partial contribution to the market portfolio can be measured through the division of its total market value to that of the market portfolio. This variable is the Beta (β) value and is calculated as the covariance of returns for the risky asset, to that of the market portfolio divided by the variance of the market portfolio (Fama & French, 2004, pp. 26-28).

I base my β-estimates on a 250-period rolling calculation of the daily covariance and variance of the risky asset and the market portfolio returns. For a calendar year, the yearly β-estimate is the mean β-estimate of all the 250-period rolling calculations performed on each day for that year; this yearly β-estimate is then the estimate used in the LIEV model.

A rolling computation of the β-estimate is suggested by Fama and French (1997, p. 158) to better capture the temporary variations in the CAPM, as the real CAPM estimate varies over time. The short estimation window (250 days before January to the end of December for each yearly β-estimate) is motivated by the wish to keep the estimation window as short as appropriately possible while maintaining a relatively large number of estimates for the yearly β-estimate.

The estimates for the risk-free yearly rates are similarly computed to that of the β-estimate. For a calendar year; the yearly estimate is the mean of all the daily yields for the risk-free benchmark in that year.

Critique of the CAPM

It would be improper not to include some of the critiques on the CAPM. The first concern is the empirical observation that β-estimates do not vary enough with the asset returns; the observed returns for a portfolio with low β stocks is too high, whereas a portfolio of high β stocks too low (Fama & French, 2004, p. 33).[12] Second, CAPM estimates are imprecise as demonstrated by Fama and French (1997); in their CAPM estimates, the standard errors were over 3 percent per year (as were estimates of a 3-factor Fama and French (1993, 1995) model).[13]

Model assumptions

The assumptions that underpin the LIEV model are technically independent from those made by Runsten (1998) for the PMB estimates, but as the PMB estimates are used in the LIEV model, their assumptions are invariably inherited in the model.

Many of the assumptions whether inherited through the extended use of the PMB estimates or conditional for the LIM are identical to those made by Runsten (1998) when he presented a valuation model in connection to the calculation of the PMB estimates. Those assumptions that are identical to or inherited through the PMB estimates are presented first next, followed by any additions unique to the LIEV model.

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[12] Fama and French (2004, p. 32) repeated this observation across a large time window with US data for the NYSE (1928-2003), AMEX (1963-2003), and NASDAQ (1972-2003).

[13] These values were captured when estimating the industry cost of equity, estimates for a single firm or project are plausible to be even more imprecise (Fama & French, 1997, p. 153).

Assumptions initially specified by Runsten

(1): The future required rate of return is constant;

(2): The accounting system complies with the "clean surplus relationship" of accounting;

(3): The timing of net dividends and cash flows occur at the end of each period;

(5): The profitability is to be "normal" after a horizon point [steady-state] in the future;

(6): The expected future return on equity follows a mean-reversion process;

(7): The expected relative accounting measurement bias can be quantified;

(8): The quantified accounting measurement bias, can be assumed to be permanent.

(Runsten, 1998, pp. 285-286)

Additional assumptions

(9): The expected equity growth rate is variable before the horizon point (steady-state), but zero at and after the horizon point;

(10): The notion of "going concern" is assumed with bankruptcy risk either being negligible, zero or captured by other variables such as the market cap based risk-additions separately added to the cost of equity (CAPM) estimates;

(11): The capital transactions with owners are restricted to dividends;

(12): The number of shares outstanding remains constant over the forecast horizon.

For the full sample period and each sample year, two data subsets are generated: (a) where both long and short positions are considered; and (b) where only long positions are considered. Hereafter, I will refer to (a) as [C. L&S] for "Case Long and Short", and (b) as [C. L] for "Case Long".

In the [C. L&S] and [C. L] portfolios of each sample year (2003 to 2015), I form "quintile groupings" of five levels for the market cap; the P/E and B/M – ratio at the time of portfolio formation, respectively. Each level represents a quintile level and contains 20 percentiles: the first (quintile) level firm values between the 0'th to 20'th percentile; the second level firms between the 20'th and 40'th percentile, and so forth, with the fifth level containing firms with values ranging between the 80'th and 100'th percentile.

Portfolio formation and the holding period

As the annual reports of listed firms commonly are not available at the year-end for that year they represent, I assume the portfolios of [C. L&S] and [C. L] to be formed at the last trading day of February the following year and held for 12 months, and reformed for the next year's samples at the last trading day of February the following year.

Thus, firms represented in the sample year of 2003 are valued at the last trading day in February of 2004 (2004-02-27) and held until the last trading day of February 2005 (2005-02-28), where the firms represented in the sample year of 2004 are valued.

Abnormal return metrics

For the calculation of yield and abnormal return metrics, I assume in [C. L&S] and [C. L] the transaction costs and slippage to be zero, and the ability for unrestricted short selling at a zero-interest cost for borrowed shares. The used return metrics are presented below.

Total yield is defined as the differences in closing prices over the holding period and includes the dividend yield.

Abnormal return (AR) is defined as the total yield across the holding period (12 months) subtracted by the cost of equity.

Average abnormal return (μ_{AR}) is defined as the abnormal return of a portfolio of securities, it follows the same computation as the abnormal return but divides for the number of securities in the portfolio.

Cumulative average abnormal return (CAAR) is the compounded average abnormal returns (μ_{AR}) over multiple years, with reformed portfolios of [C. L&S] and [C. L] in each year.

The abnormal return metrics

$$Abnormal\ return\ (AR)_{i,t} = total\ yield_{i,\ t} - r_{e,\ i,\ t}$$

$$Average\ abnormal\ return\ (\mu_{AR})_t = \frac{\sum AR_{i,t}}{n}$$

$$Cumulative\ \mu_{AR}\ (CAAR)_t = Cum.Product\ \left(\mu_{AR,t} + 1, \mu_{AR,t-1} + 1, \dots\right) - 1$$

where

$r_{e,\ i,\ t}$ = *cost of equity for security i in year t*

n = *number of securities*

Tests of abnormal return

If abnormal returns are observable by a LIEV model, the specific conditions and nature under which such returns were achieved with all samples should be examined. Thus, abnormal return is first controlled in the full sample; then for each sample year (2003 to 2015); and lastly for the quintile group formations of market cap, P/E and B/M – ratio as well as industry. Represented in the first and the second hypothesis, is the exploration of these tests:

Hypothesis I

H_I: *Can the LIEV model achieve abnormal returns?*

Hypothesis II

H_{II}: *Are μ_{AR} equal controlling for market cap, industry, P/E and B/M – ratio?*

Each hypothesis is individually tested in the portfolios of [C. L&S] and [C. L]. In the statistical tests performed, the significance level is set to 2.5 percent and 5 percent for a one-sided and double-sided test, respectively.

The statistical tests used in hypothesis I and II are the Student's t-test for one sample, the one-way ANOVA test and the Tukey's honest significant difference test (HSD) for those groups that are not significant in a one-way ANOVA. Each test assumes a Gaussian distribution for the test data in addition to homoscedasticity across the compared groups in the one-way ANOVA and Tukey's HSD test.

Determining the valuation state

In determining the degree to which the LIEV model correctly predicts the direction of subsequent stock movements after the valuation point, I define two variables, the γ_{success} and γ_{failure} to capture the states of success or failure in the predictions of "valuation states".

For a security whose share price at the portfolio formation date is lower than its estimated intrinsic value, a "buy" signal is generated; and in the reverse scenario where a share price is higher than its intrinsic value estimate, the share is "short" sold. Comparing then the initial position at the portfolio formation date to the outcome after the holding period has expired, returns whether the initial assessment was correct (i.e. the share price rose for a "buy signal" and fell for a "sell signal") or incorrect. The variable γ_{success} then denotes a correct assessment of the initial position, and the variable γ_{failure} an incorrect assessment.

Test of predictive probabilities

If the states of success and failure of the valuation outcomes occur in equal probabilities ($P =$ 0.5), the probability distributions of γ_{success} and γ_{failure} would be known under a binomial distribution. The exploration of this test is represented in the third hypothesis:

<u>*Hypothesis III*</u>

H_{III}: *Are the probabilities for a correct valuation state ($\gamma_{success}$) equal to 0.5?*

The statistical test used for hypothesis III is the exact binomial test and is provided by the *binom.test()* function in the *stats* R-package. Again, the hypothesis is individually tested in both cases of [C . L&S] and [C. L], with a level of significance of 2.5 percent and 5 percent for a one-sided and double-sided test, respectively.

Statistical tests

<u>*Exact binomial test*</u>

The exact binomial test is commonly associated with testing for the equal probabilities of a coin-flip. For a dataset with only two binary possibilities of either "success" (S) or "failure" (F), its probability distribution follows a binomial distribution if the observations are independent and the possible outcomes, (S) and (F), are mutually exclusive.

Defining the probability for "success" in a single trial by P and given n independent trials, the probability to observe x number of "successes" in n number of trials, is the probability of obtaining each combination of a sequence of x in the n trials ($p^x * q^{n-x}$) multiplied by the number of possible sequences (C_n^x). Subsequently, the distribution function that can be compared to the binomial table is the summed probability functions for observing the range of one to the *x* number of "successes" in *n* trials (Dodge, 2008, pp. 44-48; Newbold, Carlson, & Thorne, 2012, pp. 161-162).

The binomial probability and distribution function

$$P(X = x) = C_n^x * p^x * q^{n-x}$$

$$P(X \leq x) = \sum_{i=0}^{x} C_n^i * p^i * q^{n-i}$$

where

$$0 \leq x \leq n$$

$$q = 1 - p$$

$$C_n^x = \frac{n!}{x!\,(n-x)!}$$

Student's t-test for one sample

The Student's t-test for one sample tests for the mean value of a measurement variable to be equal to a theoretical value, in this case, zero. Its test statistic *t* is the difference in the mean of the measurement variable and the theoretical value tested against, divided by the standard deviation of the sample over the square-root of the number of observations.

For data that do not fit the Gaussian distribution well but is symmetrical, the Student's t-test can still be applied reasonably accurately. This observation also holds for heavily skewed data, provided that the sample size is around 50 or larger (McDonald, 2009, pp. 122-124).

The Student's t-statistic

$$t_s = \frac{\overline{x} - \mu_0}{s/\sqrt{n}}$$

where

$$\overline{x} = sample\ mean$$

$$\mu_0 = expected\ mean\ under\ the\ null - hypothesis$$

$$s = sample\ standard\ deviation$$

$$n = sample\ size$$

One-way ANOVA

The one-way ANOVA tests for the null hypothesis of equal means for groups of the same measurement variable. Its test statistic F is the variance of the group means divided by the average variance of each group's mean.

Under the null hypothesis, the F-statistic follows a known distribution whose shape is determined by two degrees of freedom. The first degree of freedom represents the numerator and is the number of groups (k) minus one, and the second degree of freedom represents the denominator and is the total number of observations (n) subtracted for the number of groups (k).

Although the test assumes a Gaussian distribution within each group, it is not particularly sensitive to this assumption as the probability for a Type I error[14] given $a = 0.05$ does not change significantly if the data were to be non-normal. Moreover, if the data design is balanced the test is not very sensitive to heteroscedasticity across the groups, however, if unbalanced, heteroscedasticity poses a more significant problem (McDonald, 2009, pp. 146-150; Newbold et al., 2012, p. 651).

In my computations of the F-statistics and its p-values I use the *aov()* function in the *stats* R-package. For the cases where the null hypothesis is rejected, a Tukey's HSD test is used to discern which groups are significantly different from each other.

The F-statistic

$$F_{k-1,n-k,a} = \frac{among - group\ variance}{within - group\ variance}$$

where

$$k = number\ of\ population\ groups$$

$$n = total\ sample\ size\ within\ each\ group$$

$$n = n_1 + n_2 +_{\dots} + n_k$$

Tukey's honest significant difference (HSD)

The Tukey's HSD test was developed for the testing of equal means across groups of equal sample sizes of the same measurement variable, but adjusting for the increased likelihood of

[14] The probability to incorrectly reject the null-hypothesis when it is true.

Type I errors when the number of pairwise comparisons increases above two. For n groups, there are $(n^2-n) / 2$ possible comparisons so that for a group of $n = 5$ the possible pairwise comparisons are 10. The test method used when there would be only two groups, and one possible comparison would be the Student's t-test for two-samples; the confidence intervals are somewhat wider for the Tukey's HSD, and the mathematical statistics is more advanced. The minimum significant difference (MSD) returned by the Tukey's HSD gives the minimum interval that is required for the means of a group to be significantly different (Crichton, 1999; Lovric, 2011, p. 888; McDonald, 2009, pp. 148-149).

In my computations of the MSD, I use the *TukeyHSD()* function in the *stats* R-package. Its arguments are explicitly tailored for the return values of the *aov()* function used in the one-way ANOVA analysis and automatically adjusts for mildly unbalanced sample sizes, so that returned intervals are sensible for those cases.

Sample selection

The sample selection is limited to the Swedish market as the PMB (Runsten, 1998) estimates were limited to the Swedish market. Furthermore, the market portfolio proxy is the OMX all-share gross index (OMXSGI) which began to be tracked from Dec. 30 – 2002. Thus, the sample data are limited to observations after Dec. 30 - 2002 and consists of four separately downloaded datasets spanning from Dec. 30 - 2002 to Feb. 28 - 2017:

- Annual fundamental data;
- Daily security prices and dividends data;
- Daily benchmark (market portfolio) prices and returns data;
- Daily risk-free rates data.

The annual fundamental data and the data for the daily security prices and dividends were downloaded from Standard & Poor's Compustat - Capital IQ database. Daily data for the market portfolio (OMXSGI) were downloaded from Nasdaq OMX Nordic's website. Lastly, daily yields for the risk-free rate; the 10-year Swedish government bond (SE GVB 10Y) were downloaded from the Swedish Central Bank's website.

For the daily security prices, Compustat provides an unadjusted closing price and the adjustment factor for splits and dividends.[15] When comparing the intrinsic value estimates by

[15] See Appendix Table T for a list of used Compustat variables and their descriptions.

the LIEV model to the share price at the time of portfolio formation, the unadjusted closing price is used; while yield computations use the adjusted closing price (unadjusted closing price divided by the adjustment factor). In the calculation of the covariance for Beta (β) estimates between the security and market portfolio returns, the adjusted closing prices are used for the security returns while the OMXSGI returns do not need adjustments.

For the annual (fundamental) financial statements data multiple competing datasets were detected for the same firm during select date-ranges. The competing datasets were compared, and that set which contained the most number of observations was selected as the "true" dataset. Similarly, competing datasets were found in the daily securities data with the same method being applied, that set of data containing the most number of observations was used.

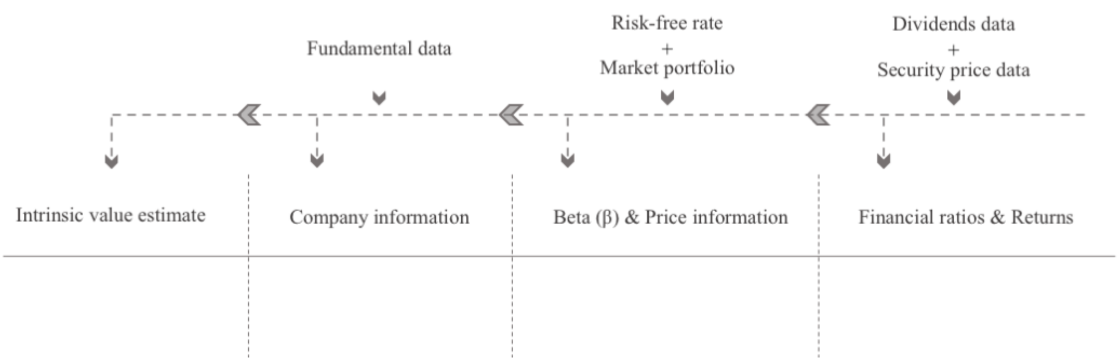
Table 3. Summary statistics of downloaded datasets

	Securities (count)	Observations (count)
Daily Security Price Data	1 079	1 652 018
Annual Fundamental Data	962	10 360
Dividends Data	642	5 412
Risk-free Rate	SE GVB 10Y	5 947
Market Portfolio	OMXSGI	3 693

Producing the intrinsic value estimate

Collectively the downloaded datasets (Table 3) produces an aggregated dataset that summarises each firm's intrinsic value estimate and other relevant information into one row for each firm-year, an illustration of their entirety is presented below.

Graph 3. [Illustration] - Simplified production workflow for the aggregated datasets



For the sake of completeness, the aggregated dataset includes a variable for the ratio between the intrinsic value estimate for each security (per share) and its market price at portfolio formation. This variable is henceforth referred to as the *intrinsic delta (= intrinsic value per share/market price per share)*.

Removing outlier samples

In the aggregated dataset of [C. L&S], clear infeasible outliers for the total yield were identified, as well as infeasible values for the Beta (β) estimates, B/M-ratio, cost of equity (r_e) and one single intrinsic delta value. The outlier samples were all removed from [C. L&S], as dropped observations (counted as firm-years) are translated into [C. L] in its formation from the final [C. L&S] dataset.[16]

Two cut-off points of twice the median absolute deviation (MAD) from the median classify the total yield observations into outliers for each year (Appendix Table U); the outlier samples are the extreme ones significantly skewing the mean and standard deviation (Std. Dev) values both in the full sample and for the individual years.

Table 4. Summary statistics of the aggregated dataset

	[C. L&S]	[C. L]
Performed Valuations[a]	5 397	1 360
Non-eligible[b]	2 577	-
Total Yield[c]		
Mean	0.002	0.16
Std. Dev	0.79	0.56
Median	0.04	0.11
MAD	0.40	0.38
Max	7.50	7.50
Min	-26.46	-0.97
Inter-Quartile Range	0.54	0.51
Eligible Valuations[d]	2 353	1 101

[a] Includes non-eligible observations (firm-years). Firms with a fiscal year-end other than December; November or October were considered non-eligible, and a valuation was not performed.

[b] Amount of firm-years where a valuation could not be performed, either due to insufficient historical data or imposed exclusion criteria for the fiscal year-end. The assessment for [C. L] is omitted as a valuation is always present due to its being a subset of [C. L&S].

[c] Descriptive statistics show for the total yield (includes the dividend yield) before filtering for outlier samples but after removing for non-eligible observations.

[d] Total number of valuations counted as firm-years that are present in the final (full sample) dataset after the removal of non-eligible observations and outlier samples.

[16] [C. L] correspond to the [C. L&S] filtered for short positions and with updated quintile levels for the market cap; P/E and B/M – ratios. Thus, any observation removed from [C. L&S] is also removed in [C. L].

As banks and insurance companies were not included in the sample of Runsten (1998), I likewise exclude these two industries which amount to 69 firm-years being dropped from the aggregated full sample dataset of [C. L&S]. Infeasible β – estimates correspond to the top 1 upper and lower percentiles of the β – estimates in [C. L&S], these 52 firm-years were also dropped. Likewise, infeasible estimates of r_e correspond to the upper and lower 2 percentiles of r_e estimates; these 102 firm-years were also dropped. Also, any firm-year with a negative B/M-ratio was dropped, amounting to 16 firm-years lost. Lastly, a single infeasible observation corresponding to the largest intrinsic delta value in [C. L&S] was dropped.

In total, the removed outlier samples amounted on average to 28 and 22 percent for each year in [C. L&S] and [C. L], respectively.[17] These numbers are primarily attributable to the yearly cut-off points of twice the MAD in either direction of the median for the definition of outliers. The intent of their purpose is not only the capture of extreme outliers but also those firms where the share price ascends or declines rapidly shortly after the portfolio formation. If not excluded, such rapid changes to the share price of a firm would inappropriate attribute to the LIEV model, given the linear expression for profitability and growth in the model.

Assumption of normality

The parametric tests used (Student's t-test, one-way ANOVA and Tukey's HSD) assume a Gaussian distribution for the test data, of which the formal tests of Kolmogorov-Smirnov and Shapiro-Wilk are run. However, for large test samples (as in this case) a small deviation from normality may be significant, and thus, a visual assessment of normality through normal Q-Q plots and density-histograms is also performed as a secondary assessment (Field, 2009, p. 148).

A conclusion drawn from these formal tests (Table 5) would be inconclusive and dual; the null hypothesis of normality is accepted by the Kolmogorov-Smirnov test in all test instances ($p < 0.025$), yet rejected in the Shapiro-Wilk tests ($p > 0.025$). In contrast, the visual tests follow a Gaussian distribution well when allowed for the light tail that is present in the abnormal returns and total yields (Graph 4 and 5).

Looking at the visual tests, I find it evident that the abnormal returns and total yields in [C. L&S] and [C. L] to be well approximated by a Gaussian distribution, both for the sample data and in expectation.

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[17] A table detailing the total number of dropped outlier samples for each year can be found in Appendix Table V.

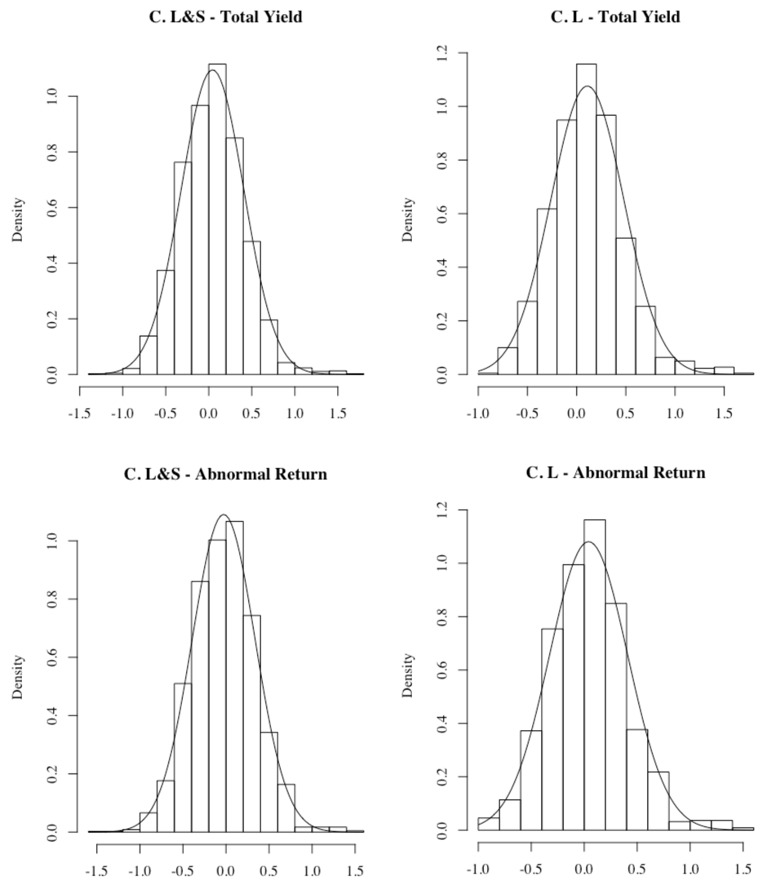
Table 5. [Full Sample] - Kolmogorov-Smirnov and Shapiro-Wilk tests for normality

	Kolmogorov-Smirnov		Shapiro-Wilk	
	statistic	p-value	statistic	p-value
Panel A: [C. L&S]				
Abnormal Return	0.013	0.8	~1	$< 1 \times 10^{-3}$
Total Yield	0.014	0.8*	0.99	$< 1 \times 10^{-3}$
Panel B: [C. L]				
Abnormal Return	0.033	0.2	0.99	$< 1 \times 10^{-3}$
Total Yield	0.034	0.2*	0.98	$< 1 \times 10^{-3}$

Comment: In the Kolmogorov-Smirnov tests the reference sample is a normal probability distribution, with a mean and standard deviation of the test samples being compared to.

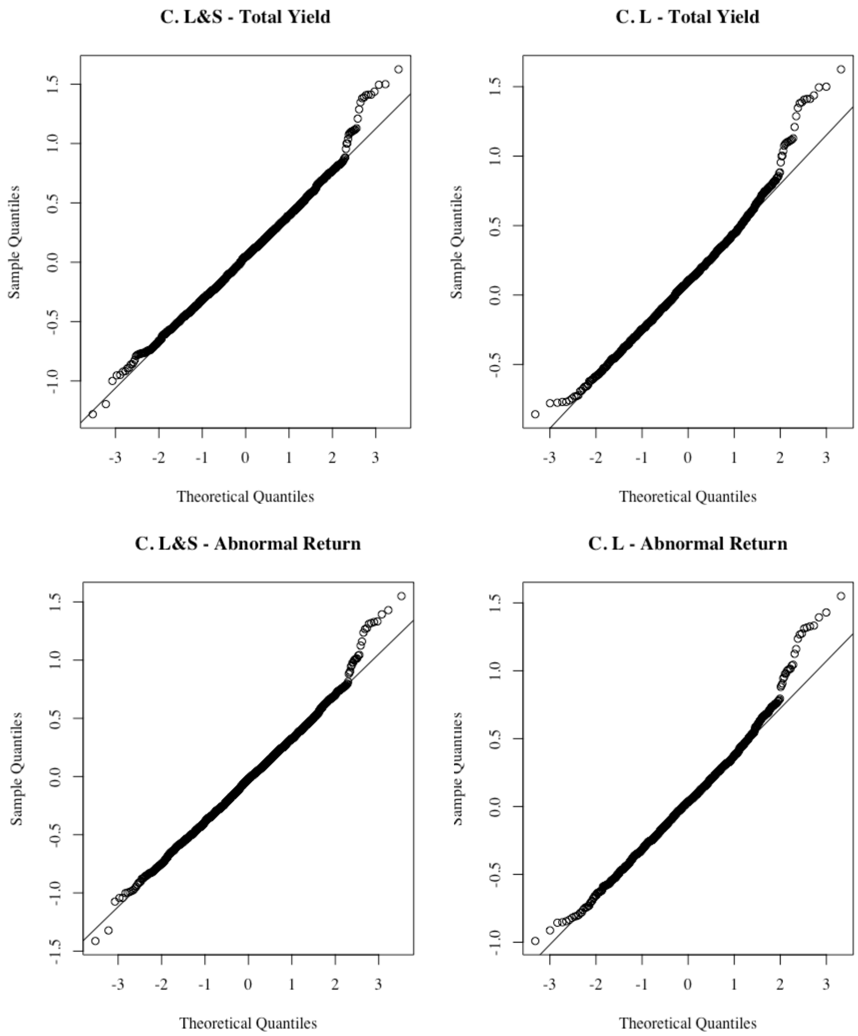
* due to ties between the two samples the p-value is an approximation.

Graph 4. [Full Sample] - Density-histogram graphs



Comment: A normal distribution with the same means and standard deviations as the test data are superimposed on each graph. The graphs all follow their Gaussian equivalent.

Graph 5. [Full Sample] - Normal Q-Q graphs



Comment: A straight line in each Q-Q graph represents the theoretical (normal) Q-Q graph when passed through the first and third quartiles of the data variable. The test data follows the theoretical lines well, except for a slight tail in the higher quartiles.

Homoscedasticity of grouping variables

Comment: A visual assessment of boxplots (not reported) for each of the grouping variables in hypothesis II (Are μ_{AR} equal controlling for market cap, industry, P/E and B/M – ratio?) reveals no cause to assume the standard deviations *not* to be equal across the grouping variables. I conclude that such a relationship is plausible to hold in future observations of the data.

Descriptive statistics

Table 6. [Full Sample] - Descriptive statistics for the selected variables

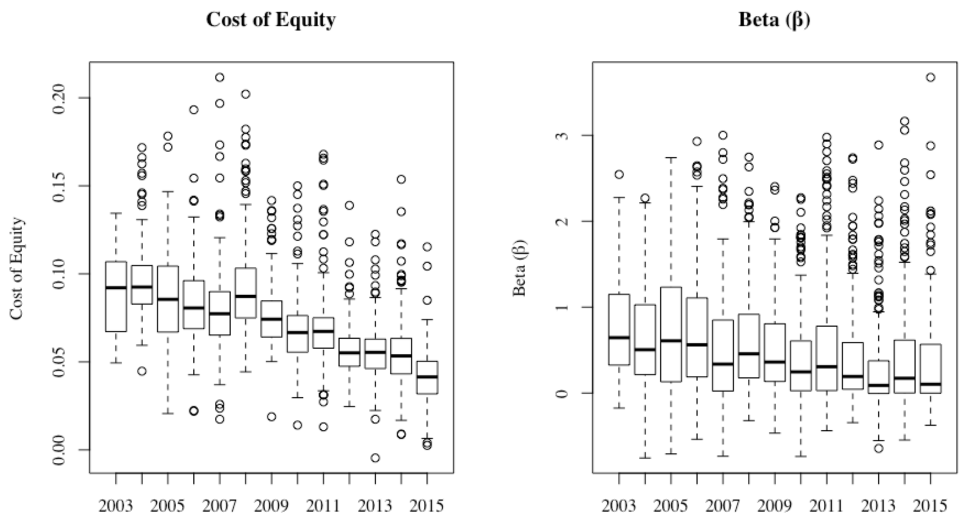
	N	Mean	Std. Dev	Min	Max	Range
Panel A: C. L&S						
Abnormal Profit	2 353	-0.03	0.37	-1.41	1.55	2.96
Total Yield	2 353	0.04	0.36	-1.28	1.62	2.91
ROE [a]	2 353	0.08	0.22	-0.80	0.98	1.78
Growth [a, b]	2 353	0.08	0.16	-0.58	0.84	1.43
Cost of Equity	2 353	0.07	0.03	-0.01	0.21	0.22
Panel B: C. L						
Abnormal Profit	1 101	0.04	0.37	-0.99	1.55	2.54
Total Yield	1 101	0.11	0.37	-0.86	1.62	2.48
ROE [a]	1 101	0.16	0.13	-0.35	0.98	1.34
Growth [a, b]	1 101	0.16	0.15	-0.38	0.84	1.23
Cost of Equity	1 101	0.07	0.03	-0.01	0.21	0.22

	10%	25%	Median	75%	90%
Panel C: C. L&S					
Abnormal Profit	-0.49	-0.28	-0.02	0.21	0.43
Total Yield	-0.42	-0.21	0.05	0.28	0.50
ROE [a]	-0.22	-0.01	0.12	0.20	0.30
Growth [a, b]	-0.09	0.00	0.07	0.17	0.29
Cost of Equity	0.04	0.05	0.07	0.09	0.11
Panel D: C. L					
Abnormal Profit	-0.42	-0.21	0.03	0.26	0.49
Total Yield	-0.35	-0.14	0.10	0.33	0.56
ROE [a]	0.02	0.09	0.15	0.23	0.33
Growth [a, b]	0.00	0.06	0.13	0.25	0.36
Cost of Equity	0.03	0.05	0.06	0.08	0.11

[a] Represents the value of the first explicit forecast year. i.e. the arithmetic means (with the replacement for missing values) of the past five years of available data.

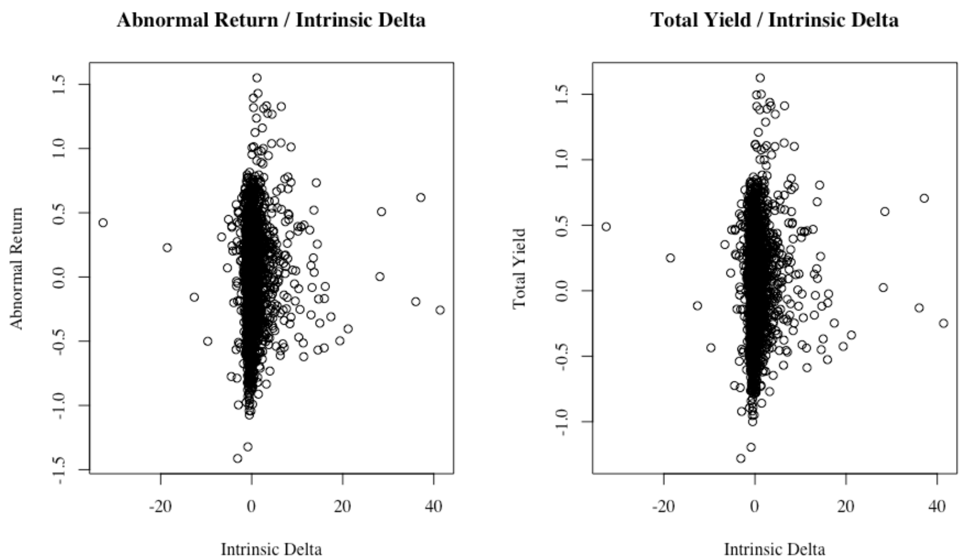
[b] Represents the equity growth that is assumed to be zero in steady-state (g_{ss}= 0 percent).

Graph 6. [Full Sample] - Boxplots of yearly cost of equity and Beta (β) – estimates



Comment: The median cost of equity estimate is trending downwards, which coincides with the declining rate of the risk-free asset over the years. Meanwhile, the Beta (β) – estimates are more uniform over the years.

Graph 7. [Full Sample] - Boxplots of return measurements divided by intrinsic delta



Comment: No apparent link between intrinsic delta values and the abnormal returns or total yield was found.

Can abnormal returns be achieved?

In the full sample period of 2003 to 2015, the μ_{AR} was statistically significant for being less than zero in [C. L&S] and greater than zero in [C. L] (one-sided t-test, $p < 0.025$) (Table 7). For the individual sample years, the μ_{AR} levels were almost exclusively significant for being less than zero in [C. L&S], whereas they were predominantly significant for being greater than zero in [C. L].

Out of the thirteen individual sample years (2003 to 2015) in [C. L&S], the μ_{AR} levels for five[18] years were *not* significantly different from zero (double-sided t-test, $p > 0.05$). Of the remaining eight years only one (2008) was significantly greater than zero (one-sided t-test, $p < 0.025$), with the remaining seven[19] years being significantly less than zero (one-sided t-test, $p < 0.025$). In an identical exploration of [C. L], eight[20] years were significantly greater than zero (one-sided t-test, $p < 0.025$); of the remaining five years: four[21] were significantly less than zero (one-sided t-test, $p < 0.025$) and one single year (2014) was not significantly different from zero (one-sided t-test, $p > 0.05$).

The cumulative μ_{AR} (CAAR) was consistently negative for [C. L&S] throughout the full sample period (Graph 8); excluding a brief respite during the 2008 and 2009 years, CAAR continued to trend downwards throughout the whole period. For the [C. L], the CAAR managed to close positive at 8.6 percent in the last sample year of 2015. Albeit a positive number, it is at a low level considering for the number of years present in the full sample.

Table 7. [Full Sample] - Student's t-tests

				p-value (null: $\mu_{AR} = 0$)		
	t	Df	μ_{AR}	two sided $\mu_{AR} \neq 0$	one sided $\mu_{AR} > 0$	one sided $\mu_{AR} < 0$
[C. L&S]	-3.6	2 352	-0.03	$< 1 \times 10^{-3}$	~1	$< 1 \times 10^{-3}$
[C. L]	3.7	1 100	0.04	$< 1 \times 10^{-3}$	$< 1 \times 10^{-3}$	~1

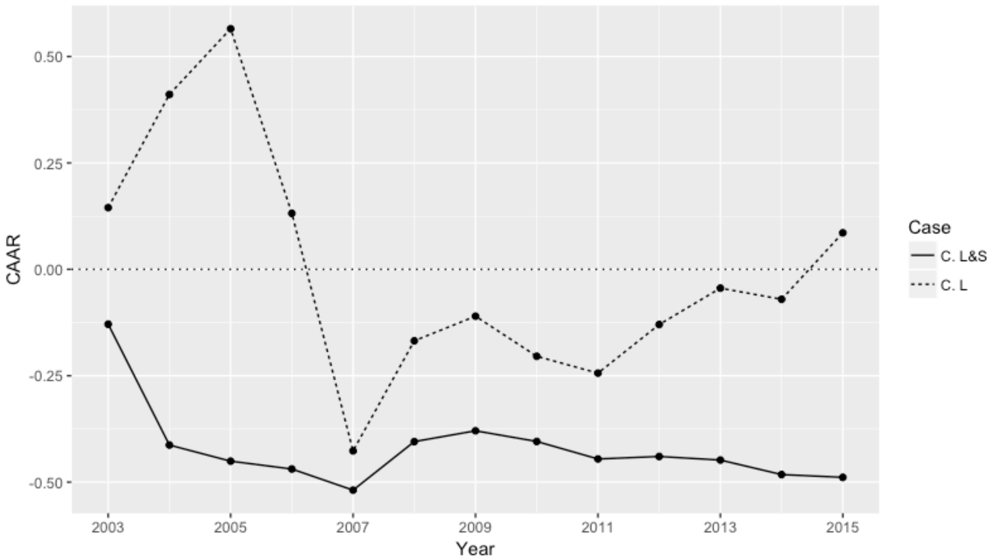
18 2006, 2009, 2012, 2013, 2015. See Appendix Table A.

19 2003, 2004, 2005, 2007, 2010, 2011, 2014. See Appendix Table C.

20 2003, 2004, 2005, 2008, 2009, 2012, 2013, 2015. See Appendix Table E.

21 2006, 2007, 2010, 2011. See Appendix Table F.

Graph 8. [Full Sample] – CAAR development of [C. L&S] and [C. L]



Comment: The CAAR for [C. L] in 2015 was positive at 8.6 percent. In contrast, the CAAR of [C. L&S] in 2015 was minus 49 percent, and trended consistently downwards excluding for a brief period in the years of 2008 and 2009.

Short selling was detrimental

Thus far, the analysis has established the negative effect of short sales in the detrimental performance of [C. L&S]. Because, if the identical statistical tests for [C. L] and [C. L&S] differ in their results, the disparity can only be attributed to the inclusion of short positions in [C. L&S], or lack thereof in [C. L] as the latter is a subset of the first. A further performance-analysis of *exclusively* the short sales of [C. L&S] in an attempt to discern their returns for the quintile groupings of market cap, P/E or B/M – ratio, further reveals the poor performance of the short sales.

For the short sales of the market cap quintile levels, the μ_{AR} levels were significantly less than zero in all quintile levels (one-sided t-test, $p < 0.025$) *except* for the 1'th (smallest) level. Similarly, for the quintile levels of the P/E and B/M – ratios; the only quintiles *not* being significantly less than zero (one-sided t-test, $p > 0.025$) were the 1'th and 2'th quintiles of the P/E - ratio, and the 4'th and 5'th quintiles of the B/M - ratio (Table 8).

Furthermore, the full sample CAAR for short sales was minus 81 percent in 2015 with a μ_{AR} of minus 8.8 percent; even the average total yield was negative at minus 1.4 percent for the full sample. Undoubtedly, the permitting of short sales in [C. L&S] was detrimental to both its abnormal returns and the total yield.

Table 8. [Selected Samples | C. L&S] - Student's t-test for short sales

Market cap	μ_{AR}	n	p-value (null: μ_{AR} = 0) two sided $\mu_{AR} \neq 0$	one sided $\mu_{AR} > 0$	one sided $\mu_{AR} < 0$
1	-0.02	312	0.44	0.78	0.22
2	-0.06	227	$< 1 \times 10^{-2}$	~1	$< 1 \times 10^{-2}$
3	-0.10	238	$< 1 \times 10^{-3}$	~1	$< 1 \times 10^{-3}$
4	-0.15	217	$< 1 \times 10^{-3}$	~1	$< 1 \times 10^{-3}$
5	-0.13	258	$< 1 \times 10^{-3}$	~1	$< 1 \times 10^{-3}$

P/E – ratio	μ_{AR}	n	p-value (null: μ_{AR} = 0) two sided $\mu_{AR} \neq 0$	one sided $\mu_{AR} > 0$	one sided $\mu_{AR} < 0$
1	-0.01	330	0.55	0.73	0.27
2	0.02	131	0.50	0.25	0.75
3	-0.11	209	$< 1 \times 10^{-3}$	~1	$< 1 \times 10^{-3}$
4	-0.17	274	$< 1 \times 10^{-3}$	~1	$< 1 \times 10^{-3}$
5	-0.13	305	$< 1 \times 10^{-3}$	~1	$< 1 \times 10^{-3}$

B/M – ratio	μ_{AR}	n	p-value (null: μ_{AR} = 0) two sided $\mu_{AR} \neq 0$	one sided $\mu_{AR} > 0$	one sided $\mu_{AR} < 0$
1	-0.07	434	$< 1 \times 10^{-3}$	~1	$< 1 \times 10^{-3}$
2	-0.13	358	$< 1 \times 10^{-3}$	~1	$< 1 \times 10^{-3}$
3	-0.10	262	$< 1 \times 10^{-3}$	~1	$< 1 \times 10^{-3}$
4	-0.02	120	0.65	0.67	0.33
5	-0.07	78	0.13	0.93	0.07

Comment: The majority of quintile levels were significant for being negative ($p < 0.025$), irrespective of the grouping variable. The left-most column represents the quintile levels of the variables. Column [n] represents the total number of observations.

A size effect or market anomaly?

A comparison of the cumulative μ_{AR} (CAAR) for the larger firms (5'th and 4'th market cap quintiles) of [C. L] to their smaller counterparts (1'th and 2'th quintiles), results in the diverge of the individual CAAR lines in displaying a close mirror image on opposite sides of the full sample line after 2007 (Graph 9). Evidently, larger firms outperformed their smaller counterparts by a wide margin after 2007.[22]

[22] A similar behaviour is not to be found in [C. L&S] (not reported).

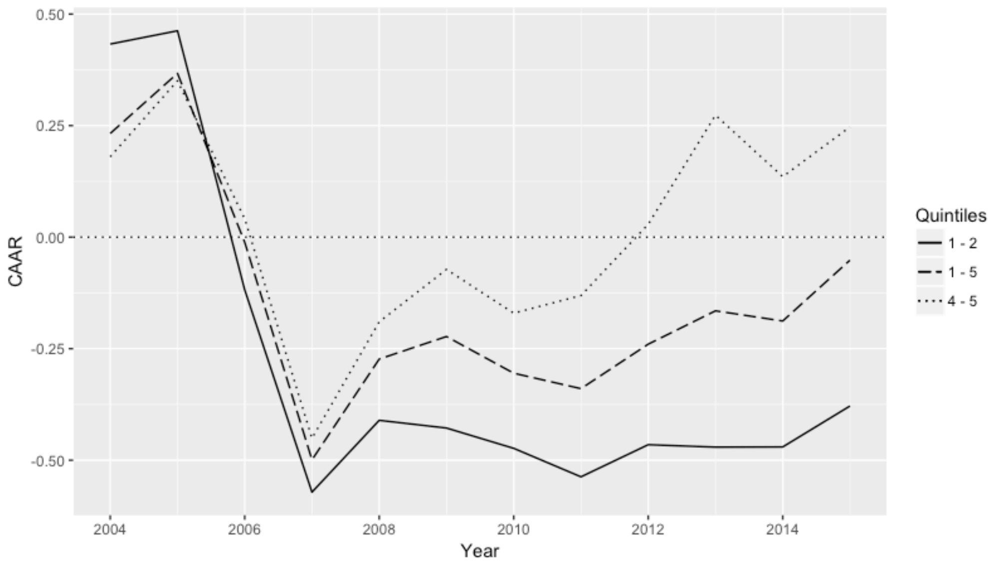
The average difference between the two CAARs of larger and smaller firms was 43.1 *percentage units* for the period of 2007 to 2015; the final CAAR in 2015 of larger firms was 24.7 percent. Over the full sample period, the μ_{AR} was 5.9 percent for larger firms, and the average total yield 12.6 percent. These return statistics are high. However, despite their significance for the plausibility of achieving positive abnormal returns by the LIEV model, they should be interpreted with precaution.

Table 9. [Selected Samples | C. L] - Descriptive statistics for larger firms

				Percentiles						
Variable	n	distinct	mean	0.05	0.10	0.25	0.50	0.75	0.90	0.95
μ_{AR}	440	440	0.06	-0.48	-0.34	-0.14	0.06	0.27	0.43	0.59
Total Yield	440	438	0.13	-0.41	-0.27	-0.07	0.13	0.34	0.50	0.66

Comment: The data represent the combined 5'th and 4'th market cap quintiles of [C. L]. Column [n] represents the total number of observations.

Graph 9. [Selected Samples | C. L] - CAAR development for "larger" and "smaller" firms



Comment: As the small number of observations for the 1'th and 2'th quintile levels in 2003 prevent an estimation of the μ_{AR}, the year 2003 is excluded. The CAAR for the full sample (quintile levels 1 - 5) of [C. L] was negative in 2015.

Conclusion of the first hypothesis (H_I: Can the LIEV model achieve abnormal returns?): the abnormal returns of the LIEV model were significantly positive (one-sample t-test, $p < 0.025$) for the full sample period and the majority of individual years. However, their certainty is weak in the face of design changes, and conditioned on the prohibition of short selling; the CAAR for [C. L] was 8.6 percent in 2015 and negative if the first sample year (2003) was excluded.

At face value, the results are supportive for the expectation of future abnormal returns to be positive, especially if short sales are prohibited, and only larger firms (5'th and 4'th market cap quintiles) were to be considered. Two reasons primarily speak against this notion:

First, the interpretation of these abnormal returns is subject to the bad-model errors that may be present in the choice of asset pricing model. Long-term return anomalies have been found to disappear with reasonable changes to the measurement method of cost of equity, or by using alternative statistical approaches in their measurement (Fama, 1998, p. 304). These changes to the measurement method need not be significant to affect the conclusion materially, considering that the CAAR for [C. L] was a modest 8.6 percent in 2015.

Second, for those larger firms in [C. L] where a positive abnormal return would be plausible in the expectations of future returns, the recent returns seem to stem from a time-specific anomaly after the year 2007 and may merely reflect the momentary under or over-reaction captured by the LIEV model (Graph 9). Such an oscillating behaviour around the baseline zero (CAAR = 0) would be consistent with market efficiency (Fama, 1998, p. 284).

Invariably, the above two considerations for the validity of observed abnormal returns to persist in expectation are interconnected and add another layer of insecurities to the results.

Are μ_{AR} equal controlling for market cap, industry, P/E and B/M – ratio?

In the full sample controlled for the μ_{AR} of quintile levels in [C. L&S] and [C. L], the industries as classified by Runsten (1998) were not significantly different from one another in both [C. L&S] and [C. L] (one-way ANOVA, $p > 0.025$).

Of the quintile levels for the market cap, P/E and B/M – ratios (Table 10 and 11), only the μ_{AR} levels of P/E and B/M – ratios were significantly different from one another in [C. L&S]; whereas in [C. L], none of the quintile groupings was significant (one-way ANOVA, $p > 0.025$). A stark contrast to the previously observed divergence in CAAR developments between the larger and smaller firms of [C. L] (Graph 9).

Following a one-way ANOVA, the Tukey's HSD test for the quintiles of the P/E and B/M – ratios in [C. L&S] reveals the pairwise comparisons[23] to be predominantly negative in their significance for the P/E - ratio, and predominantly positive for the B/M - ratio. In short, a higher

[23] Pairwise comparisons represent the value of a higher-order quintile level compared to a lower-order quintile level. For example, quintile level 5 against level 2.

quintile level of the P/E – ratio would, in general, correspond to a lower μ_{AR} level than if the quintile was of a lower rank. A reversed pattern applied for the B/M - ratio, a higher observed quintile level would suggest a higher level of μ_{AR}. Out of the five pairwise comparisons out of the ten possibilities that were significant in their μ_{AR} differences for the P/E – ratio, four were significantly negative, and one significantly positive (Tukey's HSD, $p < 0.025$). For the pairwise comparisons of B/M – ratio quintiles, all six significant differences were positive (Tukey's HSD, $p < 0.025$) (Appendix Tables G – I).

Table 10. [Full Sample | C. L&S] - One-way ANOVA for μ_{AR} levels

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Market cap	4	0.74	0.18	1.4	0.24
residuals	2348	313.95	0.13	-	-
P/E - ratio	4	6.88	1.72	13.1	$< 1 \times 10^{-3}$
residuals	2345	307.27	0.13	-	-
B/M - ratio	4	6.63	1.66	12.6	$< 1 \times 10^{-3}$
residuals	2348	308.05	0.13	-	-
Industry	12	2.5	0.21	1.6	0.09
residuals	2340	312.2	0.13	-	-

Table 11. [Full Sample | C. L] - One-way ANOVA for μ_{AR} levels

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Market cap	4	0.40	0.10	0.74	0.57
residuals	1096	149.44	0.14	-	-
P/E - ratio	4	1.09	0.27	2.01	0.09
residuals	1096	148.75	0.14	-	-
B/M - ratio	4	0.72	0.18	1.32	0.26
residuals	1096	149.12	0.14	-	-
Industry	12	2.8	0.23	1.7	0.05
residuals	1088	147.0	0.14	-	-

Conclusion of the second hypothesis (H_{II}: Are μ_{AR} equal controlling for market cap, industry, P/E and B/M – ratio?): despite the divergence in CAAR developments for the larger and smaller firms of [C. L], the individual market cap quintile levels were not statistically significant from one another in the analysis of the full sample. Neither were the μ_{AR} levels for quintiles of P/E and P/B – ratios in the full sample of [C. L] significantly different from one another. However, in the full sample of [C. L&S], the μ_{AR} levels were significantly different from one another in quintiles of the P/E and P/B – ratios (Table 10 and 11).

The increased variance in the return metrics from the inclusion of short sales in [C. L&S] is presumably the cause for this divergence of results between the [C. L] and [C. L&S], and not an inherent trait of observed μ_{AR} levels from the LIEV model. Again, [C. L] is merely [C. L&S] filtered for short sales and with updated quintile levels for the data.

The failure in rejecting the equality of means for the grouping variables in [C. L] would imply that observable μ_{AR} levels were independent of their market cap, P/E or B/M – ratio quintile level, as well as their industry belonging. In short, the observable μ_{AR} levels for long positions cannot be explained by industry, or by any of the quintile groupings, but stem from yet unidentified sets of variables.

Are the probabilities for a correct valuation state (γ_{success}) equal to 0.5?

The ratios of correctly predicted valuation states ($\gamma_{success}$) in the full samples were 55 and 61 percent for [C. L&S] and [C. L], respectively. In both cases, the probabilities for $\gamma_{success}$ were significantly greater than 50 percent (binomial test, $p < 0.025$), even when conditioned for the sign (positive or negative) of the benchmark (OMXSGI) returns for the year (Table 12).

Despite the probabilities for a correct valuation state ($\gamma_{success}$) being higher than for an incorrect prediction ($\gamma_{failure}$), their average gains were not enough to offset the average loss on a one-to-one basis (Table 13). However, when weighted for the probabilities of each outcome, respectively; the expected μ_{AR} levels correspond to their full sample mean and is minus 3 percent in [C. L&S] and positive 4 percent for [C. L].

Comparing the long and short positions of [C. L&S] in a full sample analysis, the μ_{AR} levels for the states of $\gamma_{success}$ and $\gamma_{failure}$ were significantly greater for long positions of $\gamma_{success}$ when compared to their short counterparts (two-sample t-test, $t = 5.0$, $p < 0.025$). Similarly, negative μ_{AR} levels (losses) for the incorrectly predicted valuation states ($\gamma_{failure}$) were significantly smaller for long positions than for their short equivalents (two-sample t-test, $t = 5$, $p < 0.025$).

The LIEV model showed a better capability for correctly assessing the valuation states of long positions over short sales, which is revealed in the statistics of $\gamma_{success}$ (Table 13) where the probabilities of a correct assessment were six *percentage units* higher in [C. L] than for [C. L&S]. Further reinforcing this notion, is an analysis of the significance for the $\gamma_{success}$ being greater than 0.5 (50 percent) when controlled for the quintile levels of the market cap, P/E and B/M – ratios. These probabilities were for [C. L] almost exclusively significant in all quintile levels for being greater than 0.5 (binomial test, $p < 0.025$), and although the same observation can be found for [C. L&S], it does not apply to the same degree (Appendix Tables M – R).

Table 12. [Full Sample] - Binomial test for $P(\gamma_{success}) = 0.5$

	x	n	μ	p-value (null: $P(\gamma_{success}) = 0.5$) two sided $P(\gamma_{success}) \neq 0.5$	one sided $P(\gamma_{success}) > 0.5$	one sided $P(\gamma_{success}) < 0.5$
[C. L&S]	1 285	2 353	0.55	$< 1 \times 10^{-3}$	$< 1 \times 10^{-3}$	~1
[C. L]	673	1 101	0.61	$< 1 \times 10^{-3}$	$< 1 \times 10^{-3}$	~1

Given positive OMXSGI year-end returns [a] | Binomial test for $P(\gamma_{success}) = 0.5$

	x	n	μ	p-value (null: $P(\gamma_{success}) = 0.5$) two sided $P(\gamma_{success}) \neq 0.5$	one sided $P(\gamma_{success}) > 0.5$	one sided $P(\gamma_{success}) < 0.5$
[C. L&S]	954	1 772	0.54	$< 1 \times 10^{-2}$	$< 1 \times 10^{-3}$	~1
[C. L]	483	797	0.61	$< 1 \times 10^{-2}$	$< 1 \times 10^{-3}$	~1

Given negative OMXSGI year-end returns [a] | Binomial test for $P(\gamma_{success}) = 0.5$

	x	n	μ	p-value (null: $P(\gamma_{success}) = 0.5$) two sided $P(\gamma_{success}) \neq 0.5$	one sided $P(\gamma_{success}) > 0.5$	one sided $P(\gamma_{success}) < 0.5$
[C. L&S]	331	581	0.57	$< 1 \times 10^{-3}$	$< 1 \times 10^{-3}$	~1
[C. L]	190	304	0.63	$< 1 \times 10^{-3}$	$< 1 \times 10^{-3}$	~1

Comment: The probabilities for $\gamma_{success}$ were significantly greater than 50 percent in both [C. L&S] and [C. L], irrespective of the sign for the yearly OMXSGI return ($p < 0.025$). Column [x] represents the number of successful observations, column [n] the total number of observations and column [μ] the sample mean.

[a] The yearly returns of the OMXSGI benchmark represent the geometric year-on-year (YoY) return starting from the last trading day in February. YoY return periods are thus matched for [C. L&S], [C. L] and the OMXSGI.

Table 13. [Full sample] - Probabilities of valuation states and their μ_{AR} levels

	[C. L&S] $\gamma_{success}$	[C. L&S] $\gamma_{failure}$	[C. L] $\gamma_{success}$	[C. L] $\gamma_{failure}$
μ_{AR}	0.24	-0.34	0.26	-0.31
P	0.55	0.45	0.61	0.39
$E(\mu_{AR})$	-0.03		0.04	

Comment: The expected values (E) of μ_{AR} reflect the descriptive statistics found on page 39.

Conclusion of the third hypothesis (H_{III}: Are the probabilities for a correct valuation state (γ_{success}) equal to 0.5?): the probabilities for a correct prediction of the valuation state ($\gamma_{success}$) were significantly greater than 0.5 (50 percent) in both [C. L&S] and [C. L], irrespective of whether short sales were permitted or not, and remain statistically significant regardless of the sign of the same annual returns of the benchmark index.

Reflecting on these results and the results when controlling for the quintile levels of market cap, P/E or B/M - ratio, the LIEV model seems to be a good estimator in the assessment of whether a security is over or under-valued given a 12 months forward-looking period. Its strength lies not merely in its significant probabilities for γ_{success}, but these results were stable irrespective of the inclusion of short sales, sign of the benchmark index returns, and for almost all quintile levels of market cap, P/E or P/B – ratio (the last property applies especially to [C. L]).

I find it plausible from these observations that such overwhelming support for the feasibility of the model's prediction capabilities should indicate an inherent ability in capturing short-term mispricings of the markets. The mechanisms and source of this ability, however, is yet to be identified.

The LIEV model proposed in this paper aims to provide an explicit link between the forecasts of future residual income levels and the financial statements of a firm, while appropriately considering changes in economic rents as the forecast progresses. It is an exploration of a valuation model that in addition to incorporating the linear-information dynamic as conceptually introduced by Ohlson (1995), and Feltham and Ohlson (1995), is parsimonious, and derives its forecasts upon empirical assessments of reasonable long-term profit levels through the PMB (Runsten, 1998) estimates.

I have focused on the exploration of two issues: first, the assessment of whether such a model can achieve abnormal returns (hypothesis I and II); second, to what degree such a model correctly predicts the subsequent stock movements of valued securities after the 12 months holding period (hypothesis III).

Summarising the findings, the μ_{AR} levels in [C. L] were significantly greater than zero for the full sample and the majority of individual years (one-sided t-test, $p < 0.025$). Industry (as defined by Runsten) levels of μ_{AR} were in a full sample analysis found to be not significantly different from one another; these results were stable when controlled for the quintile levels of market cap, P/E and B/M – ratios (one-way ANOVA, $p < 0.025$). Astoundingly, the probabilities for correctly predicting the valuation states ($\gamma_{success}$) were significantly higher than 50 percent in the same sample and remained significant for nearly all levels when controlled for the quintile levels of market cap, P/E and B/M – ratio (binomial test, $p < 0.025$). These results of “independent” abnormal returns and strong predictive capabilities, were even found to be stable in the subset of larger firms (5’th and 4’th market cap quintiles) of [C. L] (not reported).

In an equivalent analysis of [C. L] but with unrestricted short selling; the μ_{AR} levels in [C. L&S] for the full sample and absolute majority of individual years, was significantly less than zero (one-sided t-test, $p < 0.025$). However, the predictive capabilities as observed in [C. L] remained, albeit to a lesser degree; but was still significantly higher than 50 percent for both the full sample and in the majority of levels, when controlled for the quintile levels of market cap, P/E and B/M – ratio (binomial test, $p < 0.025$).

The overwhelming support for the “independence” and predictive capabilities of the model (if short sales are not permitted) constitutes a support for the model’s inherent ability to capture short-term mispricings in the market. The particular nature of these potential mispricings remains to be determined. Facing changes in the cost of capital, the CAAR of [C. L] does not conclusively support that the observed return levels do not merely reflect the expected cost of capital. The high abnormal return levels observed in the larger firms of [C. L] are in turn susceptible to estimation errors in the cost of capital in addition to a size-based return premium specific to the time period after 2007; further work is warranted in determining the specific nature of the observed abnormal return levels in this paper.

In summary, the utilisation of the PMB (Runsten, 1998) estimates in the context of the specified LIEV model produce good assessments of security mispricings in a 12 months forward-looking period. The abnormal returns under such a model that restricts short selling are independent of the industry, market cap, and P/E or B/M – ratio of the firm, and whereas their abnormal return levels were positive, they were however not sufficiently robust under the conditions examined.

Further research would include the re-estimation of the PMB estimates to modern conditions of the inflation rate, tax rate and accounting regimes, as these would have changed since the first estimation by Runsten in 1998; the observed abnormal return levels may be different under more “modern” PMB estimates. Furthermore, the nature of observed “independence” in abnormal return levels, and the high predictive capabilities for the LIEV model warrants additional study along with the reproduction of abnormal returns when changes to the estimation method for the cost of capital is made.

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note) Confidence intervals in appendix tables represent the 95 percent confidence level

P-values of [0.00] in appendix tables represent a p-value < 1 × 10^{-2}

Student's t-test

Appendix Table A. [Yearly] – Student's t-test for μ_{AR} in [C. L&S] being greater/less than zero

	t	Df	μ	null value	conf.int.lower	conf.int.higher	p.value
2003	-2.89	26	-0.13	0	-0.22	-0.04	0.01
2004	-8.41	115	-0.33	0	-0.40	-0.25	0.00
2005	-2.33	139	-0.06	0	-0.12	-0.01	0.02
2006	-1.39	156	-0.03	0	-0.08	0.01	0.17
2007	-2.51	166	-0.09	0	-0.17	-0.02	0.01
2008	5.46	171	0.24	0	0.15	0.32	0.00
2009	1.93	191	0.04	0	0.00	0.09	0.06
2010	-2.36	202	-0.04	0	-0.07	-0.01	0.02
2011	-4.04	217	-0.07	0	-0.10	-0.04	0.00
2012	0.47	239	0.01	0	-0.03	0.05	0.64
2013	-0.67	237	-0.02	0	-0.06	0.03	0.51
2014	-3.71	240	-0.06	0	-0.09	-0.03	0.00
2015	-0.58	241	-0.01	0	-0.06	0.03	0.56

Appendix Table B. [Yearly] – Student's t-test for μ_{AR} in [C. L&S] being greater than zero

	t	Df	μ	null value	conf.int.lower	conf.int.higher	p.value
2003	-2.89	26	-0.13	0	-0.21	Inf	1.00
2004	-8.41	115	-0.33	0	-0.39	Inf	1.00
2005	-2.33	139	-0.06	0	-0.11	Inf	0.99
2006	-1.39	156	-0.03	0	-0.07	Inf	0.92
2007	-2.51	166	-0.09	0	-0.16	Inf	0.99
2008	5.46	171	0.24	0	0.17	Inf	0.00
2009	1.93	191	0.04	0	0.01	Inf	0.03
2010	-2.36	202	-0.04	0	-0.07	Inf	0.99
2011	-4.04	217	-0.07	0	-0.10	Inf	1.00
2012	0.47	239	0.01	0	-0.03	Inf	0.32
2013	-0.67	237	-0.02	0	-0.05	Inf	0.75
2014	-3.71	240	-0.06	0	-0.09	Inf	1.00
2015	-0.58	241	-0.01	0	-0.05	Inf	0.72

Appendix Table C. [Yearly] – Student's t-test for μ_{AR} in [C. L&S] being less than zero

	t	Df	μ	null value	conf.int.lower	conf.int.higher	p.value
2003	-2.89	26	-0.13	0	-Inf	-0.05	0.00
2004	-8.41	115	-0.33	0	-Inf	-0.26	0.00
2005	-2.33	139	-0.06	0	-Inf	-0.02	0.01

2006	-1.39	156	-0.03	0	-Inf	0.01	0.08
2007	-2.51	166	-0.09	0	-Inf	-0.03	0.01
2008	5.46	171	0.24	0	-Inf	0.31	1.00
2009	1.93	191	0.04	0	-Inf	0.08	0.97
2010	-2.36	202	-0.04	0	-Inf	-0.01	0.01
2011	-4.04	217	-0.07	0	-Inf	-0.04	0.00
2012	0.47	239	0.01	0	-Inf	0.05	0.68
2013	-0.67	237	-0.02	0	-Inf	0.02	0.25
2014	-3.71	240	-0.06	0	-Inf	-0.03	0.00
2015	-0.58	241	-0.01	0	-Inf	0.02	0.28

Appendix Table D. [Yearly] – Student's t-test for μ_{AR} in [C. L] being greater/less than zero

	t	Df	μ	null value	conf.int.lower	conf.int.higher	p.value
2003	2.7	6	0.14	0	0.01	0.28	0.04
2004	5.0	22	0.23	0	0.14	0.33	0.00
2005	2.4	38	0.11	0	0.02	0.20	0.02
2006	-7.2	47	-0.28	0	-0.35	-0.20	0.00
2007	-18.2	81	-0.49	0	-0.55	-0.44	0.00
2008	11.1	125	0.45	0	0.37	0.53	0.00
2009	2.8	125	0.07	0	0.02	0.12	0.01
2010	-5.4	112	-0.11	0	-0.14	-0.07	0.00
2011	-2.3	121	-0.05	0	-0.09	-0.01	0.02
2012	5.7	126	0.15	0	0.10	0.20	0.00
2013	3.3	89	0.10	0	0.04	0.16	0.00
2014	-1.1	101	-0.03	0	-0.08	0.02	0.27
2015	5.8	95	0.17	0	0.11	0.23	0.00

Appendix Table E. [Yearly] – Student's t-test for μ_{AR} in [C. L] being greater than zero

	t	Df	μ	null value	conf.int.lower	conf.int.higher	p.value
2003	2.7	6	0.14	0	0.04	Inf	0.02
2004	5.0	22	0.23	0	0.15	Inf	0.00
2005	2.4	38	0.11	0	0.03	Inf	0.01
2006	-7.2	47	-0.28	0	-0.34	Inf	1.00
2007	-18.2	81	-0.49	0	-0.54	Inf	1.00
2008	11.1	125	0.45	0	0.38	Inf	0.00
2009	2.8	125	0.07	0	0.03	Inf	0.00
2010	-5.4	112	-0.11	0	-0.14	Inf	1.00
2011	-2.3	121	-0.05	0	-0.09	Inf	0.99
2012	5.7	126	0.15	0	0.11	Inf	0.00
2013	3.3	89	0.10	0	0.05	Inf	0.00
2014	-1.1	101	-0.03	0	-0.07	Inf	0.87
2015	5.8	95	0.17	0	0.12	Inf	0.00

Appendix Table F. [Yearly] – Student's t-test for μ_{AR} in [C. L] being less than zero

	t	Df	μ	null value	conf.int.lower	conf.int.higher	p.value
2003	2.7	6	0.14	0	-Inf	0.25	0.98
2004	5.0	22	0.23	0	-Inf	0.31	1.00
2005	2.4	38	0.11	0	-Inf	0.19	0.99
2006	-7.2	47	-0.28	0	-Inf	-0.21	0.00
2007	-18.2	81	-0.49	0	-Inf	-0.45	0.00
2008	11.1	125	0.45	0	-Inf	0.52	1.00
2009	2.8	125	0.07	0	-Inf	0.11	1.00
2010	-5.4	112	-0.11	0	-Inf	-0.07	0.00
2011	-2.3	121	-0.05	0	-Inf	-0.01	0.01
2012	5.7	126	0.15	0	-Inf	0.19	1.00
2013	3.3	89	0.10	0	-Inf	0.15	1.00
2014	-1.1	101	-0.03	0	-Inf	0.01	0.13
2015	5.8	95	0.17	0	-Inf	0.22	1.00

Tukey's HSD test

Appendix Table G. [Full Sample | C. L&S] – Tukey's HSD test for market cap quintiles

Quintiles	diff (μ_{AR})	lwr	upr	p adj	p.value < 0.025
2-1	-0.03	-0.09	0.04	0.76	-
3-1	-0.04	-0.10	0.03	0.53	-
4-1	-0.03	-0.09	0.04	0.77	-
5-1	-0.05	-0.12	0.01	0.15	-
3-2	-0.01	-0.07	0.06	1.00	-
4-2	0.00	-0.06	0.07	1.00	-
5-2	-0.03	-0.09	0.04	0.80	-
4-3	0.01	-0.06	0.07	1.00	-
5-3	-0.02	-0.08	0.05	0.95	-
5-4	-0.03	-0.09	0.04	0.79	-

Appendix Table H. [Full Sample | C. L&S] – Tukey's HSD test for P/E-ratio quintiles

Quintiles	diff (μ_{AR})	lwr	upr	p adj	p.value < 0.025
2-1	0.08	0.01	0.14	0.01	Yes
3-1	-0.01	-0.08	0.05	0.98	-
4-1	-0.08	-0.14	-0.01	0.01	Yes
5-1	-0.06	-0.12	0.00	0.08	-
3-2	-0.09	-0.15	-0.03	0.00	Yes
4-2	-0.15	-0.22	-0.09	0.00	Yes
5-2	-0.14	-0.20	-0.07	0.00	Yes
4-3	-0.06	-0.13	0.00	0.05	-
5-3	-0.05	-0.11	0.02	0.27	-
5-4	0.02	-0.05	0.08	0.95	-

Appendix Table I. [Full Sample | C. L&S] – Tukey's HSD test for B/M-ratio quintiles

Quintiles	diff (μ_{AR})	lwr	upr	p adj	p.value < 0.025
2-1	-0.02	-0.08	0.05	0.96	-
3-1	0.02	-0.04	0.09	0.86	-
4-1	0.11	0.05	0.17	0.00	Yes
5-1	0.11	0.04	0.17	0.00	Yes
3-2	0.04	-0.03	0.10	0.47	-
4-2	0.13	0.06	0.19	0.00	Yes
5-2	0.12	0.06	0.19	0.00	Yes
4-3	0.09	0.02	0.15	0.00	Yes
5-3	0.08	0.02	0.15	0.00	Yes
5-4	0.00	-0.07	0.06	1.00	-

Appendix Table J. [Full Sample | C. L] – Tukey's HSD test for market cap quintiles

Quintiles	diff (μ_{AR})	lwr	upr	p adj	p.value < 0.025
2-1	0.01	-0.09	0.10	1.00	-
3-1	0.03	-0.07	0.13	0.92	-
4-1	0.05	-0.04	0.15	0.53	-
5-1	0.03	-0.07	0.12	0.93	-
3-2	0.02	-0.07	0.12	0.97	-
4-2	0.05	-0.05	0.14	0.67	-
5-2	0.02	-0.08	0.12	0.98	-
4-3	0.03	-0.07	0.12	0.95	-
5-3	0.00	-0.10	0.09	1.00	-
5-4	-0.03	-0.12	0.07	0.94	-

Appendix Table K. [Full Sample | C. L] – Tukey's HSD test for P/E-ratio quintiles

Quintiles	diff (μ_{AR})	lwr	upr	p adj	p.value < 0.025
2-1	0.09	0.00	0.19	0.07	-
3-1	0.04	-0.06	0.13	0.82	-
4-1	0.03	-0.07	0.12	0.94	-
5-1	0.01	-0.08	0.11	1.00	-
3-2	-0.05	-0.15	0.04	0.55	-
4-2	-0.06	-0.16	0.03	0.35	-
5-2	-0.08	-0.17	0.02	0.17	-
4-3	-0.01	-0.11	0.08	1.00	-
5-3	-0.02	-0.12	0.07	0.96	-
5-4	-0.01	-0.11	0.08	1.00	-

Appendix Table L. [Full Sample | C. L] – Tukey's HSD test for B/M-ratio quintiles

Quintiles	diff (μ_{AR})	lwr	upr	p adj	p.value < 0.025
2-1	0.05	-0.05	0.14	0.70	-
3-1	0.01	-0.09	0.10	1.00	-
4-1	0.02	-0.08	0.12	0.98	-
5-1	0.07	-0.03	0.17	0.28	-
3-2	-0.04	-0.13	0.06	0.82	-
4-2	-0.02	-0.12	0.07	0.96	-
5-2	0.02	-0.07	0.12	0.96	-
4-3	0.01	-0.08	0.11	1.00	-
5-3	0.06	-0.03	0.16	0.39	-
5-4	0.05	-0.05	0.14	0.64	-

Binomial test

Appendix Table M. [Full Sample | C. L&S] - Binomial test for market cap quintiles

Quintiles	x	n	μ	test	null value	conf.int.lower	conf.int.higher	p.value
1	274	471	0.58	greater	0.5	0.54	1	0.00
2	254	470	0.54	greater	0.5	0.50	1	0.04
3	254	471	0.54	greater	0.5	0.50	1	0.05
4	257	470	0.55	greater	0.5	0.51	1	0.02
5	246	471	0.52	greater	0.5	0.48	1	0.18

Appendix Table N. [Full Sample | C. L&S] - Binomial test for P/E – ratio quintiles

Quintiles	x	n	μ	test	null value	conf.int.lower	conf.int.higher	p.value
1	260	470	0.55	greater	0.5	0.51	1	0.01
2	298	470	0.63	greater	0.5	0.60	1	0.00
3	267	470	0.57	greater	0.5	0.53	1	0.00
4	221	470	0.47	greater	0.5	0.43	1	0.91
5	237	470	0.50	greater	0.5	0.47	1	0.44

Appendix Table O. [Full Sample | C. L&S] - Binomial test for B/M – ratio quintiles

Quintiles	x	n	μ	test	null value	conf.int.lower	conf.int.higher	p.value
1	239	471	0.51	greater	0.5	0.47	1	0.39
2	224	470	0.48	greater	0.5	0.44	1	0.86
3	250	471	0.53	greater	0.5	0.49	1	0.10
4	298	470	0.63	greater	0.5	0.60	1	0.00
5	274	471	0.58	greater	0.5	0.54	1	0.00

Appendix Table P. [Full Sample | C. L] - Binomial test for market cap quintiles

Quintiles	x	n	μ	test	null value	conf.int.lower	conf.int.higher	p.value
1	120	220	0.55	greater	0.5	0.49	1	0.10
2	127	220	0.58	greater	0.5	0.52	1	0.01
3	132	221	0.60	greater	0.5	0.54	1	0.00
4	150	219	0.68	greater	0.5	0.63	1	0.00
5	144	221	0.65	greater	0.5	0.60	1	0.00

Appendix Table Q. [Full Sample | C. L] - Binomial test for P/E – ratio quintiles

Quintiles	x	n	μ	test	null value	conf.int.lower	conf.int.higher	p.value
1	123	220	0.56	greater	0.5	0.50	1	0.05
2	141	220	0.64	greater	0.5	0.58	1	0.00
3	138	221	0.62	greater	0.5	0.57	1	0.00
4	142	219	0.65	greater	0.5	0.59	1	0.00
5	129	221	0.58	greater	0.5	0.53	1	0.01

Appendix Table R. [Full Sample | C. L] - Binomial test for B/M – ratio quintiles

Quintiles	x	n	μ	test	null value	conf.int.lower	conf.int.higher	p.value
1	134	220	0.61	greater	0.5	0.55	1	0.00
2	138	220	0.63	greater	0.5	0.57	1	0.00
3	131	220	0.60	greater	0.5	0.54	1	0.00
4	140	220	0.64	greater	0.5	0.58	1	0.00
5	130	221	0.59	greater	0.5	0.53	1	0.01

Appendix Table S. [Yearly] - Ratio of correct valuation state predictions

	Case L&S	Case L
2003	0.48	1.00
2004	0.28	0.91
2005	0.55	0.79
2006	0.56	0.12
2007	0.51	0.06
2008	0.70	0.87
2009	0.67	0.70
2010	0.54	0.41
2011	0.51	0.55
2012	0.58	0.76
2013	0.55	0.70
2014	0.51	0.57
2015	0.52	0.79
Mean	0.54	0.63

Compustat table description

Appendix Table T. Descriptions of used Compustat variables

	Compustat variable	Description
1	consol	Consolidation Level
2	curcd	ISO Currency Code
3	fyr	Fiscal Year End
4	ceq	Common/Ordinary Equity
5	dvc	Dividends Common/Ordinary
6	sale	Sales/Turnover (Net)
7	exchg	Stock Exchange Code
8	isin	Isin Code Identifier
9	cshoi	Common Shares Outstanding
10	cshpria	Common Shares Used To Calculate Earnings Per Share
11	epsexcon	Earnings Per Share (Basic) - Excluding Extraordinary Items - Consolidated
12	nicon	Net Income (Loss) - Consolidated
13	conm	Firm Name
14	costat	Company Status
15	fic	Country Code
16	gsector	GIC Sectors code
17	gsubind	GIC Sub-Industries code

Sample selection

Appendix Table U. [Yearly] - cut-off limits for the total yield

Year	median	mad	upper – 2 x mad	lower – 2 x mad	n
2003	0.03	0.29	0.60	-0.54	278
2004	-0.26	0.51	0.77	-1.29	294
2005	0.03	0.37	0.78	-0.72	308
2006	0.05	0.36	0.77	-0.68	313
2007	-0.02	0.65	1.27	-1.31	332
2008	0.33	0.67	1.67	-1.00	354
2009	0.14	0.36	0.86	-0.57	398
2010	0.05	0.28	0.62	-0.51	428
2011	0.01	0.29	0.59	-0.58	444
2012	0.05	0.40	0.86	-0.75	446
2013	0.04	0.40	0.85	-0.77	454
2014	0.01	0.31	0.63	-0.61	464
2015	0.03	0.40	0.82	-0.77	487

Comment: The [upper - 2 x mad] represents the upper cut-off point, and the [lower - 2 x mad] the lower cut-off point. Column [n] represents the number of observations.

Appendix Table V. [Yearly] - Outlier samples (firm-years) removed from the aggregated datasets

	[C. L&S]			[C. L]		
	Removed (percent)	Removed (count)	Remaining (count)	Removed (percent)	Removed (count)	Remaining (count)
2003	0.44	21	27	0.50	7	7
2004	0.24	37	116	0.36	13	23
2005	0.27	53	140	0.24	12	39
2006	0.28	60	157	0.16	9	48
2007	0.28	65	167	0.12	11	82
2008	0.30	73	172	0.17	26	126
2009	0.25	65	192	0.12	18	126
2010	0.28	77	203	0.19	27	113
2011	0.26	77	218	0.18	27	122
2012	0.22	69	240	0.15	22	127
2013	0.27	89	238	0.24	29	90
2014	0.26	86	241	0.20	26	102
2015	0.28	92	242	0.25	32	96
Mean:	0.28	66.5	181.0	0.22	19.9	84.7

Comment: The number of removed observations (firm-years) are higher in [C. L&S] than [C. L] due to the latter being a subset of the first dataset.

Appendix Table W. Matched GICS sector codes to the Runsten (1998) industries

Industry	Total PMB	GICS Industry Codes								
Pharmaceutical	1.74	352010	352020	352030						
Capital-intensive service	0.76	203050	551010	551020	551030	551040	551050			
Consumer goods	0.72	252020	252030	302010	302030	303010	303020			
Investment companies	0.68	401010	401020							
Pulp and paper	0.67	151050								
Shipping	0.65	203030								
Other service	0.62	101010	202010	203010	203020	203040	253010	253020	254010	
… Other service	0.62	351020	351030	402020	402030	403010	402040	451010	501010	501020
Consultants & computer	0.59	202020	402010	451020	451030					
Real estate	0.56	601010	601020							
Mixed build. And real est.	0.55									
Trading and retail	0.47	201070	255010	255020	255030	255040	301010			
Chemical industry	0.44	151010								
Building and construction	0.38									
Engineering	0.33	201010	201030							
Other production	0.31	101020	151020	151030	151040	201020	201040	201060	251010	251020
… Other production	0.31	252010	302020	351010	452010	452020	452030	452040	452050	453010
Conglom. & mix. Inv	0.28	201050								

Comment: Data with GICS sector codes of 401010 (Banks) and 403010 (Insurance) were excluded in the final datasets of [C. L&S] and [C. L].

PwC risk-premiums

Appendix Table X. Market cap based risk-premium additions

Bracket	Rate (percent)	Market cap (MSEK)	Bracket	Rate (percent)	Market cap (MSEK)
0	0.00	8 000	27	2.10	950
1	0.06	7 700	28	2.22	800
2	0.12	7 400	29	2.33	650
3	0.19	7 100	30	2.45	500
4	0.25	6 800	31	2.58	460
5	0.32	6 500	32	2.71	420
6	0.38	6 200	33	2.83	380
7	0.45	5 900	34	2.96	340
8	0.51	5 600	35	3.09	300
9	0.58	5 300	36	3.22	260
10	0.64	5 000	37	3.35	220
11	0.71	4 700	38	3.47	180
12	0.77	4 400	39	3.60	140
13	0.84	4 100	40	3.73	100
14	0.90	3 800	41	3.86	90
15	0.97	3 500	42	3.98	80
16	1.03	3 200	43	4.11	70
17	1.10	2 900	44	4.24	60
18	1.16	2 600	45	4.37	50
19	1.23	2 300	46	4.50	40
20	1.29	2 000	47	4.62	30
21	1.41	1 850	48	4.75	20
22	1.52	1 700	49	4.88	10
23	1.64	1 550	50	5.01	0
24	1.76	1 400			
25	1.87	1 250			
26	1.99	1 100			

Comment: The rate of market cap based risk-premium additions is always rounded upwards to the nearest bracket. Under this schema, a market cap of 52 million Swedish Krona (MSEK) corresponds to a 4.24 percent (Bracket nr. 44) in added risk-premium. Firms with a market cap above 7 700 MSEK receive no risk-premium addition.