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IS THE RISK-RETURN PARADOX STILL ALIVE?[1]

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Abstract

To date, the validity of empirical Bowman's paradox papers that employ mean-variance approach for testing the risk/return relationship are inherently unverifiable and their results cannot be generalized. However, this problem can be overcome by developing an econometric model with two fundamental characteristics. The first one is the use of a time series model for each firm, avoiding the traditional cross-sectional analysis. The other one is to estimate a model with a single variable (the firm rate of return), but whose expectation and variance are mathematically related according to behavioral theories hypotheses, forming a heterocedastic model similar to "GARCH". Our results agree with behavioral theories and show that these theories can also be carry out with market measures.

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1. INTRODUCTION

Since Bowman (1980) found that the relationship between risk and return could be negative when accounting measures were used, a fruitful research stream on this Bowman's paradox has developed (e.g., Ruefli et al. 1999; Nickel and Rodríguez 2002). The most extended theoretical explanation for this paradox has been the consideration of a double risk-return relationship (negative for low outcomes and positive for high ones) derived from two behavioral theories: the Prospect Theory (Kahneman and Tversky 1979) and the Behavioral Theory of the Firm (Cyert and March 1963).

Because of the nature of the phenomenon, however, the empirical tests display an important methodological problem of lack of identification that does not allow the verification of these theories or a means to generalize their results when the mean-variance approach is used (Ruefli 1999, p. 178). There are two causes of this lack of identification problem. First, if the returns distribution is allowed to vary over time, a negative mean-variance relationship for a given period can be generated by positive or negative relations in the subperiods (Ruefli 1990, p. 372; Lehner 2000, pp. 66–67), which makes it impossible to verify if the discovered relation can be applied to other periods. Second, the cross-sectional design is employed in most of the paradox studies. In the same sense that the instability of the returns distribution across time periods can be a problem, the different returns distributions across firms can cause another identification problem (MacCrimmon and Wehrung 1986; March 1988; Lee 1997). Thus, a negative cross-sectional risk-return relation for a set of firms can be the result of positive risk-return relations for firms. Therefore, the behavioral point of view cannot be verified in a cross-sectional approach.

To solve this problem, we translate the perspective of the behavioral theories on risk taking by specifying an econometric model that is indexed by firms. According to behavioral theories, the return is considered a heteroscedastic variable because its variance at each time period is variable and it is related to the expected return. That is, we estimate heteroscedastic models with only one variable (return), but whose first statistical moments are linked.

We use market measures to test this new model for three reasons:

1. A relatively new research stream in financial economics (beta's death) has found a flat relation between risk and return with market data (Fama and French 1992), which could denote a symptom of behavior theories.

2. Despite attempts to test the "paradox" using accounting and market risk-return relations, organization scholars have not studied the relation at the market level as deeply as the accounting relation (Ruefli et al. 1999, p. 176; Nickel and Rodríguez 2002, p. 15).

3. Using market measures avoids the accounting manipulation criticism (Bowman 1980 p. 25).

This study offers two main contributions to the literature on Bowman's paradox. First, we provide a heteroscedastic model that overcomes previous criticisms and is an appropriate representation of the data. Second, this model overcomes the same tests with market measures. This provides an additional step in this research stream because the proof of the behavioral theories may also be used in financial economics. Total risk is total risk irrespective of whether the decision maker measures it by accounting or market measures.

In addition, the results allow us to make several conclusions. First, the results are consistent with behavioral theories on risk taking. Second, there is no difference between the risk-return relationship when accounting or market measures are employed. That is, there would be no "paradox" because the traditional assumption of a positive relationship between risk and return at the market level is wrong when equities are individually analyzed.

The paper is structured as follows: in the following section we explain the identification problem, and how this problem can be avoided. Next, according to behavioral theories, we develop a new econometric model that overcomes the previous criticisms. In the methods section, the sample data, the variables and the estimation methodology are described. The second last section shows the results of the tests. The paper concludes with some discussion and conclusions.

2. THEORETICAL BACKGROUND

2.1. The identification problem

An identification problem arises when the data can be explained by different theories, but it is not possible to distinguish between them (Greene 1993, p. 585). This identification problem is present in Bowman's paradox, either where a mean-variance approach is used for testing the risk-return relation or where a cross-sectional design has been used in the analysis.

There are two sources of the lack of identification problem. The first is the possible temporal instability of the return distribution. In this sense, the computed mean-variance relationship for a period can be the result of elements drawn from a single mean-variance relation, and thus it would be the accurate identification of the mean-variance relation. But that relation could also be the result of elements drawn from a series of different mean-variance relations, which have resulted from shifts in an underlying distribution of returns over time (Ruefli 1990, p. 371). In this case, the mean-variance relation obtained is meaningless. Therefore, we obtain an identification problem because it is not possible to determine if the obtained relationship corresponds to the first or the second case. Supporting this argument, Ruefli (1990) demonstrated that a negative or a double risk-return relationship for a period could be generated by a series of positive relations in the sub-periods.

The identification problem produced by the temporal instability of the returns distribution is augmented because both the sample mean and the sample variance are functions of the same variable. Therefore, if they are included as two different variables in a regression model, the number of variables is smaller than the number of parameters (Ruefli 1990, p. 372; Ruefli et al. 1999, p. 172; Lehner 2000, p. 66).

Finally, by regressing sample variances on sample means, a negative relation between the independent variable and the error term is produced, violating a key requirement of the regression model (Ruefli 1991, p. 1211).

The second source of the lack of identification, when risk attitudes are used as a basis for explaining the relationship, is the cross-sectional design. Cross-sectional analyses have been used in most of the studies that have tried to test the risk-return behavioral hypotheses (Lee 1997, p. 63). As for the former temporal instability, the differences among the firm-specific return distributions permit a negative cross-sectional risk-return relationship, which could be produced by positive risk-return relationships for each firm individually. In this sense, it is possible that each firm of an industry exhibits a risk-averse attitude, and hence the risk-return relation for each firm would be positive. However, it is also possible that the firms with more profitable investment opportunities also have the ability of obtaining profits at a lower risk level, producing a negative cross-sectional risk-return relationship for the industry.

In other words, the variation in risk taking across organizations can be produced both by stable differences among them that also produce differences in their successes, or from different risk attitudes, as behavioral theories hypothesize (March 1988, p. 6). Therefore, a cross-sectional design does not allow the differentiation between one explanation and another. In this sense, several organizational papers have demonstrated that strategic differences among firms can influence both return and risk. Among these strategic explanations are the diversification strategy (Bettis and Hall 1982; Bettis and Mahajan 1985; Amit and Livnat 1988; Chang and Thomas 1989; Kim et al. 1993), market power (Cool et al. 1989), and the influence of risk on return (Miller and Bromiley 1990). Therefore, in a cross-sectional approach it is not possible to state if the risk-return relationship is due to the risk-attitude (supporting behavioral theories) or to firm-specific characteristics.

The cross-sectional approach has been previously criticized by other authors, who point out that it is not a proper method for testing behavioral perspectives on risk taking (MacCrimmon and Wehrung 1986; Lee 1997). This criticism is based on the fact that risk attitudes are dependent not only on the context of the decision making, but also on various characteristics inherent to the decision maker or the organization (MacCrimmon and Wehrung 1986). Therefore, the risk attitude is a firm-specific concept. Since a behavioral perspective on risk taking is entirely based on changing risk-attitudes, it cannot be properly tested in a cross-sectional design but should be tested on a firm-specific basis (Lee 1997, p. 63).

2.2. Overcoming the identification problem

The second source of the lack of identification problem (the cross-sectional design) can be eliminated by adopting a longitudinal approach. Additionally, the longitudinal firm-specific design is more appropriate for testing hypotheses based on risk attitudes (Lee 1997), as stated previously.

Regarding the first source of the lack of identification, Bromiley (1991b p. 1208) stated that the most direct way to avoid the problem of the temporal instability is to assume that the returns distribution is stable for the period analyzed. This solution, however, presents several problems. First, we can assume this stability only for short periods, but not for the long run (Lehner 2000, p. 67). Second, this assumption requires that each firm have its own returns distribution in order to avoid the spurious correlation (Ruefli 1991, p. 1213; Ruefli and Wiggins 1994, p. 755). Third, if a longitudinal approach is used, this assumption contradicts the behavioral theories: the stability of the returns distribution implies the stability of its first two moments. Therefore, if both the mean and the variance are considered fixed for a period, the variance will be independent of the expectation, and hence it makes no sense to test the hypothesis that the variance is dependent on the expected return.

In conclusion, another solution, different from time stability, must be used. Ruefli et al. (1999) propose the use of alternative measures of risk for overcoming the identification problem. In this sense, various works have employed such variables, for example, the variance of the forecasts of analysts (Bromiley 1991a), content-analysis-based measures (Bowman 1984; Lee 1997), ordinal risk (Collins and Ruefli 1992) and downside risk (Miller and Leiblein 1996).

A third solution is to recover the variance as the principal risk measure. Variance is the risk measure most often used by different research streams, not only by Bowman's paradox. It is easily calculated and is easily understood by both the scientific and managerial views. Its only problem is the criticism in relation to the lack of identification of the models considered above. According to this solution, it would be possible to develop a model with a single variable (the firm rate of return), whose first two statistical moments could be related, as behavioral theories predict. In this way, variance and expectation of returns would be estimated without employing the sample variance and/or the sample mean.

In summary, all identification problems can be solved if the model meets three requirements. First, it must be a firm-specific longitudinal model, where expectation and variance can change across time. Second, it must be a heteroscedastic model, for allowing the change of variance with time. Third, the expectation and the variance are linked in the returns distribution, but not as two different variables in a regression model.

2.3. Model development

The Prospect Theory (Kahneman and Tversky 1979) and the Behavioral Theory of the Firm (Cyert and March 1963) are the two behavioral theories employed by researchers of Bowman's paradox for explaining the risk-return relationship. Both theories coincide in the existence of a double risk-attitude, which results in a double risk-return relationship.

We define the evolution of the return variable on the time to develop a new econometric model. Without loss of generality, we accept as a first assumption that returns evolve over time following an auto-regressive time-series model, as described in equation (1),

$$R_{it} = f\left(R_{it-1}, R_{it-2}, \ldots, R_{it-n}\right) + \varepsilon_{it} \qquad (1)$$

where R_{it} is the return for firm i in period t; R_{it-1}, R_{it-2} … R_{it-n} are the rates of return obtained in the n previous periods; ε_{it} is the error term, normally distributed with zero mean and finite variance.

According to behavioral theories, at the beginning of a period, managers estimate the expected return for that period (Cyert and March 1963, p. 163). This expected return is obtained by estimating, at period t-1, the expectation of equation (1) for period t:

$$E_{t-1}(R_{it}) = E_{t-1}\left[f(R_{it-1}, R_{it-2},..., R_{it-n}) + e_{it}\right] = f(R_{it-1}, R_{it-2},..., R_{it-n}) \qquad (2)$$

When the expected return for period t is estimated, the real rates of return, obtained in the previous periods, are already known, and therefore they are constants, not random variables.

To estimate the risk for each period, we calculate the variance of equation (1) for each period. Since the previous rates of return are constant at the period t, the variance of returns is equal to the variance of the error term:

$$s^2_{t-1}(R_{it}) = s^2_{t-1}(e_{it}) \qquad (3)$$

Following the arguments of behavioral theories, managers compare the returns expectation with the return level they aspire to (Kahneman and Tversky 1979, p. 277; Cyert and March 1963, p. 169). We denote this aspiration level by A_{it}. This comparison between the expected return and the aspiration level determines the amount of risk the managers will accept at the period t.

Thus, if the expected return is greater than the aspiration point, managers exhibit a risk-averse attitude (Kahneman and Tversky 1979, p. 279; Cyert and March 1963, pp. 166–167), which implies a positive risk-return association. In other words, the higher the expectation, the higher the variance. On the other hand, if the expectation falls below the aspiration point, the risk attitude is risk seeking, being the risk taken higher when the expected return is lower (Kahneman and Tversky 1979, p. 279; Cyert and March 1963, p. 167). In conclusion, the distance (positive or negative) between the expected return and the aspiration is positively related with the risk level. Therefore, the minimum risk is reached when the expectation equals the aspiration (Gooding et al. 1996; Lehner 2000). This double risk-return relationship is graphically explained in Figure 1.

Insert Figure 1 about here

If we translate this risk-taking process to an econometric model, we start by assuming that each firm has a minimum risk level, denoted by $\sigma^2(\varepsilon_i)$. This minimum level is firm specific and depends on firm-specific characteristics, such as competitive advantage, consumer orientation, market power, and diversification strategy. This minimum risk is assumed constant over the period considered.

As explained above, the variance of returns at any period is equal to the minimum risk level when the expected return exactly equals the aspiration point:

$$E_{t-1}(R_{it}) - A_{it} = 0 \quad \Rightarrow \quad \sigma^2_{t-1}(\varepsilon_{it}) = \sigma^2(\varepsilon_i) \tag{4}$$

If the expected return is greater than the aspiration point, the risk level is also greater than the minimum risk level. Following the behavioral theories, the greater the distance between the aspiration point and the expectation, the greater the distance between the risk level of the period and the minimum risk level. For simplicity, we assume that both distances are proportional. Analytically:

$$\begin{aligned} &E_{t-1}(R_{it}) - A_{it} > 0 \quad \Rightarrow \quad \sigma^2_{t-1}(\varepsilon_{it}) - \sigma^2(\varepsilon_i) = \beta_{1i} \cdot [E_{t-1}(R_{it}) - A_{it}] \quad \Rightarrow \\ &\sigma^2_{t-1}(\varepsilon_{it}) = \sigma^2(\varepsilon_i) + \beta_{1i} \cdot [E_{t-1}(R_{it}) - A_{it}] \end{aligned} \tag{5}$$

where β_{1i} denotes the relation between the expectation-aspiration distance and the actual risk level-minimum risk level distance.

On the other hand, when the expected return falls below the target level, the managers also increase risk. Once again, the distance between the actual risk level and the distance between aspiration and expectation are assumed to be proportional. Analytically:

$$E_{t-1}(R_{it}) - A_{it} < 0 \quad \Rightarrow \quad s^{2}_{t-1}(e_{it}) - s^{2}(e_{i}) = -b_{2i} \cdot [E_{t-1}(R_{it}) - A_{it}] \quad \Rightarrow$$
$$s^{2}_{t-1}(e_{it}) = s^{2}(e_{i}) + b_{2i} \cdot [A_{it} - E_{t-1}(R_{it})] \qquad (6)$$

equations (4), (5) and (6) show the double risk-return relationship predicted by the behavioral theories. Nevertheless, we obtain a single risk-return equation that resumes these relations in the next equation (sign function):

$$s^{2}_{t-1}(e_{it}) = s^{2}(e_{i}) + d_{it} \cdot b_{1i} \cdot [E_{t-1}(R_{it}) - A_{it}] + (1 - d_{it}) \cdot b_{2i} \cdot [A_{it} - E_{t-1}(R_{it})] \qquad (7)$$

where d_t is a dummy variable that is equal to one if the expected return at the period t is higher than the aspiration level, and zero otherwise. Two different parameters, $\hat{a}_{1i}$ and $\hat{a}_{2i}$, have been employed for the positive and negative distances because prospect theory postulates a different reaction to both kinds of distances. In fact, prospect theory indicates that the reaction to negative distances is higher than the reaction to positive ones (Kahneman and Tversky 1979). These different behaviors for positive and negative outcomes have been previously tested by Fiegenbaum (1990), whose results supported this asymmetric reaction.

In summary, this econometric model describes the behavior of a single variable – the firm rate or return – through a time-series model (equation 1) with a heteroscedastic problem (equation 7).

The estimation of beta parameters establishes if the behavioral theories are supported or not. Thus, if both beta parameters are significantly greater than zero, the behavioral perspective on risk taking is supported. If $\hat{a}_{1i}$ is positive and $\hat{a}_{2i}$ negative, the positive relationship between risk and return is obtained.

3. METHODS

3.1. Database

The database is composed of those firms that form the Standards and Poor's 100 index in the revision of February 2002, for the period between 1-1-1990 and 1-1-2001. Those firms with at least 500 valid observations were selected, making a final sample of 98 firms, ranging from 3651 to 1367 observations for the variation of the return measure. The adjusted stock prices used to compute the variables were obtained from Commodity Systems Inc.

3.2. Measures

In contrast with most traditional papers on Bowman's paradox, this paper employs risk and return measures based on stock market data. Three reasons justify the use of market data. First, few studies have employed market measures for studying the paradox. To our knowledge, the only previous attempts that have studied the "paradox" using market variables are Fiegenbaum and Thomas (1986), Miller and Bromiley (1990), and Veliyath and Ferris (1997). However, the results have been contradictory. Fiegenbaum and Thomas (1986) tested the relationship between the beta parameter and accounting return, finding a positive relationship between them. Miller and Bromiley (1990) used a stock risk measure, which included both systematic and unsystematic risk, but they found no influence of stock risk on performance, nor performance influence on stock risk. Finally, Veliyath and Ferris (1997) found a flat relationship between accounting return and the beta parameters, but a significant negative relationship between accounting return and the total risk, as measured by the stock returns variance.

Second, the validity of the traditional positive relationship at the market level has been challenged since Fama and French (1992), who found a flat relationship between the beta parameters and stock returns. Therefore, since the positive relationship at the market level is seriously questioned, it is interesting to apply the explanations given to the paradox to the risk-return relationship at the market level. The use of market measures by strategic researchers is not new, although accounting returns are commonly considered more directly under managerial control (Bettis and Mahajan 1982, p. 785). Many authors have employed market-based measures for both dimensions, especially when the maximization of the stockholder wealth is taken as the primary objective of the firm (Naylor and Tapon 1982; Ruefli et al. 1999, p. 173).

Third, the use of market measures avoids the criticism that the "paradox" could result from the managerial manipulation of the accounting information (Bowman 1980 p. 25).

Measure of return

The total annual rate of return measure, which has been frequently used in previous literature (e.g., Abowd 1990; Miller and Bromiley 1990; Bloom and Milkovich 1998), can be defined as follows:

$$R_{it} = \frac{P_{it} - P_{it-365}}{P_{it-365}} \qquad (8)$$

where R_{it} is the annual return for a common stock of firm i at day t; P_{it} is the closing price for a common stock of firm i at day t; and P_{it-365} is the closing price for that stock in the same day, but the year before. If the stock did not quote on that date, the nearest previous price was used, and both prices were adjusted for eliminating capital variations and dividends. This return measure was calculated for each day between 1/1/91 and 12/31/00.

Expected return

The function described in equation (1) must be calculated to estimate the expected return. For simplicity, the selected time-series model is assumed to be the first-order auto-regressive integrated (ARI(1)) model. This model is selected because it is the simplest model that fits the available data for all firms, using Box-Jenkins methodology. Therefore, equations (1) and (2) can be re-written in the following way:

$$R_{it} - R_{it-1} = a_i + b_i \cdot \left(R_{it-1} - R_{it-2}\right) + e_{it} \tag{9}$$

$$E_{t-1}\left(R_{it}\right) = R_{it-1} + a_i + b_i \cdot \left(R_{it-1} - R_{it-2}\right) \tag{10}$$

The estimation of model (10) offers values for the parameters, a_i and b_i,, that permit the estimation of the expected return for each firm individually at any period.

Risk measure

The risk measure for the model is defined in equation (7). Although the most widely used market risk measure in the strategic-management literature has been the systematic risk (Ruefli et al. 1999), we have employed a total risk measure: the total variance of returns.

There are various reasons for using the total risk measure instead of systematic risk. The first is that the variance of returns is a more appropriate proxy for the managerial perspective on risk than the systematic risk (Veliyath and Ferris 1997, p. 220). Thus the CAPM considers only the systematic risk because stockholders can reduce the firm-specific unsystematic risk to zero by simply diversifying their portfolio by buying additional shares. However, managers cannot eliminate the unsystematic portion of risk because they are concerned with firm-specific risks, and they do not have the opportunity of diversifying them in the same sense as stockholders (Veliyath and Ferris 1997, pp. 219–220). Therefore, the total risk is a more appropriate measure for the managerial concept of risk. On the other hand, the managerial control over systematic risk is theoretically less than that over the total risk, since the systematic risk depends not only on managerial actions, but also on market-wide factors (Naylor and Tapon 1982; Veliyath and Ferris 1997).

In addition to the former problems, several researchers in financial economics have obtained a flat relationship between systematic risk and return, especially from Fama and French (1992). One of the explanations for this flat relationship is that the beta parameter of the CAPM cannot capture all the systematic risk factors that can influence the stock returns (e.g., Fama and French 1993; Jegadeesh and Titman 1993; Davis, 1994; Lakonishok et al. 1994; Wang 2000). If this explanation is accepted, the traditional systematic risk measure (the beta parameter from the CAPM) does not capture all the risk factors, and, therefore, it cannot be a proper measure of risk (Ruefli et al. 1999, p. 172).

Finally, recent studies in financial economics have noted the existence of serious methodological problems in calculating the systematic measure of risk empirically. Roll and Ross (1994) demonstrated that a mean-variance efficient market index is necessary for obtaining good estimation of the systematic model. Nevertheless, since it is impossible to verify empirically this fact, the practical use of the CAPM theory is severely limited (Roll and Ross 1994, p. 111).

In summary, all these important problems with the beta parameter suggest that the variance of market return should be selected as the risk measure rather than systematic risk.

Aspiration point

The aspiration level (or target level for prospect theory) must be defined to test the model. The two aspiration levels most commonly used by researchers are the social aspiration level and the historical aspiration level (Greve 1998). The first is imposed upon the performance of the firms of the same industry, the most commonly used measure in previous works being the mean or median performance of the industry (e.g., Fiegenbaum and Thomas 1988; Fiegenbaum 1990; Jegers 1991; Bromiley 1991a; Miller and Leiblein 1996). The historical aspiration level is a firm-specific level, based upon the historical performance of the same firm, generally being the previous performance level (Bromiley 1991a; Miller and Leiblein 1996; Lee 1997; Palmer and Wiseman 1999).

The aspiration concept employed in this work is the historical aspiration level. The measure chosen as the aspiration point is the previous rate of return, R_{it-1}. This selection is based on two reasons. First, the historical aspiration level seems to be more consistent with the postulates of prospect theory than the social aspiration level (Lee 1997, p. 62): Prospect theory posits the status quo of a firm's performance as the reference point, so this status quo is more easily identifiable with the previous performance than with the mean or median performance of the industry.

Second, several authors have demonstrated that the risk-return relationship is better explained when firm-specific target levels are used instead of aspiration levels common for all the firms (Gooding et al. 1996; Lehner 2000).

3.3. Statistical methodology

With all the characteristics developed above, the final model is:

$$R_{it} - R_{it-1} = a_i + b_i \cdot \left(R_{it-1} - R_{it-2}\right) + e_{it} \qquad (11)$$

$$s^2_{t-1}\left(e_{it}\right) = s^2\left(e_i\right) + d_{it} \cdot b_{1i} \cdot \left[E_{t-1}\left(R_{it}\right) - R_{it-1}\right] + \left(1 - d_{it}\right) \cdot b_{2i} \cdot \left[R_{it-1} - E_{t-1}\left(R_{it}\right)\right] \qquad (12)$$

where R_{it} is the only real variable at the period t; R_{it-1} is the value of the aspiration level; d_t is an artificial variable to design the sign function; and a_i, b_i, β_{1i}, β_{2i}, and $\sigma^2(\varepsilon_i)$ are the parameters of the model to be estimated.

The most relevant characteristic of this model is its heteroscedasticity, hat is, the variance of the error term is not constant for all the time periods, but its changes over time depending on the difference between the expected return and the aspiration (R_{it-1}). This heteroscedasticity makes ordinary least-squares regression an inefficient method of estimation. In this paper, the maximum likelihood method is used to estimate the parameters.

The maximization of the log-likelihood function is obtained using the Large-Scale GRG Solver Engine of Frontline Systems. Appendix 1 describes in detail the development of the log-likelihood function for the model, as well as the maximization process.

The Wald statistic is calculated to test if the model and the parameters are significant. The Wald test has the advantage over other alternative tests (e.g., likelihood ratio or Lagrange multiplier) because the log-likelihood has to be maximized only once. The formulation of the Wald statistic is presented in Greene (1993 pp. 379-381). The BHHH method (Berndt, Hall, Hall and Hausman 1974) is followed to estimate the variances of the parameters because they are necessary for the computation of the Wald statistic. This method has some advantages over alternative methods, such as the efficiency of operations, and it avoids the approximation errors in the empirical results (Greene 1993, pp. 115-116).

4. RESULTS

As explained above, the estimation of beta parameters establishes whether the behavioral theories are supported or not. Thus if both beta parameters are significantly greater than zero, the behavioral perspective on risk taking is supported. If β_{1i} is positive and β_{2i} negative, the positive relationship between risk and return is obtained.

Table 1 shows the estimates of the parameters, a_i, b_i, $\sigma^2(å_i)$, β_{1i} and β_{2i}, for each firm in the sample, their significance levels, and their standard errors (in parentheses), as well as the Wald statistic for the whole model.

These results show that the econometric model is significant for all the firms (p-value<0.0001), supporting the general validity of the model. Regarding the expectation equation, the estimates for the parameters a_i and b_i are significant in most of the cases (80 and 97 out of the 98 firms of the total sample). Only one firm (BHI) shows a non-significant value for b_i, although, as we see later, this firm also has outlier values for the other parameters.

The estimates for $\hat{a}_{1i}$ and $\hat{a}_{2i}$ are positive for the majority of the firms. In fact, the $\hat{a}_{1i}$-estimates are significantly positive (at the 0.01 level) for 95 cases, which suggest only three exceptions (BHI, HIG and LU). However, HIG and LU do not contradict the assumptions of the behavioral theories because their β_{1i} estimates are not significantly different from zero. On the other hand, the $\hat{a}_{2i}$-estimates are significantly greater than zero for 97 firms, the only exception being BHI. As noted above, BHI constitutes the main exception for the model, since the estimates for both $\hat{a}_{1i}$ and $\hat{a}_{2i}$ are negative, although only the first one is significantly less than zero, at the 0.001 level. The non-significant estimate obtained for the parameter b_i makes us consider that this firm is the only real exception to the general acceptability of our model. However, we have to say that this firm is also an outlier to traditional financial economic thought because its behavior goes in the opposite direction to a positive relationship between risk and return.

In conclusion, with the exception of BHI, the empirical results generally support the behavioral hypotheses about the risk-return relationship when market data are used in 99% of the firms: the greater the distance between the expected return and the aspiration – independent of the sign of that relation – the greater the increase in the risk of the firm.

On the other hand, Prospect Theory (Kahneman and Tversky 1979, p. 279) postulates that the value function for decision makers is steeper for losses than for gains. This is translated into a steeper risk-return relationship, when the expected outcomes do not reach the aspiration point (Fiegenbaum 1990, p. 191). However, our results do not support a different relationship between losses and gains. For our empirical results, only 40 of the 98 firms have $\hat{a}_{2i}$-estimates greater than the $\hat{a}_{1i}$-estimates.

Finally, the minimum risk parameter, $\sigma^2(\mathring{a}_i)$, has significant estimates for all the firms, including the outlier BHI. This minimum risk ranges between 0.007% (AEP) and 0.202% (NXTL). A curious characteristic of these results is the low range of values for the estimates for this parameter, because, in terms of the standard deviation, all the values range from the 0.82% and the 4.49% levels.

In summary, the model has significant estimates in every case, with only three cases in which the beta estimates were not significant to support the double behavioral relationship, or because of the negative $\hat{a}_{1i}$-estimate, in the case of BHI. These results allow us to conclude that the model can be applied using market measures in studies of risk taking by firms.

5. DISCUSSION AND CONCLUSIONS

Our paper deals with two of the most important problems associated with research on Bowman's paradox: the identification problem and the lack of evidence at the market level.

Regarding the first problem, we discuss the two sources for lack of identification: the temporal instability of the returns distribution and the cross-sectional design of research. We also provide an econometric model that solves both problems: first, it is a longitudinal firm-specific model, avoiding the cross-sectional problem when behavioral theories are to be tested. Second, in this model, only one variable is used – the firm rate of return – but it involves heteroscedastic variances, which are dependent on the distance between the expected value of the return and the aspiration point.

The second problem is the lack of research about the paradox at the market level. This lack of research is even more surprising since research in financial economics is also challenging the traditional positive risk-return relation (called "beta's death"), and whose evolution is very similar to Bowman's paradox research (Nickel and Rodríguez 2002, p. 14). Besides, the works that have tried to use market measures have reached contradictory results.

The results obtained with our model, using market measures, are consistent with the behavioral perspective on risk taking: there is a positive risk-return relationship between risk and return when the expected return exceeds the aspiration point, and a negative relationship when the expected return falls below the aspiration point.

This result has important implications for the research about the paradox and "beta's death". First, if we accept that the behavioral perspective is obtained with accounting measures of risk and return, we have found that the same double relationship occurs at the market level. Therefore, there is no difference between the risk-return relationship at the market and the accounting level, and hence there is no "paradox". Simply, the traditional assumption of a positive relationship, at the market level, is not supported, but there is evidence of a double relationship as behavioral theories predict.

Second, the research on "beta's death" tries to explain why the relationship between beta and return is flat. Several reasons have been employed: from the impossibility of testing empirically the CAPM (Roll and Ross 1994), to the necessity of using additional variables for capturing systematic risk factors that the beta parameter does not capture (Fama and French 1993;

Jegadeesh and Titman 1993; Davis 1994; Lakonishok, Shleifer and Vishny 1994; Wang 2000). Nevertheless, in all these works the idea of a positive relationship between return and the proper measure of risk is still assumed, because all these works start from an assumption of risk aversion. Although our empirical results cannot be taken as direct explanation for the lack of an empirical relation between systematic risk and return, since the risk measure employed has been the variance and not the systematic risk, they point to an alternative explanation for the flat relationship between beta and returns: the existence of risk-seeking attitudes when the outcomes are too small. Further research with systematic and unsystematic risk measures, and allowing risk-seeking attitudes, as Prospect Theory and Behavioral Theory hypothesize, could throw some light on "beta's death". Thus, it would be interesting to know if the behavioral risk taking affects the systematic and unsystematic portions of risk in the same or in a different way.

The values obtained for the minimum risk measure are interesting for our model. This measure shows the portion of the variance that does not depend on the difference between the expectation and the aspiration point. The sources of this minimum risk are found in the previous literature about Bowman's paradox. For example, the product or consumer orientation (Bowman 1980; Bettis and Mahajan 1985), market power (Cool et al. 1989), and the diversification strategy (Bettis and Hall 1982; Bettis and Mahajan 1985; Chang and Thomas 1989; Kim et al. 1993) have previously been employed to explain the different risk taking among firms. In this sense, an interesting line of research would be the analysis of how the firm-specific or industry-specific characteristics influence the amount of minimum risk of the firm.

In addition to the former line of research, the differences between the beta parameters of our heteroscedastic model among firms can provide some interesting ways for future investigation. As the previous literature suggests (McCrimmon and Wehrung 1986; Lee 1997), the degree of risk avoidance or risk propensity is firm specific, as the different estimates obtained for the beta parameters demonstrate. Therefore, it would be worth studying why some firms exhibit more extreme attitudes toward risk than others (and then, their beta values are higher), i.e., what firm-specific or industry-specific characteristics determine the slope of the risk-return relationship, and in what measure they determine it.

Finally, our work presents a limitation that should be solved in future works. Although, theoretically, the proposed model could be applied to both market and accounting data, the technical estimation procedure (maximum likelihood) requires a very large number of observations. This large number of observations is almost impossible to obtain with accounting data, since the periodicity of the data is, at best, three months. A possible solution would be to employ a long historical series of accounting data, but in this case it would be much more difficult to justify the stability of the model.

Appendix 1.

Log-likelihood function of the model

The mean and the variance of the returns variable for each moment are defined by equations (11) and (12):

$$E_{t-1}(R_{it}) - R_{it-1} = \alpha_i + \beta_i \cdot (R_{it-1} - R_{it-2}) \tag{11}$$

$$\sigma^2_{t-1}(\varepsilon_{it}) = \sigma^2(\varepsilon_i) + \delta_{it} \cdot \beta_{1i} \cdot [E_{t-1}(R_{it}) - R_{it-1}] + (1-\delta_{it}) \cdot \beta_{2i} \cdot [R_{it-1} - E_{t-1}(R_{it})] \tag{12}$$

Since it is assumed that ε_{it} is normally distributed, with mean equal to zero and variance equal to $\sigma^2(\varepsilon_{it})$, the density function of ε_{it} is the following:

$$f(\varepsilon_{it}) = \frac{1}{\sqrt{2\pi}\,\sigma(\varepsilon_{it})} \cdot \exp\left[-\frac{\varepsilon_{it}^2}{2 \cdot \sigma^2(\varepsilon_{it})}\right] \tag{13}$$

The likelihood function of the sample of n observations of the ε_{it}s, assuming that they are uncorrelated, is:

$$L_i = \prod_{t=1}^{n} f(\varepsilon_{it}) = \left(\frac{1}{\sqrt{2\pi}}\right)^n \cdot \prod_{t=1}^{n} \frac{1}{\sigma(\varepsilon_{it})} \cdot \exp\left[-\sum_{t=1}^{n} \frac{\varepsilon_{it}^2}{2 \cdot \sigma^2(\varepsilon_{it})}\right] \tag{14}$$

Finally, the log-likelihood function is the following:

$$\ln(L_i) = -\frac{n}{2}\ln(2\pi) - \frac{1}{2} \cdot \sum_{t=1}^{n} \ln\left(\sigma^2(\varepsilon_{it})\right) - \frac{1}{2}\sum_{t=1}^{n} \frac{\varepsilon_{it}^2}{\sigma^2(\varepsilon_{it})} \tag{15}$$

Finally, by substituting in equation (15) the value of the error term and the variance equation, we obtain the final equation of the log-likelihood function:

$$\ln(L_i) = -\frac{n}{2}\ln(2\pi) - \frac{1}{2} \cdot \sum_{t=1}^{n} \ln\left[\sigma^2(\varepsilon_i) + d_{it} \cdot \beta_{1i} \cdot [E_{t-1}(R_{it}) - A_{it}] + (1 - d_{it}) \cdot \beta_{2i} \cdot [A_{it} - E_{t-1}(R_{it})]\right]$$
$$-\frac{1}{2}\sum_{t=1}^{n} \frac{[R_{it} - R_{it-1} - a_i - b_i \cdot (R_{it-1} - R_{it-2})]^2}{\sigma^2(\varepsilon_i) + d_{it} \cdot \beta_{1i} \cdot [E_{t-1}(R_{it}) - A_{it}] + (1 - d_{it}) \cdot \beta_{2i} \cdot [A_{it} - E_{t-1}(R_{it})]} \tag{16}$$

The maximization process of this function is made following three steps: first, initial values for parameters of the first equation (a_i and b_i) were estimated using ordinary least squares. Although ordinary least-squares regression does not offer good estimates of the parameters when there is heteroscedasticity, they can be used as starting points in the maximization process. Using these first estimates, the error terms were calculated. In the second step, first estimates of the parameters of the variance equation were also obtained by ordinary least squares. Finally, using the former estimates as starting points, the log-likelihood function was maximized using the Large-Scale GRG Solver Engine of Frontline Systems with the multi-start method. The multi-start method allows the program to start the search from different starting points, reaching different locally optimal solutions, and selecting the best of these as the proposed globally optimal solution.

Assuring that the model obtained positive values of $\sigma^2(\varepsilon_{it})$ for each period, the following three constraints were added to the model:

$$\sigma^2(\varepsilon_i) \geq 0$$

$$d_{it} \cdot b_{1i} \cdot PG_{it} \geq -\sigma(\varepsilon_i)\,\forall t \quad \Leftrightarrow \quad b_{1i} \geq -\frac{\sigma^2(\varepsilon_i)}{max(d_{it} \cdot [E_{t-1}(R_{it}) - A_{it}])}$$

$$(1-d_{it}) \cdot b_{2i} \cdot (-PG_{it}) \geq -\sigma(\varepsilon_i)\,\forall t \quad \Leftrightarrow \quad b_{2i} \geq -\frac{\sigma^2(\varepsilon_i)}{max[(1-d_{it}) \cdot [A_{it} - E_{t-1}(R_{it})]]} \qquad (17)$$

Table 1. Firm-specific estimates of parameters of the econometric model

Ticker	a_i	b_i	$s^2(å_i)$	b_{1i}	b_{2i}	Wald statistic
AES	0.00005 ****	-0.01996 ****	0.00050 ****	0.72450 ****	0.72487 ****	1690.64 ****
	(0.00001)	(0.00068)	(0.00000)	(0.03925)	(0.03319)	
AOL	-0.00030 ****	0.02379 ****	0.00034 ****	1.92474 ****	0.72821 ****	8115.53 ****
	(0.00001)	(0.00035)	(0.00001)	(0.07790)	(0.01370)	
T	-0.00001 ****	0.00171 ****	0.00019 ****	19.52872 ****	6.02938 ****	244877.60 ****
	(0.00000)	(0.00000)	(0.00000)	(0.21643)	(0.07256)	
AA	0.00000	0.08737 ****	0.00020 ****	0.09425 ****	0.08926 ****	1340.65 ****
	(0.00004)	(0.00318)	(0.00000)	(0.00544)	(0.00528)	
AEP	-0.00002 ****	0.00684 ****	0.00007 ****	0.84881 ****	0.44040 ****	3183.23 ****
	(0.00000)	(0.00017)	(0.00000)	(0.03135)	(0.01588)	
AXP	0.00004 ***	-0.02184 ****	0.00025 ****	0,36749 ****	0,64885 ****	1458,56 ****
	(0.00001)	(0.00076)	(0.00000)	(0,02094)	(0,03644)	
AIG	-0.00002	0.01396 ****	0.00014 ****	0.26829 ****	0.34966 ****	1033.34 ****
	(0.00001)	(0.00064)	(0.00000)	(0.01838)	(0.01877)	
AMGN	-0.00016 ****	-0.05324 ****	0.00037 ****	0.37835 ****	0.36876 ****	3747.16 ****
	(0.00002)	(0.00149)	(0.00001)	(0.02017)	(0.00802)	
BUD	0.00001	-0.04599 ****	0.00014 ****	0.07805 ****	0.09981 ****	820.09 ****
	(0.00002)	(0.00229)	(0.00000)	(0.00553)	(0.00677)	
AVP	0.00000	0.06655 ****	0.00017 ****	0.12754 ****	0.15925 ****	7612.61 ****
	(0.00001)	(0.00122)	(0.00000)	(0.00284)	(0.00311)	
BHI	**0.00004** ****	**-0.00024**	**0.00103** ****	**-0.85321** ***	**-0.37460**	**28.99** ****
	(0.00001)	**(0.00011)**	**(0.00001)**	**(0.17481)**	**(32.50879)**	
ONE	-0.00008 ****	0.03196 ****	0.00022 ****	0.17948 ****	0.26131 ****	12432.67 ****
	(0.00001)	(0.00040)	(0.00000)	(0.00272)	(0.00632)	
BAC	0.00029 ****	0.02923 ****	0.00021 ****	0.21413 ****	0.57640 ****	4329.51 ****
	(0.00001)	(0.00061)	(0.00000)	(0.00642)	(0.01896)	
BAX	0.00000	-0.03863 ****	0.00027 ****	0.25563 ****	0.14613 ****	1195.12 ****
	(0.00002)	(0.00156)	(0.00000)	(0.01394)	(0.00927)	
BDK	0.00006 ****	0.02335 ****	0.00035 ****	0.49532 ****	0.64242 ****	2672.57 ****
	(0.00001)	(0.00063)	(0.00000)	(0.01786)	(0.02838)	
BA	0.00000 ****	0.00066 ****	0.00029 ****	7.51485 ****	42.62593 ****	7171370.31 ****
	(0.00000)	(0.00000)	(0.00000)	(0.31430)	(1.14540)	
BCC	0.00000 ****	-0.00026 ****	0.00042 ****	62.91754 ****	31.71839 ****	415385.53 ****
	(0.00000)	(0.00000)	(0.00001)	(2.89269)	(1.72156)	
BMY	0.00002 ****	-0.00289 ****	0.00015 ****	1.21615 ****	3.73679 ****	64550.23 ****
	(0.00000)	(0.00001)	(0.00000)	(0.03553)	(0.08118)	
BNI	-0.00009 ****	0.01996 ****	0.00022 ****	0.31274 ****	0.27564 ****	3572.89 ****
	(0.00001)	(0.00046)	(0.00000)	(0.01038)	(0.00963)	
CI	0.00000	0.05139 ****	0.00017 ****	0.14706 ****	0.10739 ****	1305.35 ****
	(0.00002)	(0.00192)	(0.00000)	(0.00777)	(0.00703)	
CPB	-0.00011 ****	-0.06755 ****	0.00018 ****	0.11682 ****	0.06419 ****	5333.10 ****
	(0.00001)	(0.00131)	(0.00000)	(0.00302)	(0.00187)	
CSCO	-0.00006 ****	-0.02444 ****	0.00027 ****	0.46505 ****	0.60757 ****	2752.97 ****
	(0.00001)	(0.00070)	(0.00000)	(0.02479)	(0.01760)	
C	0.00001 ****	0.00153 ****	0.00023 ****	5.85449 ****	11.60541 ****	216508.57 ****
	(0.00000)	(0.00000)	(0.00000)	(0.21123)	(0.59447)	
CCU	0.00000 ****	-0.00033 ****	0.00015 ****	16.73174 ****	16.77639 ****	1446000.83 ****
	(0.00000)	(0.00000)	(0.00000)	(0.43956)	(0.27246)	
KO	0.00000 ****	0.00199 ****	0.00014 ****	2.46892 ****	2.10787 ****	6530.11 ****
	(0.00000)	(0.00003)	(0.00000)	(0.11483)	(0.07104)	
CL	0.00000 ****	-0.00017 ****	0.00014 ****	29.04272 ****	31.29416 ****	1250460.22 ****
	(0.00000)	(0.00000)	(0.00000)	(1.29694)	(0.86090)	
CSC	-0.00009 *	0.06377 ****	0.00020 ****	0.12379 ****	0.12675 ****	2079.53 ****
	(0.00002)	(0.00199)	(0.00000)	(0.00589)	(0.00512)	
DAL	-0.00009	0.04596 ****	0.00031 ****	0.15984 ****	0.18536 ****	1124.62 ****
	(0.00003)	(0.00188)	(0.00000)	(0.01072)	(0.01063)	

Standard Errors in parentheses; Beta parameters with p-value > 0.05 in bold type

*	p-value < 0.05
**	p-value < 0.01
***	p-value < 0.001
****	p-value < 0.0001

Table 1. Firm-specific estimates of parameters of the econometric model (continued)

Ticker	a_i		b_i		$s^2(\text{å}_i)$		b_{1i}		b_{2i}		Wald statistic
DOW	0.00001	****	-0.00333	****	0.00016	****	2.00795	****	2.59502	****	13842.78 ****
	(0.00000)		(0.00003)		(0.00000)		(0.07080)		(0.09529)		
DD	-0.00005	****	-0.03204	****	0.00015	****	0.32985	****	0.21028	****	3974.91 ****
	(0.00001)		(0.00075)		(0.00000)		(0.01100)		(0.00600)		
EMC	-0.00012	****	0.01550	****	0.00037	****	1.95065	****	1.42368	****	5842.72 ****
	(0.00000)		(0.00026)		(0.00001)		(0.09496)		(0.03313)		
EK	0.00000	****	0.00016	****	0.00023	****	76.07562	****	35.68132	****	791821.68 ****
	(0.00000)		(0.00000)		(0.00000)		(0.91654)		(1.58565)		
EP	-0.00016	****	0.05327	****	0.00016	****	0.12589	****	0.10630	****	767.58 ****
	(0.00003)		(0.00257)		(0.00000)		(0.01198)		(0.00706)		
ETR	0.00001	****	-0.00084	****	0.00011	****	5.07670	****	14.51618	****	476035.50 ****
	(0.00000)		(0.00000)		(0.00000)		(0.05994)		(0.69811)		
EXC	0.00000		-0.01780	****	0.00014	****	0.26737	****	0.12707	****	658.01 ****
	(0.00001)		(0.00092)		(0.00000)		(0.01906)		(0.01358)		
XOM	0.00000		-0.06699	****	0.00013	****	0.04946	****	0.03700	****	627.49 ****
	(0.00004)		(0.00339)		(0.00000)		(0.00402)		(0.00401)		
FDX	-0.00021	****	0.03583	****	0.00029	****	0.47568	****	0.32624	****	2756.21 ****
	(0.00002)		(0.00092)		(0.00000)		(0.02180)		(0.01175)		
F	0.00036	****	-0.03869	****	0.00030	****	0.16006	****	0.22371	****	4127.51 ****
	(0.00002)		(0.00139)		(0.00000)		(0.00602)		(0.00435)		
GD	0.00023	****	0.01891	****	0.00016	****	0.23182	****	1.88805	****	29713.16 ****
	(0.00000)		(0.00012)		(0.00000)		(0.00409)		(0.06256)		
GE	0.00000		-0.02602	****	0.00013	****	0.11646	****	0.14253	****	640.35 ****
	(0.00002)		(0.00145)		(0.00000)		(0.00893)		(0.01174)		
GM	-0.00013	****	0.03155	****	0.00031	****	0.28638	****	0.19428	****	741.80 ****
	(0.00002)		(0.00145)		(0.00001)		(0.02528)		(0.01632)		
G	0.00000	****	0.00294	****	0.00015	****	2.84730	****	2.92671	****	43359.39 ****
	(0.00000)		(0.00002)		(0.00000)		(0.05981)		(0.04754)		
HCA	0.00016	****	0.01960	****	0.00040	****	0.37533	****	0.65607	****	1276.85 ****
	(0.00001)		(0.00076)		(0.00001)		(0.01777)		(0.05017)		
HAL	-0.00042	****	0.01158	****	0.00046	****	7.48346	****	0.50408	****	10967.55 ****
	(0.00000)		(0.00012)		(0.00001)		(0.51784)		(0.01557)		
HET	0.00002	****	-0.00396	****	0.00067	****	4.22423	****	5.50119	****	22863.04 ****
	(0.00000)		(0.00003)		(0.00001)		(0.18228)		(0.36350)		
HIG	**0.00003**		**0.04986**	****	**0.00018**	****	**0.00000**		**0.13711**	****	**1768.04** ****
	(0.00012)		**(0.00198)**		**(0.00000)**		**(0.00006)**		**(0.00407)**		
HNZ	0.00000		-0.03918	****	0.00065	****	0.13158	**	0.09104	****	94.88 ****
	(0.00013)		(0.00582)		(0.00002)		(0.03042)		(0.01639)		
HWP	0.00000		-0.03788	****	0.00033	****	0.22301	****	0.32770	****	1792.25 ****
	(0.00002)		(0.00138)		(0.00000)		(0.01212)		(0.01237)		
HD	-0.00002	****	0.00336	****	0.00018	****	3.56056	****	1.92086	****	31138.98 ****
	(0.00000)		(0.00002)		(0.00000)		(0.19729)		(0.02075)		
HON	0.00000	****	0.00037	****	0.00018	****	23.68995	****	19.70041	****	274519.03 ****
	(0.00000)		(0.00000)		(0.00000)		(0.39660)		(0.42498)		
INTC	0.00000	****	-0.00017	****	0.00035	****	45.65086	****	48.95842	****	968471.83 ****
	(0.00000)		(0.00000)		(0.00000)		(2.41163)		(3.60856)		
IBM	0.00000	****	-0.00058	****	0.00029	****	30.35934	****	14.20691	****	119795.78 ****
	(0.00000)		(0.00000)		(0.00000)		(1.48797)		(0.49665)		
IP	-0.00002	****	-0.00381	****	0.00024	****	2.36199	****	0.62795	****	3743.27 ****
	(0.00000)		(0.00008)		(0.00000)		(0.07360)		(0.02757)		
JPM	0.00042	****	0.04636	****	0.00026	****	0.16327	****	0.44999	****	2679.62 ****
	(0.00002)		(0.00133)		(0.00000)		(0.00505)		(0.02193)		
JNJ	0.00003	****	0.00584	****	0.00016	****	0.87919	****	1.75057	****	4306.19 ****
	(0.00000)		(0.00010)		(0.00000)		(0.04793)		(0.09767)		
LEH	0.00026	****	-0.02245	****	0.00028	****	0.95697	****	2.77130	****	64360.44 ****
	(0.00000)		(0.00009)		(0.00001)		(0.02168)		(0.08439)		

Standard Errors in parentheses; Beta parameters with p-value > 0.05 in bold type

* p-value < 0.05
** p-value < 0.01
*** p-value < 0.001
**** p-value < 0.0001

Table 1. Firm-specific estimates of parameters of the econometric model (continued)

Ticker	a_i	b_i	$s^2(å_i)$	b_{1i}	b_{2i}	Wald statistic
LTD	0.00000 ****	-0.00190 ****	0.00044 ****	6.51690 ****	6.44938 ****	25727.24 ****
	(0.00000)	(0.00001)	(0.00001)	(0.33571)	(0.35393)	
LU	**0.00035** ****	**0.01336** ****	**0.00020** ****	**-0.00001**	**3.70411** ****	**3585049.04** ****
	(0.00000)	**(0.00001)**	**(0.00000)**	**(0.00003)**	**(0.01804)**	
MAY	0.00008 ****	-0.02629 ****	0.00022 ****	0.17097 ****	0.23357 ****	1084.14 ****
	(0.00001)	(0.00127)	(0.00000)	(0.01123)	(0.01134)	
MCD	0.00000	0.01674 ****	0.00034 ****	0.52860 ****	0.49831 ****	904.68 ****
	(0.00001)	(0.00075)	(0.00000)	(0.03588)	(0.03633)	
MEDI	-0.00094 ****	-0.03680 ****	0.00191 ****	6.64815 ****	3.43530 ****	43804.65 ****
	(0.00000)	(0.00020)	(0.00004)	(0.12829)	(0.03739)	
MDT	0.00000 ****	0.00127 ****	0.00026 ****	5.36967 ****	6.84266 ****	20181.42 ****
	(0.00000)	(0.00001)	(0.00000)	(0.40450)	(0.40878)	
MRK	0.00006 ****	-0.00814 ****	0.00017 ****	0.81357 ****	1.91651 ****	9052.37 ****
	(0.00000)	(0.00009)	(0.00000)	(0.03318)	(0.09281)	
MER	0.00000 ****	0.00007 ****	0.00022 ****	67.47695 ****	69.66400 ****	24402774.1 ****
	(0.00000)	(0.00000)	(0.00000)	(2.26074)	(1.00258)	
MSFT	0.00000 ****	0.00006 ****	0.00022 ****	72.51121 ****	74.90687 ****	28208647.4 ****
	(0.00000)	(0.00000)	(0.00000)	(2.42958)	(1.07808)	
MMM	0.00000 ****	0.00046 ****	0.00012 ****	10.25278 ****	28.20995 ****	1597207.48 ****
	(0.00000)	(0.00000)	(0.00000)	(0.40779)	(1.26869)	
MWD	0.00020 ****	0.01473 ****	0.00028 ****	0.43807 ****	1.76599 ****	7082.13 ****
	(0.00000)	(0.00019)	(0.00000)	(0.01767)	(0.13999)	
NXTL	0.00000 ****	0.00104 ****	0.00202 ****	42.36717 ****	39.88253 ****	1243921.50 ****
	(0.00000)	(0.00000)	(0.00002)	(1.58182)	(1.41134)	
NSM	-0.00012 ****	0.01955 ****	0.00110 ****	2.64449 ****	1.92343 ****	14863.75 ****
	(0.00000)	(0.00019)	(0.00001)	(0.04812)	(0.05144)	
NSC	0.00000 ****	0.00006 ****	0.00016 ****	111.24529 ****	62.82893 ****	8541559.85 ****
	(0.00000)	(0.00000)	(0.00000)	(2.39148)	(1.27260)	
NT	-0.00032 ****	0.09693 ****	0.00032 ****	0.18378 ****	0.11738 ****	5358.67 ****
	(0.00002)	(0.00179)	(0.00000)	(0.00472)	(0.00388)	
ORCL	0.00057 ****	-0.05555 ****	0.00056 ****	0.79239 ****	1.03347 ****	15264.41 ****
	(0.00001)	(0.00059)	(0.00001)	(0.01190)	(0.02297)	
PEP	0.00000	-0.05119 ****	0.00022 ****	0.17504 ****	0.15311 ****	1473.17 ****
	(0.00003)	(0.00186)	(0.00000)	(0.00922)	(0.00814)	
PFE	0.00000 ****	0.00094 ****	0.00017 ****	7.06910 ****	8.28843 ****	62332.62 ****
	(0.00000)	(0.00000)	(0.00000)	(0.30375)	(0.37207)	
PHA	0.00000 ****	0.00068 ****	0.00020 ****	17.41077 ****	16.10054 ****	1569158.43 ****
	(0.00000)	(0.00000)	(0.00000)	(0.27164)	(0.24607)	
MO	0.00026 ****	-0.04872 ****	0.00022 ****	0.29436 ****	0.25076 ****	19747.38 ****
	(0.00000)	(0.00076)	(0.00000)	(0.00275)	(0.00387)	
PG	0.00006 ****	-0.02171 ****	0.00013 ****	0.23054 ****	0.42488 ****	55107.81 ****
	(0.00000)	(0.00015)	(0.00000)	(0.00130)	(0.00995)	
RSH	0.00016 ****	0.05396 ****	0.00028 ****	0.19537 ****	0.33513 ****	3519.44 ****
	(0.00002)	(0.00132)	(0.00000)	(0.00541)	(0.01450)	
ROK	0.00000 ****	0.00030 ****	0.00019 ****	42.16846 ****	32.04724 ****	1044830.94 ****
	(0.00000)	(0.00000)	(0.00000)	(1.25048)	(0.61210)	
SLE	-0.00005 ****	-0.02273 ****	0.00016 ****	0.30849 ****	0.29743 ****	4589.16 ****
	(0.00001)	(0.00054)	(0.00000)	(0.01046)	(0.00670)	
SBC	-0.00001	-0.04732 ****	0.00015 ****	0.09128 ****	0.09833 ****	2236.58 ****
	(0.00002)	(0.00159)	(0.00000)	(0.00422)	(0.00330)	
SLB	0.00000 ****	-0.00085 ****	0.00026 ****	11.32617 ****	20.56762 ****	1211623.64 ****
	(0.00000)	(0.00000)	(0.00000)	(0.45321)	(0.53673)	
S	0.00002 ****	-0.00478 ****	0.00022 ****	2.11264 ****	2.49513 ****	19168.68 ****
	(0.00000)	(0.00004)	(0.00000)	(0.04941)	(0.07723)	
SO	0.00001	-0.00568 ****	0.00012 ****	0.18352 ****	0.23941 ****	217.83 ****
	(0.00001)	(0.00060)	(0.00000)	(0.02414)	(0.02857)	

Standard Errors in parentheses; Beta parameters with p-value > 0.05 in bold type

* p-value < 0.05
** p-value < 0.01
*** p-value < 0.001
**** p-value < 0.0001

Table 1. Firm-specific estimates of parameters of the econometric model (continued)

Ticker	a_i	b_i	$s^2(å_i)$	b_{1i}	b_{2i}	Wald statistic
TXN	-0.00001 ****	-0.00483 ****	0.00050 ****	3.65502 ****	1.75878 ****	2420.45 ****
	(0.00000)	(0.00011)	(0.00001)	(0.18200)	(0.11386)	
TOY	0.00000 ****	-0.00060 ****	0.00043 ****	14.45354 ****	19.20345 ****	362695.40 ****
	(0.00000)	(0.00000)	(0.00001)	(0.49905)	(0.94440)	
TYC	0.00006 ****	0.05964 ****	0.00022 ****	0.20545 ****	0.15824 ****	5784.12 ****
	(0.00001)	(0.00112)	(0.00000)	(0.00414)	(0.00726)	
USB	0.00000 ****	0.00069 ****	0.00016 ****	5.55825 ****	13.34574 ****	5199129.72 ****
	(0.00000)	(0.00000)	(0.00000)	(0.10016)	(0.08709)	
UIS	0.00153 ****	-0.08621 ****	0.00077 ****	0.96128 ****	1.29328 ****	118765.13 ****
	(0.00001)	(0.00031)	(0.00001)	(0.00546)	(0.01164)	
UTX	0.00018 ****	0.05160 ****	0.00017 ****	0.09662 ****	0.15594 ****	1230.56 ****
	(0.00002)	(0.00236)	(0.00000)	(0.00553)	(0.00736)	
VZ	0.00000 *	-0.00224 ****	0.00015 ****	2.99074 ****	2.30141 ****	11097.91 ****
	(0.00000)	(0.00002)	(0.00000)	(0.08552)	(0.06851)	
VIA	-0.00028 ***	0.11835 ****	0.00053 ****	0.18977 ****	0.12614 ****	2250.28 ****
	(0.00006)	(0.00330)	(0.00000)	(0.00850)	(0.00582)	
WMT	-0.00004 ****	0.01395 ****	0.00047 ****	1.24535 ****	1.13159 ****	2831.51 ****
	(0.00000)	(0.00032)	(0.00001)	(0.06612)	(0.04523)	
DIS	-0.00013 ****	-0.05243 ****	0.00022 ****	0.14213 ****	0.05249 ****	1620.53 ****
	(0.00003)	(0.00171)	(0.00000)	(0.00695)	(0.00321)	
WFC	0.00005 ****	0.00466 ****	0.00017 ****	0.81478 ****	3.34699 ****	53514.10 ****
	(0.00000)	(0.00002)	(0.00000)	(0.04259)	(0.12918)	
WY	0.00007 ***	-0.02603 ****	0.00029 ****	0.24034 ****	0.11803 ****	892.82 ****
	(0.00001)	(0.00122)	(0.00000)	(0.01318)	(0.01146)	
WMB	0.00010 ****	0.01947 ****	0.00022 ****	0.21310 ****	0.43456 ****	1223.08 ****
	(0.00001)	(0.00085)	(0.00000)	(0.01174)	(0.02259)	
XRX	0.00000	-0.00462 ****	0.00017 ****	2.20041 ****	1.14983 ****	1262786.11 ****
	(0.00000)	(0.00001)	(0.00000)	(0.00506)	(0.00187)	

Standard Errors in parentheses; Beta parameters with p-value > 0.05 in bold type

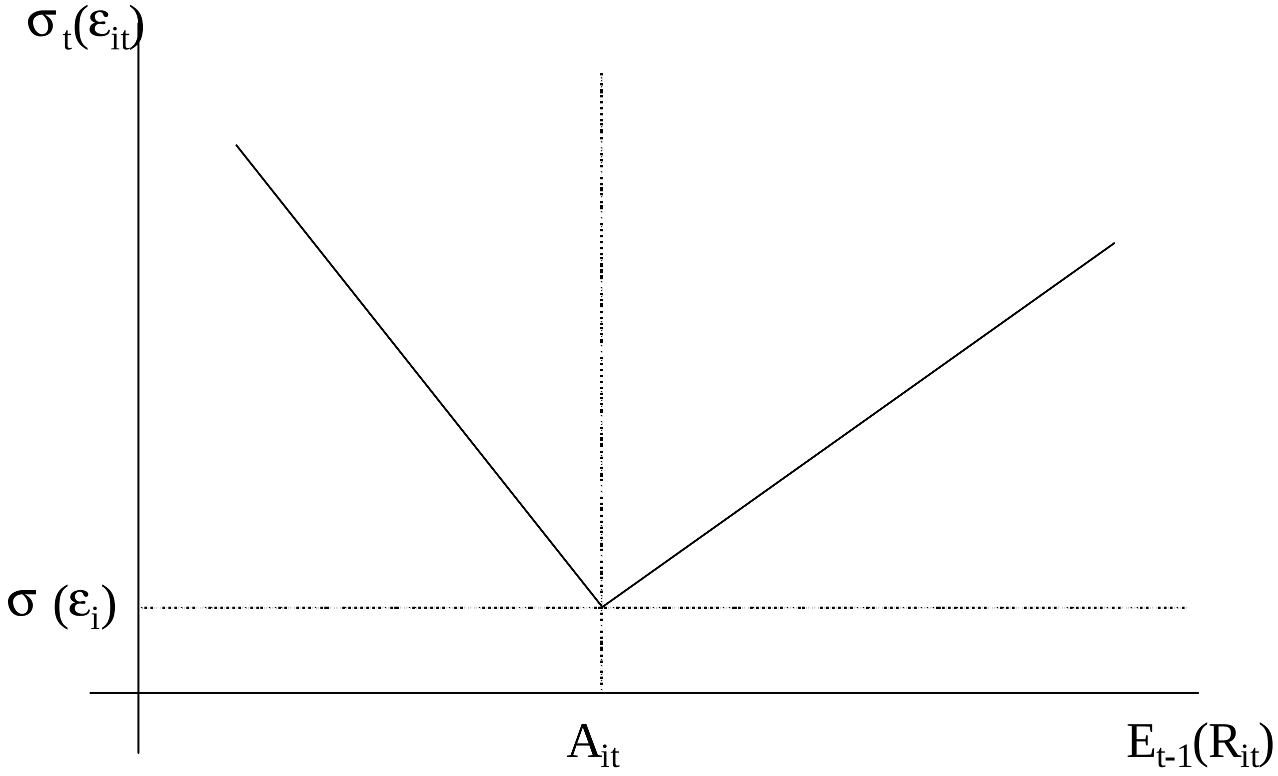
* p-value < 0.05

** p-value < 0.01

*** p-value < 0.001

**** p-value < 0.0001

Figure 1. Double risk-return relationship hypothesized by behavioral theories



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