

CAPM: an absurd model

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A previous version of this paper was published in *Business Valuation Review*, Volume 34, issue 1 (Spring 2015), pp 4-23

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Previous drafts: 2014, 15, 17 **May 17, 2019**

The CAPM is about **expected** return. If you find a formula for expected returns that works well in the real markets, would you publish it? Before or after becoming a billionaire?

The CAPM is an absurd² model because its **assumptions** and its **predictions/conclusions** have no basis in the real world.

According to the dictionary, a **theory** is “an idea or set of ideas that is intended to explain facts or events”; and a **model** is “a set of ideas and numbers that describe the past, present, or future state of something”. With the vast amount of information and research that we have, it is quite clear that the CAPM does not “explain facts or events”, nor does it “describe the past, present, or future state of something”.

The use of CAPM is also a source of litigation: many professors, lawyers... get nice fees because many professionals use CAPM instead of common sense to calculate the required return to equity. Users of the CAPM make many illogical errors valuing companies, accepting/rejecting investment projects, evaluating fund performance, pricing goods and services in regulated markets, calculating value creation...

It is important to differentiate between a **fact** (something that truly exists or happens: something that has actual existence; a true piece of information) and an **opinion** (what someone thinks about a particular thing).

We all should try to explain a portion of “the world as it is”, not of “the world as we model it”. Ricardo Yepes, professor of philosophy of my university, wrote: “Learning means being able to keep perceiving reality as it truly is: complex - and not trying to fit every new experience into a **closed and pre-conceived notion** or overall scheme”.

We may find out an investor’s expected return for IBM by asking him. However, it is impossible to determine the expected return for IBM of the market, because this parameter does not exist. Different investors have different cash flow expectations and different expected (and required) returns to equity. One could only talk of the expected return of the market if all investors had the same expectations. But investors do not have homogeneous expectations.

Sections 11 and 12 show how to calculate required returns in a sensible way and how to use betas being a reasonable person (using common sense, experience and some finance knowledge).

Valuation is about **required** return. There are persons, papers and books that mix (or assume that are equal) expected and required returns.

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¹ I thank very much to the readers of the first draft that sent me interesting comments, criticism and suggestions that are collected in “CAPM: the model and 305 comments about it” <http://ssrn.com/abstract=2523870>. I did rewrite this paper following some of them.

² Absurd means 1. *ridiculously unreasonable, unsound, or incongruous <an absurd argument>*. 2: *having no rational or orderly relationship to human life. Meaningless. utterly or obviously senseless, illogical, or untrue; contrary to all reason or common sense; laughably foolish or false*. Source: <http://www.merriam-webster.com/dictionary/absurd>

1. Main assumptions of the CAPM

All investors:

- a. have homogeneous expectations (same expected return, volatility and correlations for every security) ,
- b. can lend and borrow unlimited amounts at the risk-free rate of interest,
- c. can short any asset, and hold any fraction of an asset,
- d. plan to invest over the same time horizon.
- e. investors only care about the expected return and the volatility of their investments³.

2. Main predictions of the CAPM

The CAPM assumptions imply that all investors:

- a. will always combine a risk free asset with the market portfolio,
- b. will have the same portfolio of risky assets (the market portfolio)⁴,
- c. agree on the expected return and on the expected variance of the market portfolio and of every asset,
- d. agree on the expected MRP and on the beta of every asset,
- d. agree on the market portfolio being on the minimum variance frontier and being mean-variance efficient,
- e. expect returns from their investments according to the betas.

As there are homogeneous expectations, constant utility functions and there is not disagreement about the price or the value of any security:

- f. trading volume of financial markets will be very small.

3. Why is the CAPM an absurd model?

The CAPM is based on many unrealistic assumptions. It is true that *"all interesting models involve unrealistic simplifications"* and CAPM has some assumptions that are convenient simplifications, but other assumptions (specially the homogeneous expectations) are obviously senseless.

None of the CAPM predictions happens in our world⁵. Still, many professors affirm that *"the CAPM is not testable"* or *"it is difficult to test the validity"*. CAPM is a model a) based on senseless assumptions, and b) none of its predictions happens in our world. Which other test do we need to reject the model?

But I have to thank some CAPM users that allowed me to participate as an expert witness in several trials, arbitrage procedures and consulting projects usually originated by senseless uses and results of the CAPM.

4. Why are many people still using the CAPM?

Fernandez (2009b)⁶ shows that many professors acknowledge that there are problems estimating two ingredients of the CAPM formula (the beta and the MRP [market risk premium]), but, nevertheless, they continue using it for several reasons:

- *"Has received a Nobel Prize in Economics". "Fortune 500 firms use the CAPM to estimate their cost of equity".*
- *"While not perfect, it is used extensively in practice". "Beta is simple and it is used in the real world".*
- *"If one does not use beta then what is there?" "No substitution so far. There are no better alternatives". "There is no other satisfactory tool in finance".*
- *"Calculated betas are on the CFA exam". "Referees want to see them as the underlying model".*
- *"Almost every practitioner book uses betas such as the McKinsey publications". "Regulatory practice often requires it".*
- *"Beta allows you to defend a valuation, impress management and come across as a finance guru". "That point estimate gives the impression of truth".*
- *"In consulting, it is essential to fully support your estimates". "It is a useful tool to compare one stock with another".*

Other professors argue that *"I teach CAPM because it is based on the important concept of diversification and it is an easy recipe for most students"*. I think that we can teach diversification without the CAPM and, more important, business and management (which includes investing and valuation) is about common sense, not about recipes.

³ Other assumptions are: no transaction costs (no taxes, no commissions...); all information is available at the same time to all investors; each investor is rational and risk-averse, and wants to maximize his expected utility.

⁴ Very risk-averse investors will put most of their wealth in risk-free asset, while risk-tolerant investors will put most of their wealth in the market portfolio.

⁵ Although Roll (1977) concludes that the only legitimate test of the CAPM is whether or not the market portfolio is mean-variance efficient, I think that we have enough evidence to conclude that: 1) the CAPM does not help to explain the financial markets, and 2) users of the CAPM make many errors valuing companies, accepting/rejecting investments, evaluating fund performance, pricing goods and services in regulated markets...

⁶ "Betas Used by Professors: A Survey with 2,500 Answers", <http://ssrn.com/abstract=1407464>

5. Schizophrenic approach to valuation

Valuation is about expected cash flows and about required returns. We all admit that different investors may have different expected cash flows, but many of us affirm that the required return (discount rate) should be equal for everybody.

That is the schizophrenic approach: to be a “*democrat*” for the expected cash flows but a “*dictator*” for the discount rate.

Most professors teach that the expected cash flows should be computed using common sense⁷ about the company, its industry, the national economies... However, some professors teach the CAPM to calculate the discount rate (instead of using again common sense): they acknowledge that there are problems estimating two ingredients of the formula (the beta and the MRP), but, nevertheless, continue using it.

We may find out an investor’s expected IBM beta [or expected return] by asking him. However, it is impossible to determine the expected IBM beta [or expected return] for the market as a whole, because it does not exist. Even if we knew the expected market risk premiums and the expected IBM betas of the different investors who operated on the market, it would be meaningless to talk of an expected IBM beta [or expected return] for “the market” as a whole. A rationale for this is to be found in the aggregation theorems of microeconomics, which in actual fact are non-aggregation theorems. A model that works well individually for a number of people may not work for all of the people together⁸.

6. Consequences of using the CAPM

Just an example: calculation of the beta of electrical companies done by a European Electricity Regulatory Commission. “*We calculate the betas of all traded European companies. Levered betas were calculated using 2 years of weekly data. The Market Index chosen was the Dow Jones STOXX Total Market Index. There is a great dispersion (from -0.24 to 1.16) and some odd betas (negative and higher than one). We decided to maintain all betas... We unlever the betas, calculate the average of the unlevered betas and relever it using the average debt to equity ratio of comparable companies. The levered beta proposed by the Commission for the transport activity is 0.471870073*”. The Commission acknowledges that calculated betas have a “*great dispersion (from -0.24 to 1.16)*” but calculates the average of all of them and finally provides betas with a precision of 9 figures after the decimal point!

Fernandez and Bilan (2007)⁹ contains a collection of errors seen in company valuations performed by analysts, investment banks, consultants and expert witnesses. Some of the errors are *wrong betas and wrong market risk premia*. The most common error consists in using the historical industry beta, or the average of the betas of similar companies, when this magnitude does not make sense. Users of the CAPM have made many errors valuing companies, accepting/rejecting investment projects, evaluating fund performance, pricing goods and services in regulated markets, calculating value creation...

7. Papers about the CAPM

Many papers have the explicit or implicit assumption that “*the market*” has a “*true beta*” for each security and an expected MRP (common to all investors): we have to refine our statistical methods to estimate this figures. Other papers find discrepancies between the CAPM and the market and try to explain what is wrong... with the market!

The CAPM of Sharpe (1964), Lintner (1965) and Mossin (1966) asserts that the expected return for any security is a function of three variables: expected beta, expected market return, and the risk-free rate. Sharpe (1964) and Lintner (1965) demonstrate that, with some senseless assumptions, a financial asset’s return must be positively linearly related to its beta (β): $E(R_i) = a_1 + a_2 E(\beta_i)$, for all assets i . $E(R_i)$ is the expected return on asset i , $E(\beta_i)$ is asset i ’s expected market beta, a_1 is the expected return on a “zero-beta” portfolio, and a_2 is the market risk premium: $E(R_M) - R_f$

Original tests of the CAPM focused on whether the intercept in a cross-sectional regression was higher or lower than the risk-free rate, and whether stock individual variance entered into cross-sectional regressions.

Miller and Scholes (1972) report that the sample average of the standard error of the beta estimates of all NYSE firms is around 0.32, as compared to the average estimated beta coefficient of 1.00. Thus, a random draw from this distribution of betas is going to produce any number between 0.36 and 1.64 ninety-five percent of the time. It is this

⁷ By “common sense”, we mean good judgment, experience and some financial knowledge. Merriam-Webster dictionary, Common sense: “*sound and prudent judgment based on a simple perception of the situation or facts.*”

⁸ Mas-Colell et al. (1995): “*It is not true that whenever aggregate demand can be generated by a representative consumer, this representative consumer’s preferences have normative contents. It may even be the case that a positive representative consumer exists but that there is no social welfare function that leads to a normative representative consumer.*”

⁹ “119 Common Errors in Company Valuations”, <http://ssrn.com/abstract=1025424>

imprecision in individual beta estimates (or the better known “errors in variables” problem) that motivated portfolio formation techniques of Black, Jensen, and Scholes (1972) and Fama and MacBeth (1973).

Scholes and Williams (1977) found that with nonsynchronous trading of securities, OLS estimators of beta coefficients using daily data are both biased and inconsistent.

Subsequent work by (among many others) Basu (1977), Banz (1981), Reinganum (1981), Litzenberger and Ramaswamy (1979), Keim (1983, 1985)¹⁰ and Fama and French (1992) suggests that either:

1. expected returns are determined not only by the beta and the expected market risk premium but also by other firm characteristics such as price-to-book value ratio (P/B), firm size, price-earnings ratio and dividend yield (it means that the CAPM requires the addition of factors other than beta to explain security returns), or
2. the historical beta has little (or nothing) to do with the expected beta and the historical market risk premium has little (or nothing) to do with the expected market risk premium, or
3. the heterogeneity of expectations¹¹ in cross-section returns, volatilities and covariances, and market returns is the reason why it makes no sense to talk about an aggregate market CAPM (although at the individual level expected CAPM could work). Each investor uses an expected beta, an expected market risk premium, and an expected cash flow stream to value each security, and investors do not agree on these three magnitudes for each security. Consequently, it makes no sense to refer to a “market” expected beta for a security or to a “market” expected market risk premium (or to a “market” expected cash flow stream), for the simple reason that they do not exist.

Next table contains the main differences between the “CAPM world” and the real world

CAPM	Real world
Homogeneous expectations All investors have equal expectations about asset returns	Heterogeneous expectations. Investors DO NOT have equal expectations about asset returns.
Investors only care about expected return and volatility of their investments	Investors also care about jumps, crashes and bankruptcies
All investors use the same beta for each share	Investors use different betas (required betas) for a share
All investors hold the market portfolio	Investors hold different portfolios
All investors have the same expected market risk premium	Investors have different expected market risk <i>premia</i> and use different required market risk <i>premia</i>
The market risk premium is the difference between the <i>expected</i> return on the market portfolio and the risk-free rate	The market risk premium is NOT the difference between the <i>expected</i> return on the market portfolio and the risk-free rate

Roll (1977) concluded that the only legitimate test of the CAPM is whether or not the market portfolio (all assets) is mean-variance efficient. Roll (1981) suggests that infrequent trading of shares of small firms may explain much of the measurement error in estimating their betas.

Constantinides (1982) points out that with consumer heterogeneity “in the intertemporal extension of the Sharpe-Lintner CAPM, an asset’s risk premium is determined not only by its covariance with the market return, but also by its covariance with the $m-1$ state variables” (m is the number of heterogeneous consumers). He also points out that the assumption of complete markets is needed for demand aggregation.

Lakonishok and Shapiro (1984, 1986) find an insignificant relationship between beta and returns and a significant relationship between market capitalization and returns

Shanken (1992) presents an integrated econometric view of maximum-likelihood methods and two-pass approaches to estimating historical betas.

The poor performance of the CAPM has inspired multiple portfolio based factors. The hardest blow to the CAPM was published by Fama and French (1992): they showed that in the period 1963-1990, the correlation between stocks’ returns and their betas was very small, while the correlation with the companies’ size and their (P/B) was greater. They concluded “our

¹⁰ Basu (1977) found that low price/earnings portfolios have higher returns than could be explained by the CAPM. Banz (1981) and Reinganum (1981) found that smaller firms tend to have high abnormal rates of return. Litzenberger and Ramaswamy (1979) found that the market requires higher rates of return on equities with high dividend yield. Keim (1983, 1985) reports the January effect, that is, seasonality in stock returns. Tinic and West (1984) reject the validity of the CAPM based on intertemporal inconsistencies due to the January effect.

¹¹ Lintner (1969) argued that the existence of heterogeneous expectations does not critically alter the CAPM in some simplified scenarios and said that “in the (undoubtedly more realistic) case with different assessments of covariance matrices, the market’s assessment of the expected ending price for any security depends on every investor’s assessment of the expected ending price for every security and every element in the investor’s assessment of his $N \times N$ covariance matrix (N is the number of securities), as well as the risk tolerance of every investor.”

tests do not support the most basic prediction of the Sharpe-Lintner-Black CAPM that average stock returns are positively related to market betas". The authors divided the shares into portfolios and found that the cross-sectional variation in expected returns may be captured within a three-factor model, the factors being: 1) the return on the market portfolio in excess of the risk-free rate; 2) a zero net investment portfolio that is long in low P/B stocks and short in high P/B stocks, and 3) a zero net investment portfolio that is long in small firm stocks and short in large firm stocks. The following table shows the article's main findings.

Main findings of Fama and French's article (1992)

Size of the companies	Average beta	Annual average return	Beta of the companies	Average beta	Annual average return	P/B Price / book value	Average beta	Annual average return
1 (biggest)	0.93	10.7%	1 (high)	1.68	15.1%	1 (high)	1.35	5.9%
2	1.02	11.4%	2	1.52	16.0%	2	1.32	10.4%
3	1.08	13.2%	3	1.41	14.8%	3	1.30	11.6%
4	1.16	12.8%	4	1.32	14.8%	4	1.28	12.5%
5	1.22	14.0%	5	1.26	15.6%	5	1.27	14.0%
6	1.24	15.5%	6	1.19	15.6%	6	1.27	15.6%
7	1.33	15.0%	7	1.13	15.7%	7	1.27	17.3%
8	1.34	14.9%	8	1.04	15.1%	8	1.27	18.0%
9	1.39	15.5%	9	0.92	15.8%	9	1.29	19.1%
10 (smallest)	1.44	18.2%	10 (low)	0.80	14.4%	10 (low)	1.34	22.6%

Roll and Ross (1994) attribute the observed lack of a systematic relation between risk and return to the possible mean-variance inefficiency of the market portfolio proxies.

Lakonishok, Shleifer and Vishny (1994) argue that the size and P/B effects are due to investor overreaction rather than compensation for risk bearing. According to them, investors systematically overreact to corporate news, unrealistically extrapolating high or low growth into the future. This leads to underpricing of "value" (small capitalization, high P/B stocks) and overpricing of "growth" (large capitalization, low P/B stocks).

Kothary, Shanken and Sloan (1995) point out that using historical betas estimated from annual rather than monthly returns produces a stronger relation between return and beta. They also claim that the relation between P/B and return observed by Fama and French (1992) and others is exaggerated by *survivor bias* in the sample used and conclude: "our examination of the cross-section of expected returns reveals economically and statistically significant compensation (about 6 to 9% per annum) for beta risk."

Pettengill, Sundaram and Mathur (1995) find "consistent and highly significant relationship between beta and cross-sectional portfolio returns". They insist: "the positive relationship between returns and beta predicted by CAPM is based on expected rather than realized returns". They remark that their results are similar to those of Lakonishok and Shapiro (1984)

Fama and French (1996) argue that survivor bias does not explain the relation between P/B and average return. They conclude that historical beta alone cannot explain expected return.

Kothary and Shanken (1999) insist on the fact that Fama and French (1992) tend to ignore the positive evidence on historical beta and to overemphasize the importance of P/B. They claim that, while statistically significant, the incremental benefit of size given beta is surprisingly small. They also claim that P/B is a weak determinant of the cross-sectional variation in average returns among large firms and it fails to account for return differences related to momentum and trading volume.

Berglund and Knif (1999) propose an adjustment of the cross-sectional regressions of excess returns against betas to give larger weights to more reliable beta forecasts. They find a significant positive relationship between returns and the beta forecast when the proposed approach is applied to data from the Helsinki Stock Exchange, while the traditional Fama-MacBeth (1973) approach as such finds no relationship at all.

Elsas, El-Shaer and Theissen (2000) "find a positive and statistically significant relation between beta and return in our sample period 1960-1995 as well as in all subperiods we analyze" for the German market. They claim, "Our empirical results provide a justification for the use of betas estimated from historical return data by portfolio managers."

Cremers (2001) claims that the data do not give clear evidence against the CAPM because it is difficult to reject the joint hypothesis that the CAPM holds and that the CRSP value-weighted index is efficient or a perfect proxy for the market portfolio. He also claims that the poor performance of the CAPM seems often due to measurement problems of the market portfolio and its beta. He concludes that "according to the data, the CAPM may still be alive."

Bartholdy and Peare (2001) argue that five years of monthly data and an equal-weighted index provide the most efficient estimate of the historical beta. However, they find that the ability of historical betas to explain differences in returns in subsequent periods ranges from a low of 0.01% to a high of 11.73% across years, and at best 3% on average. Based on these results, they say "it may well be appropriate to declare beta dead".

Chung, Johnson and Schill (2001) use size-sorted portfolio returns at daily, weekly, quarterly and semi-annual intervals and find in every case that the distribution of returns differs significantly from normality. They also show that adding

systematic co-moments (not standard) of order 3 through 10 reduces the explanatory power of the Fama-French factors to insignificance in almost every case.

Zhang, Kogan, and Gomes (2001) claim that *“size and P/B play separate roles in describing the cross-section of returns. These firm characteristics appear to predict stock returns because they are correlated with the true conditional market beta of returns.”*

Avramov and Chordia (2001) test whether the Zhang, Kogan, and Gomes (2001) scaling procedure improves the performance of the CAPM and consumption CAPM. They show that equity characteristics often enter beta significantly. However, *“characteristic scaled factor models”* do not outperform their unscaled counterparts.

Shalit and Yitzhaki (2002) argue that the OLS regression estimator is inappropriate for estimating betas. They suggest alternative estimators for beta. They eliminate the highest four and the lowest four market returns and show that the betas of the 75% of the firms change by more than one standard error.

Avramov (2002) shows that small-cap value stocks appear more predictable than large-cap growth stocks, and that model uncertainty is more important than estimation risk: investors who discard model uncertainty face large utility losses.

Griffin (2002) concludes that country-specific three-factor models are more useful in explaining stock returns than are world and international versions.

Koutmos and Knif (2002) propose a dynamic vector GARCH model for the estimation of time-varying betas. They find that in 50% of the cases betas are higher during market declines (the opposite is true for the remaining 50%). They claim that the static market model overstates unsystematic risk by more than 10% and that dynamic betas follow stationary, mean reverting processes.

McNulty et al. (2002), say that *“although Apple’s stock was almost twice as volatile as IBM’s during the five years (1993-1998) we looked at (52% volatility for Apple; 28% for IBM), its correlation with the market’s movement was only one-fourth as great (0.105 for Apple; 0.425 for IBM)... resulting in a beta of 0.47 for Apple compared with 1.09 for IBM”*. They also point out that for a *“UK-based multinational, a two-day shift in the sampling day (using Friday’s stock prices rather than Wednesday’s) to calculate beta, generated quite different betas of 0.70 and 1.41.”*

Fama and French (2004) affirm that *“the failure of the CAPM in empirical tests implies that most applications of the model are invalid”*.

Merrill Lynch and Bloomberg adjust betas in a very simple way: Expected beta = 0.67 historical beta + 0.33. Of course, this “Expected beta” works better than the “historical beta” because *“ $\beta = 1$ does a better job than calculated betas”*¹².

Thompson et al (2006), in their paper “Nobels for Nonsense”, show evidences against Markowitz and the CAPM: a) the correlation between the return and the volatility of the Ibbotson Index in 1926-2000 was negative (-0.32); b) 65% of the portfolios chosen randomly had a higher return than the CAPM could predict; c) an “equal weight index” had in 1970-2002 an annualized return 4.8% higher than the S&P 500. They conclude that *“the use of flawed models by true believers can cause mischief not only for individual investors but also for the economy generally.”*

Bossaerts, Plott, and Zame (2007) suggest a new approach to asset pricing and portfolio choices based on unobserved heterogeneity and offer a novel econometric procedure to test their novel model (they name it CAPM+ ϵ). Then, they apply the econometric tests to data generated by **large-scale laboratory asset markets** and they claim that CAPM+ ϵ is not rejected. OK in a laboratory, but in the real financial markets?

Aktas and McDaniel (2009) show cases *“where CAPM-generated costs of equity are less than zero; less than the risk-free rate and less than the company’s marginal cost of debt”*. They calculate betas using 60 and 120-monthly returns. They also refer to a *“COMPUSTAT file with 8361 companies with listed betas: 925 of these are negative”*.

Magni (2009, 2010) explains the incorrectness of the CAPM and its development. He also points out that Dybvig and Ingersoll (1982) were the first that noticed that CAPM is at odds with arbitrage pricing.

Shalit and Yitzhaki (2010) argue (with theoretical papers) that the only problem of CAPM is relying on the Normal distribution.

Levy and Roll (2010), with a provocative title (The Market Portfolio May Be Mean/Variance Efficient after All) affirm that *“many conventional market proxies could be perfectly consistent with the CAPM and useful for estimating expected returns... if one allows for only slight estimation errors in the return moments”*. They call this data-massage *“a reverse-engineering approach”*: *“we find the minimal variations in sample parameters required to ensure that the proxy is mean/variance efficient.”* This paper is an example of **“using the hammer to fit the data into a model”**; its graphic representation are the 2 charts in page 2486 about which the authors surprisingly say that *“sample betas are quite close to*

¹² Fernandez and Bermejo (2009), *“ $\beta = 1$ Does a Better Job than Calculated β ”*, <http://ssrn.com/abstract=1406923>. They compute the correlations of the annual stock returns (1989-2008) of the Dow Jones companies with a) β Rm; and with b) Rm; and find that the 2nd correlation (assuming $\beta = 1$ for all companies) is higher than the first one for all companies except Caterpillar and GM. Rm is the return of the S&P 500.

Carvalho and Barajas (2013) study the betas in the Portuguese market and conclude that *“the results could reinforce the position of those who affirm that calculated betas do not work better than beta = 1. In fact, in most of the cases (62.5%) in the sample the beta = 1 provides a better correlation than calculated betas”*.

betas that have been adjusted". Levy and Roll (2010) is an experiment because they use monthly returns of only the 100 biggest US companies in the period Dec. 1996- Dec. 2006 (in that period the average returns of all companies were positive). They work with historical returns but claim to prove or disprove something for the CAPM that deals with expected returns. Brennan and Lo (2010) designate an efficient frontier as "impossible" when every efficient portfolio has at least one negative weight. They prove that the probability of an impossible frontier approaches 1 as the number of assets increases and with sample parameters. Levy and Roll (2011) refer to Brennan and Lo (2010) and admit that "sample parameters lead to an impossible frontier"... "But a slight modification of the parameters leads to a segment of positive portfolios on the frontier".

Levy (2011) argues that although behavioral economics contradicts aspects of expected utility theory, CAPM and M-V (mean-variance rule) are intact in both expected utility theory and cumulative prospect theory frameworks. He says that there is furthermore no evidence to reject CAPM empirically when ex-ante parameters are employed. De Giorgi, Hens and Levy (2012) conclude (in an only-theoretical paper) that "the CAPM is intact also in CPT (Cumulative Prospect Theory) framework".

Giannakopoulos (2013) finds that "regarding the Levy/Roll (2010) approach, the results for the optimizations are very sensitive to the choice of the portfolio used, the market returns and standard deviation, as well as to the choice of the risk free rate... it is possible to manipulate these results, up to a certain point... in order to accomplish a better outcome and improve the robustness of the model". And also that when we "feed the models with their real market values, the performance of the models is not robust enough in order to justify global acceptance".

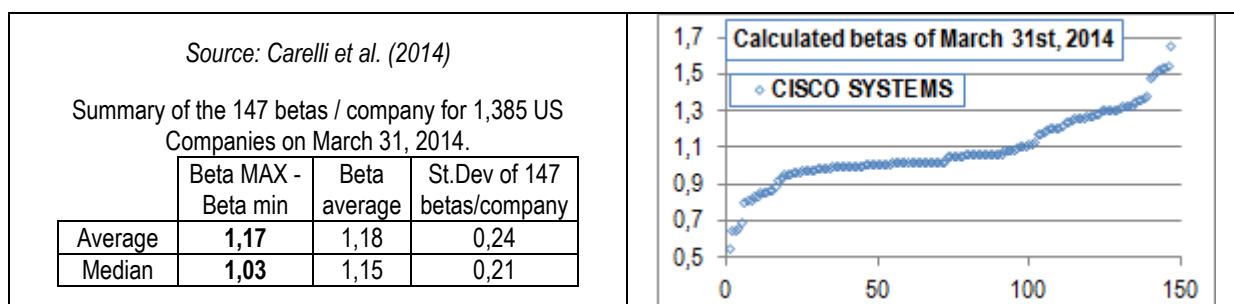
Dempsey (2013) concludes that "unfortunately, the facts do not support the CAPM." He also notes that "A good deal of finance is now an **econometric exercise in mining data**... The accumulation of explanatory variables advanced to explain the cross-section of asset returns has been accelerating, albeit with little overall understanding of the correlation structure between them. We might consider that the published papers exist 'on the periphery of asset pricing'. They show very little attempt to formulate a robust risk-return relationship that differentiates across assets." He finishes with a sensible recommendation: "we must seek to understand markets on their own terms and not on our own."

Stassopoulos (2013) affirms that "Rear-View Mirror Is Misleading", that "the past is no guide to future performance" and that the "rear-view mentality is not the only problem that bedevils traditional methods of assessing future risk". Nevertheless he also advises learning from the past: "think of plausible reasons why a stock has failed to reach our price target, grouping them under four general headings: compliance, financial, operational and strategic".

Antoniou, Doukas, and Subrahmanyam (2014) argue that "the security market line (SML) accords with the CAPM by taking on an upward slope in pessimistic sentiment periods, but is downward sloping during optimistic periods". "High beta stocks become overpriced in optimistic periods", "CFOs can use the CAPM for capital budgeting decisions in pessimistic periods, but not optimistic ones". "Betas are calculated using 24 to 60 monthly returns (as available)"

Gilbert et al. (2014) report that "beta, varies across return frequencies". They show that "Berkshire has a market beta below 0.60 when estimated with daily return data but a beta of about 0.95 when estimated with quarterly data". They conclude that "beta differences across frequencies occur even in large and liquid stocks and cannot be explained by microstructure and trading frictions." They calculate the betas using returns over the previous 60 months.

Carelli et al. (2014)¹³ calculate betas of 1,385 US companies on March 31, 2014: "147 betas for each company using monthly, weekly and daily returns and using different intervals: from 1 to 5 years. The median of the difference [maximum beta - minimum beta] was 1.03. Ranking the companies according to their betas, we find that the average of the [maximum ranking - minimum ranking] for the 1,385 companies is 786."



Almost all of the papers about CAPM published in journals in the last 48 years relay in one calculated beta per date. Carelli et al. (2014) show that for a single date, calculated betas have an average range of 1.03. It is easy to contrast that Carelli's numbers are correct: they imply that most papers that use calculated betas are irrelevant. How is it possible that so many very intelligent referees and editors have approved the publication of so many papers during so many years?

¹³ "Which is the right "Market Beta?", <http://ssrn.com/abstract=2509849>). The authors calculate betas of 1,385 US companies on March 31, 2014: 147 betas for each company.

8. Problems with calculated betas

According with the CAPM “the market” “assigns” an expected beta to every company and that beta may be calculated with a regression of historical data. Of course, every investor should use this “market beta”. As we have already mentioned, the first problem is that this “market beta” does not exist.

When we calculate betas using historical data we encounter several well-known problems:

1. They depend very much on which stock index is used as the market reference.
2. They depend very much on the historical period (5 years, 3 years...) used¹⁴.
3. They depend on what returns (monthly, yearly...) are used to calculate them.
4. They change considerably from one day to the next¹⁵.
5. Very often we do not know if the beta of one company is lower or higher than the beta of another.
6. Calculated betas have little correlation with stock returns.
7. $\beta = 1$ has a higher correlation with stock returns than calculated betas for many companies
8. The correlation coefficients of the regressions used to calculate the betas are very small.
9. The relative magnitude of betas often makes very little sense: companies with high risk often have lower calculated betas than companies with lower risk.

Damodaran (1994) calculates the beta of Disney using daily, weekly, monthly and quarterly returns of the last 3, 5 and 10 years, with respect to the Dow 30, the S&P 500 and the Wilshire: the betas ranged from 0.44 to 1.38. Damodaran (2001) calculates different betas for Cisco versus the S&P 500 ranging from 1.45 to 2.7.

Fernandez (2004)¹⁶ shows the calculated betas of Coca-Cola and other companies on September 30, 2003. Betas were calculated with respect to different indexes, and using different frequencies (daily, weekly, biweekly and monthly), and different periods (6 months, 1 year and 5 years). The calculated betas of Coca-Cola varied between -0.08 and 0.82; and those of Merck between 0.05 and 1.48.

Fernandez (2006)¹⁷ calculated betas of 3,813 US companies using 60 monthly returns each day of December 2001 and reports: 1. The median of [maximum beta / minimum beta] was 3.07 for the whole sample (2.11 for the companies in the S&P 500). 2. Industry betas: the average of [maximum beta / minimum beta] was 2.7. 3. Constructing portfolios in the Fama and French (1992) way on December 1 and on December 15, 2001, 71.3% of the companies changed from one portfolio on December 1 to another on December 15.

Different beta sources provide us with different betas. Bruner et al. (1998) found sizeable differences among beta providers. Fernandez (2009b)¹⁸ shows betas provided by 16 webs and databases: the betas of Coca Cola ranged from 0.31 to 0.8; and the betas of Wall-Mart Stores from 0.13 to 0.71.

Copeland, Koller and Murrin (2000) recommend “checking several reliable sources because beta estimates vary considerably”. But about the CAPM, they conclude (see their page 225), “It takes a better theory to kill an existing theory, and we have not seen the better theory yet. Therefore, we continue to use the CAPM.” We do not agree: common sense, experience and some business and financial knowledge are much better than a bad theory.

Fernandez (2009b) reports 2,510 answers from professors from 65 countries: 1,791 respondents used betas. 97.3% of the professors that justify the betas use regressions, webs, databases, textbooks or papers, although many of them admit that calculated betas “are poorly measured and have many problems”. Only 0.9% of the professors justified the beta using exclusively personal judgment (named *qualitative betas*, *common sense betas*, *intuitive betas*, *logical magnitude betas* and *own judgment betas* by different professors). The Webs and Databases most cited by the professors were: Yahoo Finance; Bloomberg; Damodaran Website; Value Line; Google finance; Reuters; DataStream; Morningstar; Barra; MSN.

¹⁴ Brigham and Gapenski (1977, p. 354, footnote 9) report an illustrative anecdote in this respect: “A company that supplied betas told the authors that their company, and others, did not know what was the most appropriate period to use, but that they had decided to use 5 years in order to eliminate apparent differences between the betas provided by different companies, because big differences undermined the credibility of all of them”

¹⁵ Some authors, such as Damodaran (2001, p. 72), acknowledge that company betas vary considerably, but claim that industry betas (the beta of the portfolio composed of the companies in a given industry) vary very little. They therefore recommend using the calculated beta of an industry. However, although industry betas vary less than company betas, they still vary significantly and using them can lead to serious errors.

¹⁶ “On the instability of betas: the case of Spain” <http://ssrn.com/abstract=510146>

¹⁷ “Are Calculated Betas Good for Anything?”, <http://ssrn.com/abstract=504565>

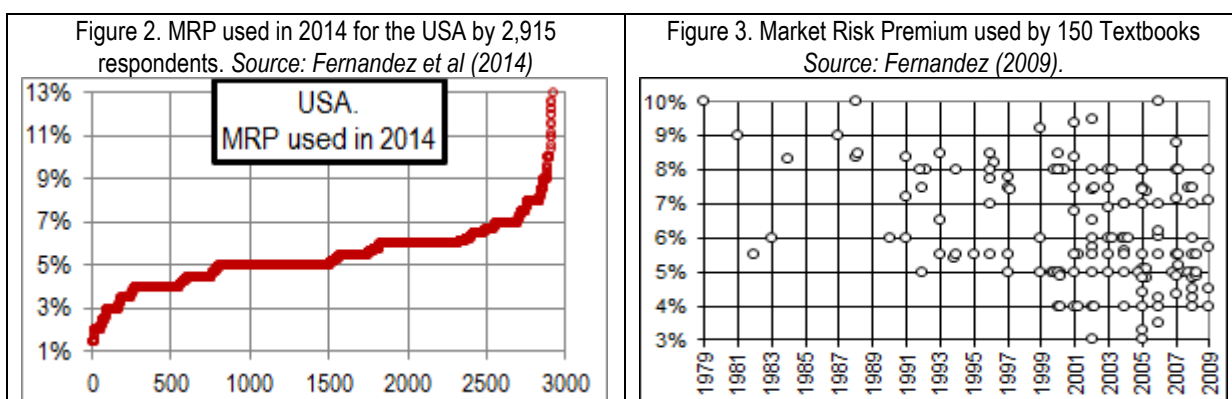
¹⁸ “Betas used by Professors: a survey with 2,500 answers” <http://ssrn.com/abstract=1407464>

9. Problems calculating the Market Risk Premium

Other error of many CAPM users is to assume that “the market” has an expected MRP (market risk premium). They consider the MRP as a parameter “of the market” and not a parameter that is different for different investors.

Fernandez, Aguirreamalloa and Corres (2011)¹⁹ show that the average MRP used in 2011 for the USA by professors, analysts and company managers were 5.7%, 5.0% and 5.6% (standard deviations: 1.6%, 1.1% and 2.0%). They also found a great dispersion in the MRP used even if it was justified with the same reference: those that cited Ibbotson as their reference used MRP for USA between 2% and 14.5%, and those that cited Damodaran as their reference used MRP between 2% and 10.8%. Figure 2 shows the dispersion of the MRP used by 2,915 respondents in 2014.

Fernandez (2009)²⁰ reviews 150 textbooks on corporate finance and valuation written by authors such as Brealey, Myers, Copeland, Damodaran, Merton, Ross, Bruner, Bodie, Penman, Arzac... and finds that their recommendations regarding the MRP range from 3% to 10% (see figure 3), and that 51 books use different MRP in various pages. Some confusion arises from not distinguishing among the four concepts that the MRP designates: the Historical, the Expected, the Implied and the Required equity premium (incremental return of a diversified portfolio over the risk-free rate required by an investor).



10. Expected, required and historical parameters

Fernandez (2006b)²¹ claims that “the equity premium (EP or MRP) designates four different concepts: Historical Equity Premium (HEP); Expected Equity Premium (EEP); Required Equity Premium (REP); and Implied Equity Premium (IEP)... confusing message in the literature. The confusion arises from not distinguishing among the four concepts and from not recognizing that although the HEP should be equal for all investors, the REP, the EEP and the IEP differ for different investors”. “The CAPM assumes that REP and EEP are unique and that $REP = EEP$ ”. Different authors claim different relations among the four equity premiums defined. These relationships vary widely:

- **HEP = EEP = REP:** Brealey-Myers (1996); Copeland *et al* (1995); Ross *et al* (2005); Stowe *et al* (2002); Pratt (2002); Bruner (2004); Bodie *et al* (2003); Damodaran (2006); Goyal-Welch (2008); Ibbotson (2006).
- **EEP is smaller than HEP:** Copeland *et al* (2000, HEP-1.5 to 2%); Goedhart *et al* (2005, HEP-1 to 2%); Bodie *et al* (1996, HEP-1%); Mayfield (2004, HEP-2.4%); Booth (1999, HEP-2%); Bostock (2004, 0.6 to 1.8%); Dimson *et al* (2006, 3 to 3.5%); Siegel (2005b, 2 to 3%); Ibbotson (2002, < 4%); Campbell (2002, 1.5 to 2%); Campbell (2007, 4%).
- **EEP is near zero:** McGrattan and Prescott (2001); Arnott and Ryan (2001); Arnott and Bernstein (2002).
- **“that no one knows what the REP is”:** Penman (2003).
- **“it is impossible to determine the REP for the market as a whole, because it does not exist”:** Fernandez (2002).
- **“different investors have different REPs”:** Fernandez (2004).

The Historical Equity Premium (HEP) is not a good estimator of the EEP. Although Mehra and Prescott (2003) state that “...over the long horizon the equity premium is likely to be similar to what it has been in the past”, the magnitude of the error associated with using the HEP as an estimate of the EEP may be substantial. Shiller

¹⁹ “US MRP Used in 2011 by Professors, Analysts and Companies: A Survey”, <http://ssrn.com/abstract=1805852>

²⁰ “The Equity Premium in 150 Textbooks”, <http://ssrn.com/abstract=1473225>. 129 of the books identify EEP and REP and 82 identify EEP and HEP.

²¹ “Equity Premium: Historical, Expected, Required and Implied” <http://ssrn.com/abstract=933070>

(2000) points out that *“the future will not necessarily be like the past”*. Booth (1999) concludes that the HEP is not a good estimator of the EEP and estimates the later in 200 basis points smaller than the HEP²².

Survivorship bias²³ was identified by Brown, Goetzmann and Ross (1995): they pointed out that the observed return, *conditioned on survival* (HEP), can overstate the unconditional expected return (EEP). However, Li and Xu (2002) show that the survival bias fails to explain the equity premium puzzle: *“To have high survival bias, the probability of market survival over the long run has to be extremely small, which seems to be inconsistent with existing historical evidence”*.

Constantinides (2002) says that the conditional EEPs at the beginning of the 21st century are substantially lower than the estimates of the unconditional EEP (7%) *“by at least three measures”*.

Dimson *et al* (2003) highlight the survivorship bias relative to the market, *“even if we have been successful in avoiding survivor bias within each index, we still focus on markets that survived”* and concluded that the geometric EEP for the world’s major markets should be 3% (5% arithmetic). Dimson *et al* (2006) admit that *“we cannot know today’s consensus expectation for the equity premium”*, but they conclude that *“investors expect an equity premium (relative to bills) of around 3-3½% on a geometric mean basis”*, substantially lower than their HEP.

Regressions to find the EEP. Attempts to predict the MRP typically look for some independent lagged predictors (X) on the MRP: $MRP = a + b \cdot X_{t-1} + \varepsilon_t$. Many predictors have been explored in the literature:

- Dividend yield: Ball (1978), Rozeff (1984), Campbell (1987), Campbell and Shiller (1988), Fama and French (1988), Hodrick (1992), Campbell and Viceira (2002), Campbell and Yogo (2003), Lewellen (2004), and Menzly, Santos, and Veronesi (2004).
- The short term interest rate: Hodrick (1992).
- Earnings price and payout ratio: Campbell and Shiller (1988), Lamont (1998) and Ritter (2005).
- The term spread and the default spread: Avramov (2002), Campbell (1987), Fama and French (1989), and Keim and Stambaugh (1986).
- The inflation rate (money illusion): Fama and Schwert (1977), Fama (1981), and Campbell and Vuolteenaho (2004a,b), and Cohen, Polk and Vuolteenaho (2005).
- Interest rate and dividend related variables: Ang and Bekaert (2003).
- Book-to-market ratio: Kothari and Shanken (1997).
- Value of high and low-beta stocks: Polk, Thompson and Vuolteenaho (2006).
- Consumption and wealth: Lettau and Ludvigson (2001).
- Aggregate financing activity: Baker and Wurgler (2000) and Boudoukh *et al* (2006).
- Momentum: Fama and French (2012)
- Accounting profitability: Fama and French (2014)

Goyal and Welch (2008) show that most of these models did not performed well for the last thirty years, that were not stable, and that were not useful for market-timing purposes.

Campbell and Thompson (2008) conclude that: *“The basic lesson is that investors should be suspicious of predictive regressions with high R² statistics, asking the old question ‘if you’re so smart, why aren’t you rich?’”*

Harvey, Liu and Zhu (2014) revise 313 papers that study cross-sectional return patterns. They mention that *“at least 316 factors have been tested to explain the cross-section of expected returns”* and Cochrane (2011) refers to that as *“a zoo of new factors”*. They argue that *“it is a serious mistake to use the usual statistical significance cutoffs (e.g., a t-ratio exceeding 2.0) in asset pricing tests”* and conclude that *“many of the factors discovered in the field of finance are likely false discoveries”* and that *“most claimed research findings in financial economics are likely false.”*

Other estimates of the EEP. Siegel (2002, page 124): *“the future equity premium is likely to be in the range of 2 to 3%, about one-half the level that has prevailed over the past 20 years”*²⁴. Siegel (2005a, page 172): *“over the past 200 years, the equity risk premium has averaged about 3%”*. Siegel (2005b): *“although the future equity risk premium is apt to*

²² He also points out that the nominal equity return did not follow a random walk and that the volatility of the bonds increased significantly over the last 20 years.

²³ *“Survivorship”* or *“survival”* bias applies not only to the stocks within the market (the fact that databases contain data on companies listed today, but they tend not to have data on companies that went bankrupt or filed for bankruptcy protection in the past), but also for the markets themselves: *“US market’s remarkable success over the last century is typical neither of other countries nor of the future for US stocks”* (Dimson *et al* 2004).

²⁴ Siegel also affirms that: *“Although it may seem that stocks are riskier than long-term government bonds, this is not true. The safest investment in the long run (from the point of view of preserving the investor’s purchasing power) has been stocks, not Treasury bonds”*.

be lower than it has been historically, U.S. equity returns of 2-3% over bonds will still amply reward those who will tolerate the short-term risk of stocks”.

McGrattan and Prescott (2001) forecasted that the real returns on debt and equity should both be near 4%. Arnott and Ryan (2001) claim that the expected equity premium is near zero. Arnott and Bernstein (2002) also conclude that *“the current risk premium is approximately zero”*. In June 2002, Ibbotson forecasted *“less than 4% in excess of long-term bond yields”*, and Campbell *“1.5% to 2%”*.

Bostock (2004) concludes that equities should offer a risk premium over government bonds between 0.6% and 1.8%. Grabowski (2006): *“after considering the evidence, any reasonable long-term estimate of the normal EEP as of 2006 should be in the range of 3.5% to 6%”*. Maheu and McCurdy (2006) suggest an EEP between 4.02% and 5.1%.

11. How to calculate required returns?

The easiest way is in Fernandez (2013)²⁵: *“As the expected equity cash flows (ECF) are riskier than the cash flows promised by the Government bonds and also riskier than the cash flows promised by the Debt of the company the **required return to equity** (K_e) should be higher than risk-free rate (R_f) and also higher than the required return to Debt (K_d): $K_e = R_f + RPs$ (shares risk premium)”*.

Company valuation using discounted cash flows is based on the valuation of the Government bonds: it consists of applying the procedure used to value the Government bonds to the debt and shares of a company. This is easy to understand. But company valuations are often complicated by ‘additions’ (formulae, concepts, theories...) that complicate its understanding and provide a more *“scientific”, “serious”, “intriguing”, “impenetrable”,...* appearance. Among the most commonly used ‘additions’ are: WACC, beta (β), market risk premium, beta unlevered... Most of these ‘additions’ are unnecessary complications and are the source of many errors

12. How to use betas and to be a reasonable person

We may want to calculate RPs (shares risk premium) as a product: $RPs = \beta \text{ MRP}$

The MRP (**market risk premium**) is the “shares risk premium” of the investor applied to the whole market (or to a portfolio with shares of most of the companies traded in the stock markets). The MRP is the answer to the following question: *Knowing that your money invested in long-term Government bonds will provide you a return of $R_f\%$ almost for sure, which additional return do you require to another investment (in a portfolio with shares of most of the companies with shares traded in the financial markets) for feeling compensated for the extra risk that you assume?* In 2012 about 75% of the MRP used for the USA market were in the range between 4% and 6.5%²⁶. The MRP is also called *“equity premium”, “equity risk premium”, “market premium” and “risk premium”*.

The β (**beta**) is a specific parameter for each company. We know that $\beta=0$ corresponds to Government bonds (no risk) and $\beta=1$ to an investment with a risk similar to that of the market. About 80% of the betas used in valuations are in the interval between 0.7 and 1.5. A beta lower than 0.7 could be applicable to companies with Equity Cash Flows (ECF) highly predictable (electric companies and other utilities in countries with expectations of very few surprises and sensible managers...). A beta higher than 1.5 could be applicable to new companies with high uncertainty about the market acceptance of their products, companies with managers with little common sense... Using beta and MRP, $K_e = R_f + \beta \text{ MRP}$

Calculating a qualitative beta. According to the CAPM, all investors should use the same β and the same MRP. On top of that, the β of each company and the MRP are parameters that “exist” and we should be able to estimate accurately with appropriate statistical tools. We do not share this view and we think that the β of each company and the MRP should be computed for each company and every investor using common sense (experience²⁷ and some business and financial knowledge) about the company, its industry, the national economies...²⁸

Given the instability and the meaninglessness of historical betas, some companies are increasingly resorting to calculating a qualitative beta of companies or investment projects. Example: A real company uses the MASCOFLAPEC method (from the initials of the parameters used to evaluate the risk of each project) to estimate the beta. Each parameter is scored from 1 to 5 according to its contribution to the risk. Each factor also has to be

²⁵ “Cash Flow Discounting: Fundamental Relationships and Unnecessary Complications” <http://ssrn.com/abstract=2117765>

²⁶ “MRP Used in 82 Countries in 2012: A Survey with 7,192 Answers”, <http://ssrn.com/abstract=2084213>

²⁷ *“Experience doesn’t consist of the number of things one has seen, but of the number of things on which one has reflected”*. Pereda, José María. Writer. Santander. Spain

²⁸ Another method for family business is explained by my friend Guillermo Fraile, IAE professor at Buenos Aires, in his classes: the HMDYWD (initials for *How much do you want, Dad?*) method. It is not a joke: it does not make sense to say that K_e (required return to equity) is a magnitude shared by all investors; but it does to talk about Dad’s K_e .

weighted. In the attached example, the sum of the scores of each parameter, bearing in mind its weight, was 3.5. Multiplying this number by 0.5, we obtain a beta of 1.75. Note that with this system (owing to the parameter 0.5) the beta can vary between 0.5 and 2.5. If a parameter equal to 0.6 were used, then the beta could vary between 0.6 and 3.0.

Alternatives to MASCOFLAPEC: MARTILLO and BAMIFLEX

MARTILLO: **M**anagement; **A**sset quality; **R**isk exposure; **T**rade analysis: product/market; **I**RR of new investments; **L**everage; **L**iquidity; **O**ther relevant factors.

BAMIFLEX: **B**usiness: product / demand / market; **A**ccess to credit: capacity to obtain finance; **M**anagement: managers, shareholders...; **I**ndebtedness, solvency and long-term survival; **F**lows: resource generation (capacity to pay debts) and return; **L**iquidity of the shares; **E**xposure to other risks: foreign exchange, country, interest rate, raw materials...

Calculation of a "common sense beta": MASCOFLAPEC

Weight			Risk					Weighted risk
			low	average	substantial	high	very high	
			1	2	3	4	5	
10%	M	Management	1					0.1
25%	A	Assets: Business: industry / product ...					5	1.2
3%	S	Strategy				4		0.1
15%	C	Country risk				4		0.6
10%	O	Operating leverage				4		0.4
15%	F	Financial leverage		2				0.3
5%	L	Liquidity of investment					5	0.2
5%	A	Access to sources of funds			3			0.1
2%	P	Partners				4		0.0
5%	E	Exposure to other risks (currencies...)		2				0.1
5%	C	Cash flow stability			3			0.1
100%								3.5
			Beta of equity =					
			3.5 x 0.5 =					1.75

These methods are simply an aid to common sense. The beta that should be used to value a company will depend on the risk that the valuer sees in the expected flows of the company.

13. Conclusion

An anecdote from Merton Miller (2000, page 3) about the expected return in the Nobel context: "I still remember the teasing we financial economists, Harry Markowitz, William Sharpe, and I, had to put up with from the physicists and chemists in Stockholm when we conceded that the basic unit of our research, the expected rate of return, was not actually observable. I tried to tease back by reminding them of their neutrino – a particle with no mass whose presence was inferred only as a missing residual from the interactions of other particles. But that was eight years ago. In the meantime, the neutrino has been detected".

CAPM is about **expected** return. It is clear that both, the assumptions and the predictions/conclusions of the CAPM, have no basis in the real world²⁹. On the other hand, if you find a formula for expected returns that works reasonable well in the real markets, would you publish it? Before or after being billionaire?

Valuation and capital investment is about **required** return. But there are professors and finance professionals that mix (or assume that are equal) expected return and required return.

Fama and French (2004) stated that "Unfortunately, the empirical record of the model is poor – poor enough to invalidate the way it is used in applications... Evidence mounts that much of the variation in expected return is unrelated to market beta."

Several professors, professionals and Ph.D. students wrote many interesting comments and criticism to this document that are collected in Fernandez (2015)³⁰. I have learned a lot reading (and thinking about) all of them because are real opinions of real persons that know finance and have thought about it.

²⁹ **An assumption:** homogeneous expectations (same expected return, volatility and correlations for every security),

Some predictions: All investors: **a**) will always combine a risk free asset with the market portfolio; **b**) will have the same portfolio of risky assets (the market portfolio); **c**) agree on the expected MRP and on the beta of every asset, **d**) expect returns from their investments according to the betas.

³⁰ Fernandez, P. (2015), "CAPM: The Model and 305 Comments About It", <http://ssrn.com/abstract=2523870>

Imagine that we build a “model” of how Peter Pan, Cinderella and some friends should analyze and decide about investments in “their” financial market. Then we test that “model” with real market data and realize that the “model” has nothing to do with the data. There are 2 reactions to that:

- a) This model is absurd
- b) This model is useful because it is testable and allows you to think why it does not work. Not only that: we can try to improve the “model” adding variables, measuring better the parameters (of the Peter Pan & Co. market).

We think that common sense, experience and some business and financial knowledge are much better than a bad theory and an absurd model.

“Experience doesn’t consist of the number of things one has seen, but of the number of things on which one has reflected”.
Pereda, José María. Writer. Santander. Spain

Merriam-Webster dictionary:

Common sense: "sound and prudent judgment based on a simple perception of the situation or facts."

Opinion: a belief, judgment, or way of thinking about something:: advice from someone with special knowledge : advice from an expert

Wishful thinking: an attitude or belief that something you want to happen will happen even though it is not likely or possible. The attribution of reality to what one wishes to be true or the tenuous justification of what one wants to believe

Cause: something or someone that produces an effect, result, or condition; something or someone that makes something happen or exist. **Mystery:** something not understood or beyond understanding.

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