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X-CAPM REVISITED: THE INSTITUTIONAL EXTRAPOLATIVE CAPITAL ASSET PRICING MODEL (I-X-CAPM)

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Abstract

This study constructs and tests a consumption-based asset pricing model in which some investors form beliefs about future price changes in the stock market by extrapolating past price changes, while other investors hold fully rational beliefs. The contribution of the present work is the inclusion of institutional investor bias. As such it extends theory. But it also conducts econometric tests by using daily survey data on individual and institutional investors' sentiment on the current economic situation and their future expectations. Empirical findings may imply that institutions' sentiment reverts quicker to the equilibrium price than individual sentiment, at least with regard to their beliefs on future economic outlook. If studied further with a bigger dataset, it may imply that institutional investors are closer to the rational-decision making mechanism compared to individual investors. The theoretical framework rests on prospect theory. The market studied is the US equity market, however findings and suggestions can be applied to global markets and various financial instruments.

Keywords: Investor Bias, Behavioral Finance, Institutional Investors, Capital Asset Pricing Model, Extrapolation

JEL Classifications: G12, G02

1. Introduction

Attempting to predict future prices or price returns of financial assets is a recurring theme in the finance literature. The lack of inclusion of human sentiment and bias that was marked by modern portfolio theory's (Markowitz, 1952) normative approach with the basic premise of the rational decision maker as financial actor, has been complemented by behavioral finance explanations of limited or bounded rationality. As such Kahneman and Tversky's (1979) prospect theory has explored new venues of approaching human thinking and behavior. Deleveraging the previously praised decision-making processes of the homo economicus whose actions were believed to rely solely on the evaluation of all possible statistical outcomes of an event, the two social psychologists argued that humanly possible "errors" or biases derived from sentiment inherent in social animals should not be ignored in the decision-making process. Thaler (1980) pioneered economic studies and underscored that in certain situations consumers do not necessarily exhibit an economic theoretically prescribed attitude. Those are the instances where normative theories of decision-making are prone to systematic errors in predicting behavior.

The aim of this study is to revisit the Extrapolative Capital Asset Pricing model "X-CAPM" study of Barberis *et al.* (2015) by introducing a new financial actor into the model: the institutional investor.

2. X-CAPM

The Capital Asset Pricing Model (CAPM) (Sharpe, 1964; Lintner, 1965), which is considered the milestone of asset pricing, provides a rough estimation of what the asset price return will be for putting funds at risk and foregoing another type of investment. Numerous models, based on critiques due to failed empirical tests and suggestions for betterment with extensions and modifications of the CAPM are available in the asset pricing literature.

The X-CAPM study seeks to reconcile survey-based investor sentiment data originally described by Greenwood and Shleifer (2014) with empirical evidence on the aggregate stock market using a modified consumption-based capital asset pricing model. The authors' rationale is that prior studies in this genre rely on "traditional", "behavioral" or "belief"-based models not compatible with this data. This model comprises two investor groups, where the primary underlying assumption is that rational investors and extrapolators hold different beliefs about future stock returns. It is this incompatibility between real-life survey-based data and observed stylized facts of stock returns that the X-CAPM model tries to capture. The central proposition of the model is that even in an economy where the extrapolator-rational investor composition is equal, the extrapolated effect on prices is not completely remedied by rational investors, and thus, prices do not immediately go back to their "normal levels". The stated reason is that rational investors tend to be risk-averse and, thus, do not completely counteract the overvaluation caused by the extrapolators. This is the amplification mechanism caused by the existence of extrapolators who put "too much weight" on a news shock as opposed to the reaction a rational investor would exhibit.

Although it is not specifically voiced by the authors, it is this section that comes closest to the title of their study. In their consumption-based extrapolators' sentiment integrated beta calculation, which is a derivation of the present value of the some of future dividends, they propose an alternative beta calculation.

However, there are several shortcomings of the X-CAPM study Barberis *et al.* (2015) determine: (i) Even though some of the investors in the economy are price extrapolators, the model does not predict momentum in price changes: the presence of fully rational traders means that price changes are negatively autocorrelated at all lags. (ii) There is no mechanism in the model, other than high risk aversion, that can generate a large equity premium. (iii) While the presence of extrapolators reduces the correlation of consumption changes and price changes, this correlation is still much higher in the model than in actual data.

3. X-CAPM Revisited

While the X-CAPM study presents, with its well-developed model, a unique contribution to modern asset pricing literature, it fails to account for the behavior of institutional investors. A possible reason may be that the survey results are an aggregate of several surveys, only some of which were administered to institutional investors.

Clearly, investors have different attributes and although it is a fact that most of the US equity market is held by institutional investors, most representative agent models of the individual investor are being studied. As an alternative solution, the present study uses Sentix data, which specifically differentiates between individual and institutional investors.

One major expected hypothesis-testing outcome is that due to institutional investors' market dominance and herding power, the amplification mechanism described in the X-CAPM study may completely be offset. The reasoning behind this hypothesis is that institutions have different utility functions, consumption constraints and risk sensitivity than individuals. In as such, while rational individual investors may be reluctant to completely counteract the overvalued price, (rational) institutional investors may be more aggressive with abundant resources to "pull back" the market price more or completely offset the amplification effect caused by extrapolators.

4. Literature Review

Institutional investors form an important part of the trading volume in financial markets and trade in very large amounts and thus have a great impact on asset pricing. Hence, the assumption of market efficiency entailing easily and equally accessible information and implicitly perfect competition does not hold since not all investors are price takers.

This, in turn, implies that equity risk premia are different for all groups of investors. Furthermore, heterogeneous groups of investors have different objectives, where individual investors trade on their own behalf and submit limit orders, institutional traders, such as money managers with a concrete benchmark like the market index, have a greater risk appetite and more leeway to submit market orders and provide liquidity. Thus, their incentives and motives are markedly different and so is their interactions in between other groups of investors and amongst themselves (the effect of peer-benchmarking was recently shown by Acharya and Pedrzza (2015), who estimate the asset prices effects from institutional trades due to peer-benchmarking incentives among pension fund managers.). All of these factors and the fraction and, thus, power of trading, affect the asset pricing mechanism.

Another strand of the literature argues that asset pricing is essentially determined by two significant phenomena: market clearing conditions and asset demand. Empirical studies related to the significant price impact with respect to large institutional trades are undertaken by scholars such as Scholes (1972), Holthausen *et al.* (1990), Chan and Lakonishok (1993), and Keim and Madhavan (1996).

Showing the impact of institutional traders, Harris and Gurel (1986), Shleifer (2000) and Chen *et al.* (2004) present evidence from index additions and deletions, while Greenwood (2005) and Hau (2011) present evidence from more general index redefinitions.On the other hand, Basak and Pavlova (2013) assert that the presence of institutional investors results in: an index effect, amplification of shocks, time varying sharpe ratios which are higher in bad times, and an asset class effect.

The role of institutions and the necessity to develop an asset-pricing model based on heterogeneous investor types in the market is also stressed by Koijen and Yogo (2015), who underscore the fact that traditional asset pricing models are not fit for answering questions such as:

1. Have asset markets become more liquid over the last 30 years with the growing importance of institutional investors?
2. How much of the volatility and predictability of asset prices is explained by institutional trades?
3. Do large investment managers amplify volatility and bad times?

Koijen and Yogo (2015) propose an equilibrium model of institutional demand, whereby the equilibrium price vector is uniquely determined by market clearing, which equates the supply of each asset to aggregate demand.

The reason that researchers till the present time have failed to account for the presence of heterogeneous investors, and in particular, institutions, and have instead relied upon broad assumptions such as those in the X-CAPM model, may have been the complexity of modelling diverse preferences and incentives.

Cornell and Roll (2004), emphasizing the underlying assumption of agency theory that objective functions cannot be isomorphic to principals' preferences and beliefs suggesting that asset pricing could differ fundamentally from what existing theory predicts, try to establish a single period delegated asset pricing model that explains objective functions of professional money managers. The authors, focusing on the delegation process, draw attention to implications for research in behavioral finance. “Instead of simply noting a limitation on rational-decision making, such as overconfidence, and then developing an asset pricing model that incorporates the limitation, behaviorists could analyze how the limitation influences the delegation process” (Cornell and Roll, 2004, p. 6). The institutional environments the authors envision are composed of two groups of institutional managers: passive ones that mimic the index and active ones trying to beat the market and employing various trading strategies. Hodor (2014) who studies benchmark heterogeneity, takes a different approach to identifying institutional investors and regards those that do not follow a specific benchmark index as retail investors.

Allen (2001) argues that traditional asset pricing models assume that investors are investing directly in financial markets and that the role of financial institutions is ignored. He further explains that the reason for ignoring institutional investors being their negligible impact on asset prices may have been valid in the US in the 1950s when individuals directly held over 90 percent of corporate equities, or even in 1970 when they held 68 percent, it has become increasingly less appropriate as time progresses. By 2000, the fraction of directly held equity was less than 40 percent. Allen (2001) underlines that there is clearly a potential agency problem when financial institutions control such a high proportion of stocks.

5. I-X-CAPM Model Settings

The model settings rest on an infinite-horizon model set in continuous time. There are two assets; a safe asset with a fixed return “r” and perfect elastic supply; and a risky asset, representing the aggregate stock market, with a fixed per-capita supply “Q”. The risky asset is a claim to a continuous dividend stream whose level per unit time evolves as an arithmetic Brownian motion.

The Sentix survey data consists of “private” and “institutional” investors. Private investors maximize expected lifetime consumption utility and differ in their expectations about the future stock market return. For institutions, there is the principal agent problem in maximizing lifetime consumption because, on the one hand, they are trying to maximize returns from trading, and, on the other hand, they are trying to maximize their fees they get from investors. The investor, however, is interested in beating his benchmark, obtaining high returns but paying low fees to the institution. Furthermore, the institution operates in a profit-oriented corporate and competitive culture of financial institutions where one major difficulty is to retain clients on a continuous basis.

The main proposition is that expected price changes are an outcome of the interaction of beliefs (sentiment) of heterogeneous agents in the market. Thus, the main equation is

$$S_t = \beta \int_{-\infty}^{t} e^{-\beta(t-s)^2} dP_{s-dt}\,, \;\; \beta > 0 \qquad (1)$$

where, β,t,s,and dt denote the speed of mean reversion to the equilibrium price, time, sentiment and change in dividend over time. The value of the stock market at time is denoted by P_t and determined endogenously in equilibrium.

The rationally “correct” dividend growth model known by the rational investor is as follows:

$$dD_t = g_D dt + \sigma_D d\omega_t \qquad (2)$$

where, g_D and σ_D are the expected value and standard deviation of dividend changes, respectively, and where ω_t is a standard one-dimensional Wiener process. Both g_D and σ_D are constant.

Deviations from this model from the perspectives of institutional and extrapolating investors, respectively, are

$$dD_t^a = g_D^a dt + \sigma_D d\omega_t^a \quad (3)$$

and

$$dD_t^e = g_D^e dt + \sigma_D d\omega_t^e \quad (4)$$

where, the perceived expected dividend change depends explicitly on Eq. (2).[1]

For institutional and extrapolating investors, the following equations for expected dividend change apply, respectively,

$$g_D^a(S_t) = (1-\beta B)\lambda_0^a r + \big((1-\beta^a B)\lambda_1^a r + \beta^a B r\big)S_t \quad (5)$$

and

$$g_D^e(S_t) = (1-\beta B)\lambda_0^e r + \big((1-\beta^e B)\lambda_1^e r + \beta^e B r\big)S_t \quad (6)$$

where, we denote $B \in (0, \beta^{-1})$.

The institutional investors' and extrapolators' expected change in the aggregate stock price, respectively, is

$$g_{p,t}^a(S_t) = \lambda_0^a + \lambda_1^a S_t \quad (7)$$

and

$$g_{p,t}^e(S_t) = \lambda_0^e + \lambda_1^e S_t \quad (8)$$

The β, λ_0 and λ_1 coefficients of equations (5), (6), (7), (8) are obtained through a two-stage regression analysis of equations (10) and (11), respectively.

Similar to the study of Baberis *et al*. (2015), we do not take a strong stand on the source of extrapolation. Isolated, extrapolators could form their extrapolative expectations on the "representativeness" heuristic. However, different from the study of Barberis *et al*. (2015), we assume that the institutional investors form an important part of our aggregate model, based on the interaction with institutional (a.k.a. professional) investors, extrapolators' could use several other heuristics such as "herding".

For the institutional investors Eq. (9a) encompasses their beliefs about the expected price change and the evolution of future prices

$$dP_t^a = (\lambda_0^a + \lambda_1^a S_t)dt + \sigma_p d\omega_t^a \quad (9a)$$

whereas in extrapolators' minds prices evolve as shown in Eq. (9b)

$$dP_t^e = (\lambda_0^e + \lambda_1^e S_t)dt + \sigma_p d\omega_t^e \quad (9b)$$

[1] Note that superscripts "a" and "e" are abbreviations for "institutional investors" and "extrapolators", respectively.

From the institutions' (extrapolators') perspective ω_t^a (ω_t^e) is a Wiener process. The drift term simply reflects the expectations in Eq. (7) and in Eq. (8), respectively, while the instantaneous volatility σ_p^a and σ_p^e is the actual instantaneous volatility that is endogenously determined in equilibrium and that we assume is a constant. Since volatility can easily be estimated from past data, we assume that institutions and extrapolators know its true value.

Both investors' expectations about price change over a finite horizon are given in Eq. (10)

$$\mathrm{E}_t\left[P_{t_1} - P_t\right] = \left(\lambda_0 + \lambda_1 S_t(\beta)\right)(t_1 - t) + \lambda_1\left(\beta\lambda_0 - mS_t(m)\right)\frac{m(t_1 - t) + e^{-m(t_1 - t)} - 1}{m^2} \quad (10)$$

where, $m = \beta(1-\lambda_1)$, investors' expected instantaneous price change at time t, $\lambda_0 + \lambda_1 S_t(\beta)$ multiplied by the time horizon $(t_1 - t)$.

To determine β, λ_0 and λ_1 we specify Eq. (11)

$$\mathrm{E}_t\left[P_{t_1} - P_t\right] = \left(\hat{\lambda}_0 + \hat{\lambda}_1 S_t(\hat{\beta}, n)\right)(t_1 - t) + \hat{\lambda}_1\left(\hat{\beta}\hat{\lambda}_0 - mS_t(\hat{\beta}, n)\right)\frac{m(t_1 - t) + e^{-m(t_1 - t)} - 1}{m^2} + \varepsilon_t \quad (11)$$

with $m(\hat{\beta}, \hat{\lambda}_1) = \hat{\beta}\left(1 - \hat{\lambda}\right)$ and $S_t(\hat{\beta}, n) = \sum_{l=0}^{n-1} \frac{e^{-\beta l \Delta t}}{\sum_{j=0}^{n-1} e^{-\beta j \Delta t}}\left(P_{t - l\Delta t} - P_{t-(l+1)\Delta t}\right)$, where β and n parameterize how far back investors look when forming their beliefs.[2] In the case where λ_1 is fixed at one, Eq. (11) becomes

$$\mathrm{E}_t\left[P_{t_1} - P_t\right] = \left(\hat{\lambda}_0 + S_t(\hat{\beta}, n)\right)(t_1 - t) + \frac{\hat{\beta}\hat{\lambda}_0 (t_1 - t)^2}{2} + \varepsilon_t. \quad (12)$$

Equations (10), (11), (12) form a system that is necessary to obtain the β, λ_0, and λ_1 coefficients, which are needed to understand how sentiment evolves.

6. Results

We have used Sentix private and institutional investors' economic sentiment data on the US (expectations regarding future economic outlook and current economic sentiment) and S&P 500 data. All data series were logarithmic transformed and tested for stationarity using the Augmented Dickey-Fuller test. The frequency of the data is daily. A two-stage OLS model was used to derive that the parameters ensure the endogeneity of the variables and instrumental variables. We verify that instrumental variables are not correlated with error terms in time *t*. We use equations (11) and (12) to determine the parameter values for the β, λ_0 and λ_1 coefficients.

As shown in Table 1, comparing the coefficients for institutional current vs private current results, we determine that: (i) for institutions the β coefficient for both equations is higher than that for private individuals, and all values are significant at the 5% level except for the β for institutional investors' current beliefs with respect to Eq. 11, (ii) the λ_0 coefficient is higher (lower) for institutions in Eq. (11) (Eq. (12)) and all values are significant at the 5% level, (iii) λ_1 for institutions is lower in Eq. (11), however the β value for the former is insignificant at the 5% level and fixed at 1 in Eq. (12) for both.

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[2] We set the following values for the mentioned parameters, $\Delta t = 1/4$ and $n = 60$.

Comparing the coefficients for institutional future vs private future results we find that: (i) for institutions the β coefficient for Eq. (11) is lower than that for private investors, however the former is significant whereas the latter is insignificant at the 5% level. As for Eq. (12) the β value for institutional investors' future expectations is higher in comparison to that of private investors, however, it is insignificant at the 5% level, whereas that for the latter type of investors is significant at the 5% level, (ii) the λ_0 coefficient is higher for institutions is significant and lower for Eq. (11), whereas for Eq. (12) the λ_0 coefficient is insignificant for institutions but significant for private investors, (iii) λ_1 for institutions is significant at 5% and insignificant for private investors in Eq. (11) and fixed at 1 in Eq. (11) for both.

Table 1. Parameter values based on I-X-CAPM

	Institutional Investor Current Beliefs		**Private Investor Current Beliefs**		**Institutional Investor Future Beliefs**		**Private Investor Future Beliefs**	
Coefficient	Eq. (11)	Eq. (12)	Eq. (11)	Eq. (12)	Eq. (11)	Eq. (12)	Eq. (11)	Eq. (12)
β	9.85	0.65	0.65	0.63	0.89	0.85	4.76	0.76
[t-stat]	0.05	18.20	25.15	26.29	48.07	0.00	00.00	56.57
λ_0	1.00	0.69	0.65	0.73	0.88	0.94	1.00	0.86
[t-stat]	18.99	20.18	25.95	32.96	43.01	0.00	32.68	57.75
λ_1	0.34		1.06		0.34		-0.01	
[t-stat]	0.00		398.88		11.08		0.77	
Chi-square	360.8929	584.8921	2540.662	3254.494	505.8812	24.60562	2638.006	14837.48
Sum sq. res.	8097.29	57.43	6019966	8897.27	190.89	2.35	80.28	8895.37
Durbin Watson	1.86	2.44	4.32	2.01	1.79	2.00	1.60	2.01

Note: Institutional Current, Private Current, Institutional Future, Private Future refer to USA Sentix Economic Sentiment, Current Situation and Future expectations of Institutional / Private Investors.

Comparing the coefficients for future and current results, we observe that: (i) in the case for institutions in Eq. (11) (Eq. (12)) the β coefficient is higher though insignificant at the 5% level (lower yet significant at the 5%level) when it comes to the current outlook, with regard to λ_0, in Eq. (11) (Eq. (12)) the λ_0 coefficient is higher and significant at the 5% level (lower but significant at the 5% level) for current results, with regard to λ_1, in Eq. (11) (Eq. (12)) the λ_1 coefficient is the same but insignificant at the 5% level (fixed at 1) for current outlook, (ii) for private individuals in Eq. (11) (Eq. (12)) the β coefficient is lower but significant at 5% level (lower and significant at %5 as well) when it comes to the current outlook, with regard to λ_0, in Eq. (11) (Eq. (12)) the λ_0 coefficient is lower (lower) for current outlook, where all λ_0 coefficients are significant at the 5% level. With regard to λ_1, in Eq. (11) (Eq. (12)) the λ_1 coefficient is significant at the 5% level in the current outlook whereas in the future outlook it is not significant at the 5% level (fixed at 1) for current outlook.

As for the interpretation of these findings comparing institutional vs individual investors on the current economic outlook expectation level in the realm of Eq. (11), β is 9.85 but not significant on the 5% level vs a significant β value of 0.65. Thus, it is difficult to compare and to contrast in this context. In this realm, we cannot comment on whether or not sentiment reverts more quickly to its equilibrium level (mean – reversion). The results for λ_1 are again not significant for institutional investors. However, more interpretable findings are present for future economic outlook. As such, λ_0 is lower with a value for 0.88 vs 1 for institutional investors in comparison to private investors, where both values are significant at the 5% level.

As stated in Barberis *et al*. (2015) that if λ_0 is 0 and λ_1 is 1, the extrapolators think that sentiment follows a random walk whereas in reality it is mean reverting. According to our output λ_1 is close to 1, however λ_0 is different from 0, for institutional investors, future beliefs. Thus, one of the main findings is that institutional investors, in their future economic beliefs, have an unbiased outlook and can judge future situations realistically. Another interpretation based on our output table is that the private institutional investors in their current outlook are also somewhat realistic, but more prone to bias as compared to the future economic expectations of institutional investors.

7. Conclusion

The role of institutions and the necessity to develop an asset pricing model based on heterogeneous investor types in the market is also stressed by Koijen and Yogo (2015), who underscore the fact that traditional asset pricing models are not fit for answering questions such as liquidity, asset price volatility and regimes switching issues.

The present study has sought to complement the X-CAPM through integrating the assumption of heterogeneous investors. While the integration of institutional investors and the differentiation between expectations regarding current and future economic outlook is a novelty in the X-CAPM literature, we have come to the conclusion that more data is necessary. Our aim was to show that the institutional investor, while still displaying “irrational” or “rationally bounded” behavior, is closer to the rational-decision making mechanism compared to the individual, who is closer to the role of an extrapolator. While this conclusion is a little far-fetched, there is still some evidence in our findings, which may imply that institutions revert quicker to their means than individual investors do.

In some countries including the US, most institutional investors may be pension funds. This is an important consideration since the nature of the institutional investor (hedge fund, mutual fund, pension fund, etc.) determines its motivation, time and consumption preferences. Institutions may act from time to time for hedging, arbitrage or speculation purposes. Thus, perhaps dividing investors into rational, institutional and extrapolator and building models on these broad categories may lead to only theoretical models. However, for practical applicability purposes, other factors such as objectives and incentives as well, need to be taken into account. Clearly, there is still a lot of room for research in asset pricing. With the present work, the authors hope to have contributed to the behavioral asset pricing literature and have tried to offer their theoretical suggestions to the X-CAPM model by Barberis *et al.* (2015).

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