OVERCOMING THE LACK OF IDENTIFICATION IN BOWMAN'S PARADOX TESTS

Heteroskedastic Behavior of Returns

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ABSTRACT: To date, the validity of the empirical tests that employ the mean–variance approach for testing the risk–return relationship in the research stream named Bowman's paradox is inherently unverifiable, and the results cannot be generalized. However, this problem can be solved by developing an econometric model with two fundamental characteristics: first, the use of a time-series model for each firm, avoiding the traditional cross-sectional analysis; and, second, the estimation of a model with a single variable (firm's rate of return), whose expectation and variance are mathematically related according to behavioral theories, forming a heteroskedastic model similar to GARCH (generalized autoregressive conditional heteroskedasticity). The application of this methodology for Bowman's paradox is new, and its main advantage is that it solves the previous criticism of the lack of identification. With this model, we achieve results that agree with behavioral theories and show that these theories can also be carried out with market measures.

RESUMEN: Los contrastes empíricos sobre la relación entre la rentabilidad y riesgo dentro de la corriente de investigación conocida como la Paradoja de Bowman realizados hasta la fecha, que están basados en el binomio media-varianza, presentan el problema de su no verificabilidad y la imposibilidad de generalizar sus resultados. Este problema puede resolverse usando un modelo econométrico definido por dos características principales: primero, se usará un modelo de series temporales específico para cada empresa, evitando los problemas del tradicional análisis de corte transversal; y, segundo, en el modelo se estimará una única variable (la rentabilidad de la empresa) cuyos momentos esperanza y varianza estarán relacionados matemáticamente de acuerdo con lo previsto en las Teorías del Comportamiento, conformando un modelo similar a los modelos GARCH (modelos autorregresivos de heterocedasticidad condicional generalizados). La aplicación de esta metodología en la investigación sobre la Paradoja de Bowman es nueva y su principal ventaja es que resuelve los problemas de falta de identificación señalados en la literatura previa. Los resultados obtenidos con este modelo apoyan lo previsto por las Teorías del Comportamiento y muestran que los postulados de estas teorías pueden extenderse al ámbito de los mercados de capitales.

A common assumption in strategic management, as well as in financial economics, is the positive relationship between risk and return. Criticizing this idea, Bowman (1980) found that the relationship between risk and return could be negative with accounting measures. This work was the origin of a fruitful research stream that studied the causes of Bowman's paradox (e.g., Ruefli, Collins, & LaCugna, 1999).

In this stream, we find works that theoretically try to justify the inverse risk–return relationship (theoretical explanations), in addition to works that defend the methodological problems associated with the empirical tests that can be the origin of such a relationship (Nickel & Rodríguez, 2002). Inside the first group of works are two different streams: first are theories such as prospect theory (Kahneman & Tversky, 1979) and behavioral theory of the firm (Cyert & March, 1963) that consider a double risk–return relationship (negative for low outcomes and positive for high ones), and, second is the influence of strategic differences among firms in the risk–return relationship. Thus, the diversification strategy (Bettis & Hall, 1982; Bettis & Mahajan, 1985), market power (Cool, Dierickx, & Jemison, 1989), or a long history of high-risk levels (Miller & Bromiley, 1990; Deephouse & Wiseman, 2000) could also influence the risk–return association. On the other hand, those works that have proven how the paradox could be the natural consequence of methodological problems do not allow for the generalization of its results. These problems could be associated with the lack of identification in every test that has employed a mean–variance approach for representing return and risk (Ruefli et al.,

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1999: 178) or used cross-sectional methodology (Lehner, 2000: 63). Therefore, at the present time, the main gap in the research on Bowman's paradox is the lack of identification of the tests, and, as a consequence, theories cannot be accepted and generalized.

The aim of this paper is to translate the postulates on risk taking of one theory in particular—prospect theory—to a heteroskedastic econometric model that removes the lack of identification.

This new model is tested on a sample formed by the companies of the S&P Global 100 index. This sample is interesting because of the lack of research that has tested the paradox in economies that differ from the United States; there is also a scarcity of tests that have used market measures.

In summary, this study seeks to offer three main contributions to the literature on Bowman's paradox. First, we provide a heteroskedastic model that overcomes the identification problems and allows generalizing prospect theory as an explanation for Bowman's paradox. Second, this model is empirically tested using market measures. This provides an additional step in this research stream, because the support obtained by prospect theory may be extended with market data. Third, it is tested on an international database so that we are able to generalize this behavior to countries other than the United States.

THEORETICAL BACKGROUND

The Identification Problem

The identification problem arises when the data can be explained by different theories, but it is not possible to distinguish between them (Greene, 1993: 585). There are two identification problems in Bowman's paradox tests: the use of a mean–variance approach and a cross-sectional design.

In the mean–variance approach, its relation could be produced by the behavior of the decision maker or by a possible temporal instability of the return distribution (Ruefli, 1990: 371). 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 subperiods.

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 (Lehner, 2000: 66; Ruefli, 1990: 372; Ruefli et al., 1999: 172). 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: 1211).

The second source of misidentification is the cross-sectional design. This kind of analysis has been used in most studies that have tested the risk attitude explanations for the risk–return relationship (Lee, 1997: 63). Similar to the former temporal instability, the differences among the firm-specific return distributions could permit a negative cross-sectional risk–return relationship from different 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 have the ability to obtain 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 either by stable differences among them that also produce differences in their successes (Bettis & Hall, 1982; Cool et al., 1989; Miller & Bromiley, 1990), or from different risk attitudes, as behavioral theories hypothesize (March, 1988: 6). Therefore, a cross-sectional design does not allow for the differentiation between one explanation or another and would be an improper method with which to test behavioral perspectives (Lee, 1997; MacCrimmon & Wehrung, 1986). 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 of the decision maker or the organization (MacCrimmon and Wehrung, 1986). Therefore, the risk attitude is a firm-specific concept. Because 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: 63).

Overcoming the Identification Problem

Figure 1 shows us the methodologies that are the origin of the identification problem: the mean–variance approach and the cross-sectional model. Close to its antithetic methodology, we arrange the solution methodologies that we propose in this paper to avoid the lack of identification: heteroskedastic and time-series models. Each cell of the matrix puts together different phenomena that could explain the data with the different methodologies. Thus, we see that the only solution that overcomes the identification problem is the fourth cell of Figure 1. That is, data can be explained by only one phenomenon.

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

FIGURE 1
Methodological Matrix

	Methodologies	Problem: Mean–Variance Approach	Solution: Heteroskedastic Model
Problem	Cross-Sectional Model	1st Cell Temporal instability Prospect Theory Differences among firms	2nd Cell Prospect Theory Differences among firms
Solution	Time-Series Model	3rd Cell Temporal instability Prospect Theory	4th Cell Prospect Theory

The time-varying returns distribution problem. Regarding the first source of the lack of identification, Bromiley (1991a: 1208) stated that the most direct way to avoid the problem of 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, not for the long run (Lehner, 2000: 67). Second, this assumption requires that each firm has its own returns distribution to avoid the spurious correlation (Ruefli, 1991: 1213; Ruefli & Wiggins, 1994: 755). Third, if a longitudinal approach is used, this assumption implicitly contradicts a postulate of prospect theory: the stability of the distribution of returns 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 arising from the validation problem of the variance (Bromiley, Miller, & Rau, 2002: 264; Nickel & Rodríguez, 2002: 13). In this sense, various works have employed variables such as the variance of the forecasts of analysts (Bromiley, 1991b), content analysis–based measures (Bowman, 1984; Lee, 1997), ordinal risk (Collins & Ruefli, 1992), and downside risk (Miller & Leiblein, 1996). However, these measures can also present their own problems, they are still rarely studied, and the variety of measures makes the comparison between different works difficult (Bromiley et al., 2002: 264–266; Nickel & Rodríguez, 2002: 14).

Therefore, it is desirable to obtain a third solution: to recover the variance as the principal risk measure, provided that the problems associated with this measure are solved. The advantages of this solution are clear: variance is the risk measure most often utilized by different research streams, not only by Bowman's paradox, so it can make the comparison between works easier. Its calculation is also simple and is easily understood from both the scientific and managerial views. Finally, the variance is a good measure of uncertainty, and the theories employed to study the paradox from the risk attitude perspective—prospect theory (Kahneman & Tversky, 1979) and behavioral theory of the firm (Cyert & March, 1963)—make their hypotheses about the relationship between return and uncertainty. Nevertheless, the literature has highlighted two problems related to the use of the variance—an identification problem and a validity problem.

The first problem, which is the central point of this paper, is that the variance can cause the identification problem if it is estimated by the sample variance and the expectation is estimated by the sample mean. This problem is overcome in this work by developing a model with a single variable (the firm rate of return) whose first two moments are mathematically related in the sense that prospect theory predicts. In this way, the variance and the expectation of returns are estimated without employing the sample variance or the sample mean. The second problem (the validity of the variance as a measure of risk) is dealt with below.

In summary, as noted in Figure 1, the identification problem can be solved if the model meets three requirements. First, it must be a firm-specific time-series model, where expectation and variance can change across time. Second, it must be a heteroskedastic model, allowing the change of variance over time. Third, the expectation and the variance can be linked in the returns distribution, but not as two different variables in a regression model.

Model Development

Prospect theory (Kahneman & Tversky, 1979) has commonly been employed by researchers of Bowman's paradox to explain the risk–return relationship (see, for example, the literature reviews by Bromiley et al., 2002, and Nickel and Rodríguez, 2002). According to this theory, there is a double attitude toward risk, which results in a double risk–return relationship. This double attitude depends on the comparison between the expected return and the return the decision maker aspires to (Kahneman & Tversky, 1979: 277). Thus, when the expected return exceeds a target or aspiration point, decision makers exhibit a risk-averse attitude; on the other hand, when the expected return does not reach the target point, the risk attitude becomes risk seeking. Therefore, for the development of the model, we must define three concepts: expected return, aspiration or target point, and risk. The development of the model is completed when the relationships between these measures are established.

Expected return. We define the evolution of the return variable over time to develop a new econometric model. Without loss of generality, we accept, as a first assumption, that returns evolve over time following an autoregressive 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; and ε_{it} is the error term that is assumed to be normally distributed with zero mean and constant variance.

The expected return is obtained by calculating, at period $t-1$, the expectation of Equation (1) for period t:

$$\begin{aligned} E_{t-1}\left(R_{it}\right) &= E_{t-1}\left[f\left(R_{it-1}, R_{it-2}, \ldots, R_{it-n}\right) + \varepsilon_{it}\right] \\ &= E_{t-1}\left[f\left(R_{it-1}, R_{it-2}, \ldots, R_{it-n}\right)\right]. \end{aligned} \qquad (2)$$

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

The aspiration point. The aspiration or reference point for prospect theory corresponds to an asset position that the decision maker had expected to attain (Kahneman & Tversky, 1979: 286). Previous literature on strategic management (Bamberger & Fiegenbaum, 1996; Fiegenbaum, Hart, & Schendel, 1996) has proposed that managerial aspiration levels can be the result of a combination of internal (managerial considerations and outcome criteria), external (competitors, customers, suppliers, stakeholders), and temporal considerations (past, current, and future performance). However, at the empirical level, there is, to our knowledge, no model that explains how these three groups of variables can be combined for obtaining the "right" reference point. The most common solution applied in the previous literature has been the selection of one of the three sources of aspiration points, assuming that it prevails over the other two.

In this sense, the empirical studies of prospect and behavioral theory have employed mainly two kinds of reference points—the social aspiration level and the historical aspiration level (Greve, 1998). The social aspiration level is the result of the influence of external forces and is imposed upon the performance of the firms of the same industry. The most common way of measuring this social aspiration has been by using the mean or median performance of the industry (e.g., Bromiley, 1991b; Fiegenbaum, 1990; Fiegenbaum & Thomas, 1988; Jegers, 1991; Miller & Leiblein, 1996). The historical aspiration level is a firm-specific level based on the historical performance of the same firm, generally being the previous performance level (Bromiley, 1991b; Lee, 1997; Miller & Leiblein, 1996; Palmer & Wiseman, 1999).

The aspiration concept employed in this work is the historical aspiration level, considering the previous rate of return as the aspiration level. 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: 62). Prospect theory posits the status quo of a firm's performance as the reference point (Kahneman & Tversky, 1979: 286), 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 firms (Gooding, Goel, & Wiseman, 1996; Lehner, 2000).

Nevertheless, although we have employed the historical aspiration point in the empirical tests of our model, the theoretical model can be applied to any aspiration point, and hence we denote the aspiration point by A_{it} instead of its empirical value R_{it-1}.

The risk measure. The risk measure is probably the most controversial point of the works that have studied the paradox (Bromiley et al., 2002: 261). As noted above, the variance has been criticized because of two problems—an identification problem and a validation problem. The first is solved with the different methodology of our model.

However, the variance has also been criticized, and, as a consequence, it might be considered a "wrong" way to measure the risk. From a managerial focus, "risk" is not the same as "uncertainty" (Bromiley et al., 2002: 260). "Risk" is associated with the chance and the magnitude of loss, whereas "uncertainty" is associated with the variance (March & Shapira, 1987; Sitkin & Pablo, 1992). If we accept these two identifications—risk equals the chance of loss and uncertainty equals the variance—prospect theory reaches this same conclusion, although it identifies implicitly "risk" with "uncertainty." That is, in Kahneman and Tversky's (1979) nomenclature, the risk-averse or risk-seeking attitudes (uncertainty from management focus) are a consequence of the permanent loss-aversion attitude (risk from management focus) of the decision maker (Barberis & Huang, 2001: 1252; Olsen, 1997: 226). Therefore, and because we want to test prospect theory hypotheses, we should employ an uncertainty measure, which is the variance. Although "uncertainty measure" could be more appropriate for the variance than "risk measure," for coherency with the mentioned theory and the previous works, we will continue referring to the variance as the "risk measure."

There is a second validation problem with the variance: the traditional financial tenet states that only the systematic portion of risk (that is, the portion of risk that is related to the global economic forces) is priced in the market, and hence only this portion of risk should be considered by managers (Aaker & Jacobson, 1987: 279; Chatterjee, Lubatkin, & Schulze, 1999: 556; Lubatkin & Chatterjee, 1994: 100). This financial idea has resulted in the fact that the most widely used market risk measure in the strategic management literature has been systematic risk (Ruefli et al., 1999) instead of the variance of returns.

Nevertheless, there are several reasons for using the total risk measure (variance) instead of systematic risk. First, the variance of returns could be a more appropriate proxy for the managerial perspective on risk than the systematic risk (Veliyath & Ferris, 1997: 220). Thus, the capital asset pricing model (CAPM) considers only the systematic risk, because stockholders can reduce the firm-specific unsystematic risk to zero by simply diversifying their portfolios 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 & Ferris, 1997: 219–220).

On the other hand, the managerial control over systematic risk is theoretically lower than that over the total risk, because the systematic risk depends not only on managerial actions but also on market-wide factors (Naylor & Tapon, 1982; Veliyath & Ferris, 1997).

Moreover, several researchers in financial economics have obtained a flat relationship between systematic risk and return, especially 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., Davis, 1994; Fama & French, 1993; Jegadeesh & Titman, 1993; 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 could not be a proper measure of risk (Ruefli et al., 1999: 172).

Finally, the value relevance of the systematic risk is based upon the idea that investors' portfolios are fully diversified, and they pursue this full diversification because they are risk averse in the financial economics sense. Nevertheless, and according to prospect theory, it would be possible that investors could exhibit a risk attitude different from the aversion. If this is true, they will not always be as fully diversified as the CAPM predicts, and hence they can also value unsystematic risks (Chatterjee et al., 1999). In this sense, some works from financial economics have applied prospect theory to the stock market's behavior, finding that the loss aversion predicted by this theory fits much better than the risk aversion defended by the traditional CAPM model (see, for example, Barberis & Huang, 2001; Barberis, Huang, & Santos, 2001).

In summary, all these ideas suggest that the variance of market return could be selected as the risk measure rather than systematic risk.

In conclusion, the variance is preferable to other measures employed in strategic management, because it fits better with the "risk" concept inherent in prospect theory; and it is also preferable to systematic risk, because its relevancy from the focus of managers (not investors) is higher.

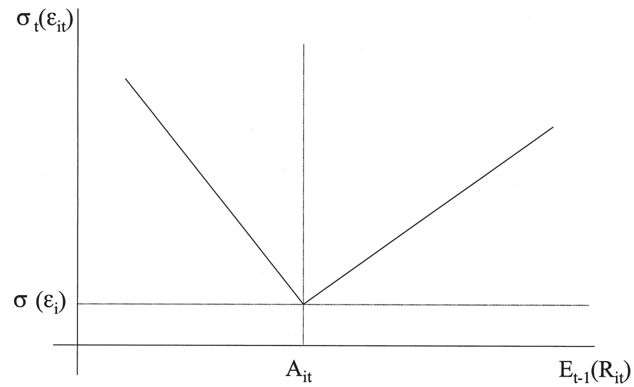
Returning to our model, we can obtain the time-varying risks by calculating the variance of Equation (1) for each period. Because the previous rates of return are constant at period t, the variance of returns is equal to the variance of the error term in the absence of autocorrelations among the error terms:

$$\sigma_{t-1}^2\left(R_{it}\right) = \sigma_{t-1}^2\left(\varepsilon_{it}\right). \qquad (3)$$

Relations between expectation, aspiration, and risk. As noted above, when the expected return is greater than the aspiration point, managers exhibit a risk-averse attitude (Kahneman & Tversky, 1979: 279), 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 is higher when the expected return is lower (Kahneman & Tversky, 1979: 279). In conclusion, the distance (positive or negative) between the expected return and the aspiration point is positively related with the risk level. This double risk–return relationship is graphically presented in Figure 2.

Translating this risk-taking process into an econometric model, we will have a positive relationship between the variance of returns and the difference between the expectation and the aspiration point. We assume that this relationship is linear because Kahneman and Tversky (1979) simply asserted that there would be risk aversion in the domain of gains and

FIGURE 2
Double Risk–Return Relationship Hypothesized by Behavioral Theories



risk seeking in the domain of losses, but they do not explicitly make any assertion about the variations of the degrees of risk aversion or risk seeking (Bromiley et al., 2002: 268–269):

$$E_{t-1}(R_{it}) - A_{it} > 0$$
$$\Rightarrow \sigma_{t-1}^{2}(\varepsilon_{it}) = \alpha_i + \beta_{1i} \cdot [E_{t-1}(R_{it}) - A_{it}], \quad (4)$$

where β_{1i} is the coefficient that relates the expectation-aspiration distance with the risk level, and α_i is the constant of the model.

On the other hand, when the expected return falls below the target level, managers also increase risk. Once again, we assume a linear relationship:

$$E_{t-1}(R_{it}) - A_{it} < 0$$
$$\Rightarrow \sigma_{t-1}^{2}(\varepsilon_{it}) = \alpha_i + \beta_{2i} \cdot [E_{t-1}(R_{it}) - A_{it}]. \quad (5)$$

In this expression, β_{2i} relates the aspiration-expectation distance with the risk level. The parameter α_i is assumed to be the same constant for simplicity and for assuring the continuity of the function.

Equations (4) and (5) show the double risk–return relationship predicted by prospect theory. Nevertheless, we can combine these expressions in a single risk–return equation that resumes these relations in the next equation (sign function):

$$\sigma_{t-1}^{2}(\varepsilon_{it}) = \alpha_i + d_{it} \cdot \beta_{1i} \cdot [E_{t-1}(R_{it}) - A_{it}] + (1 - d_{it}) \cdot \beta_{2i} \cdot [A_{it} - E_{t-1}(R_{it})], \quad (6)$$

where d_{it} is a dummy variable that is equal to 1 if the expected return at period t is higher than the aspiration level, and 0 otherwise. Two different parameters, β_{1i} and β_{2i}, are employed for the positive and negative distances, because prospect theory postulates different reactions for both kinds of distances. In fact, prospect theory indicates that the reaction to negative distances is higher than the reaction to positive ones (Kahneman & 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 of return—through a time-series model (Equation (1)) with a heteroskedastic problem (Equation (6)). The estimation of the beta parameters establishes whether the prospect theory postulates are supported. Thus, if the estimates for both beta parameters are significantly greater than zero, the prospect theory perspective on risk taking is supported. If β_{1i} is positive and β_{2i} is negative, the traditional positive relationship between risk and return is obtained.

METHODS

Database

The database employed for testing the model is comprised of the companies that form the S&P Global 100 by February 2002. Stock prices, adjusted for dividends and splits, for the 1990–2000 period were used to compute the variables. When a company was quoted in various stock markets, prices from the NYSE were selected, unless the number of valid observations was less than 500. All prices were obtained from Commodity Systems Inc.

Our final database consisted of 97 companies, with the number of valid observations for the return variable ranging between 551 and 3,650. The final number of countries was 15, with 10 different sectors. As there is only one variable for each model, Table 1 shows the sector, country, estimated expectation, and standard deviation for each company. The reason for testing our model with this database is the lack of works that have tested the "paradox" in economies different from the United States. To our knowledge, there are only two tests with this characteristic—Jegers (1991) and Sinha (1994).

Measures

In contrast with most traditional papers on Bowman's paradox, this paper employs risk and return measures based on stock market data. Previous studies of the "paradox" using market variables have produced contradictory results (Fiegenbaum & Thomas, 1986; Miller & Bromiley, 1990; Veliyath & Ferris, 1997). Fiegenbaum and Thomas (1986) tested the relationship between the beta parameter and accounting return, finding a positive relationship between them.

TABLE 1
Firm-Specific Estimates of Parameters of the Econometric Model

Sector/ company	Country	Expectation of return	Standard deviation of return	α_i	β_{i1}	β_{i2}	Wald	Q′ (8)
Consumer discretionary								
AOL Time Warner Inc.	United States	–0.00015	0.09242	0.00038****	0.44932****	0.23355****	40,962****	0.136
				(0.00001)	(0.01562)	(0.00612)		
Bridgestone Corp.	Japan	–0.00032	0.02636	0.00045****	0.06589****	0.08238****	2,042****	0.282
				(0.00001)	(0.00655)	(0.00372)		
DaimlerChrysler AG	Germany	–0.00005	0.02772	0.00042****	0.30014****	0.09714****	58,601****	0.005
				(0.00000)	(0.00332)	(0.00623)		
Fiat SpA	Italy	–0.00004	0.03322	0.00053****	0.20774****	0.31095****	4,676****	0.005
				(0.00001)	(0.01083)	(0.01384)		
Ford Motor Company	United States	0.00011	0.01513	0.00035****	0.11686****	0.12867****	7,355****	0.041
				(0.00000)	(0.00601)	(0.00285)		
Fuji Photo Film Company	Japan	0.00000	0.02290	0.00048****	0.04818****	0.09030****	1,151****	0.131
				(0.00001)	(0.00580)	(0.00667)		
General Motors	United States	0.00010	0.04268	0.00034****	0.15220****	0.08309****	1,434****	0.074
				(0.00001)	(0.01231)	(0.00965)		
Honda Motor Corporation	Japan	0.00007	0.02731	0.00052****	0.09960****	0.12045****	1,070****	0.030
				(0.00001)	(0.01084)	(0.01069)		
Ito-Yokado Company	Japan	0.00052	0.04168	0.00047****	0.25115****	0.21297****	13,967****	0.202
				(0.00001)	(0.01023)	(0.00747)		
Koninklijke (Royal) Philips Electronics	Netherlands	–0.00058	0.03262	0.00082****	0.37976****	0.55733****	9,155****	0.066
				(0.00001)	(0.01507)	(0.02207)		
Matsushita Electric Industries	Japan	0.00019	0.02806	0.00038****	0.12307****	0.10362****	1,486****	0.044
				(0.00001)	(0.00837)	(0.00884)		
McDonald's Corporation	United States	–0.00013	0.03429	0.00036****	0.09139****	0.12972****	2,046****	0.047
				(0.00001)	(0.00759)	(0.00745)		
News Corporation	Australia	0.00006	0.02313	0.00106****	0.22804****	0.34235****	921,385****	0.147
				(0.00001)	(0.00494)	(0.00797)		
Reuters Group	Great Britain	0.00008	0.02550	0.00052****	0.27210****	0.32992****	26,042****	0.102
				(0.00001)	(0.00991)	(0.01094)		
Sony Corporation	Japan	0.00012	0.02657	0.00033****	0.18549****	0.15566****	180,062****	1.370
				(0.00001)	(0.00444)	(0.00356)		
Toyota Motor Corporation	Japan	0.00010	0.03084	0.00029****	0.25756****	0.13955****	10,308****	0.027
				(0.00001)	(0.00921)	(0.00718)		
Vivendi Universal SA	France	0.00000	0.02849	0.00029****	0.14651****	0.15816****	9,156****	0.050
				(0.00001)	(0.00648)	(0.00678)		
Volkswagen AG	Germany	–0.00007	0.02201	0.00043****	0.69048****	0.43289****	38,451****	0.004
				(0.00000)	(0.00678)	(0.02055)		
Wal-Mart Stores	United States	–0.00001	0.01886	0.00064****	0.13147****	0.15886****	4,164****	0.283
				(0.00001)	(0.01002)	(0.00761)		

(continues)

TABLE 1
Continued

Sector/ company	Country	Expectation of return	Standard deviation of return	α_i	β_{i1}	β_{i2}	Wald	Q′ (8)
Consumer Staples								
Altria Group, Inc.	United States	0.00006	0.03550	0.00042****	0.15428****	0.20031****	102,092****	0.037
				(0.00000)	(0.00421)	(0.00463)		
Carrefour SA	France	–0.00012	0.02045	0.00047****	0.12320****	0.20866****	3,545****	0.068
				(0.00001)	(0.01007)	(0.00869)		
Coca-Cola Company	United States	0.00013	0.02113	0.00017****	0.12533****	0.12518****	7,871****	0.089
				(0.00000)	(0.00602)	(0.00552)		
Colgate-Palmolive	United States	–0.00005	0.02613	0.00017****	0.09311****	0.06530****	5,420****	0.082
				(0.00000)	(0.00379)	(0.00257)		
Diageo	**Great Britain**	0.00005	0.01743	**0.00057******	**0.00792**	**0.05430**	**61******	**0.164**
				(0.00002)	**(0.01250)**	**(0.01492)**		
Gillette Company	United States	–0.00004	0.01644	0.00019****	0.13414****	0.13509****	22,583****	0.733
				(0.00000)	(0.00420)	(0.00347)		
Kimberly-Clark	United States	–0.00002	0.01908	0.00041****	0.04166****	0.05088****	789****	0.014
				(0.00001)	(0.00575)	(0.00558)		
L'Oréal SA	France	–0.00034	0.03489	0.00074****	0.05858****	0.07042****	1,136****	0.267
				(0.00001)	(0.00679)	(0.00752)		
Nestlé SA	Switzerland	–0.00002	0.02374	0.00025****	0.07609****	0.06587****	1,931****	0.596
				(0.00000)	(0.00580)	(0.00571)		
PepsiCo Inc.	United States	–0.00006	0.02041	0.00026****	0.07141****	0.06237****	3,006****	0.129
				(0.00000)	(0.00375)	(0.00413)		
Procter & Gamble	United States	–0.00078	0.11267	0.00023****	0.07113****	0.09829****	91,165****	0.369
				(0.00000)	(0.00371)	(0.00100)		
Unilever NV	Netherlands	0.00033	0.02521	0.00021****	0.18646****	0.20786****	12,588****	0.027
				(0.00000)	(0.00684)	(0.00805)		
Energy								
BP plc	Great Britain	0.00009	0.01889	0.00033****	0.04445****	0.03619****	857****	0.196
				(0.00001)	(0.00428)	(0.00366)		
ChevronTexaco Corporation	United States	–0.00047	0.05601	0.00031****	0.04407****	0.02372*	485****	0.191
				(0.00001)	(0.00552)	(0.00494)		
ExxonMobil Corporation	United States	–0.00004	0.02408	0.00016****	0.03744****	0.01701***	1,208****	0.479
				(0.00000)	(0.00333)	(0.00287)		
Repsol YPF SA	Spain	–0.00010	0.02720	0.00039****	0.03635*	0.03469**	217****	0.030
				(0.00001)	(0.00715)	(0.00676)		
Royal Dutch Petroleum Company	Netherlands	–0.00010	0.05740	0.00021****	0.10619****	0.09914****	6,306****	0.172
				(0.00000)	(0.00503)	(0.00534)		
TotalFinaElf SA	France	0.00012	0.02369	0.00045****	0.09015****	0.06377**	357****	0.104
				(0.00001)	(0.01058)	(0.01159)		
Allianz AG	Germany	0.00007	0.02957	0.00061****	0.08200****	0.11606****	4,896****	0.021
				(0.00000)	(0.00515)	(0.00713)		
Financials								
American International Group	United States	–0.00188	0.05614	0.00015****	0.05363****	0.05512****	2,659****	0.409
				(0.00000)	(0.00340)	(0.00368)		

Assicurazioni Generali SpA	**Italy**	0.00002	0.02624	**0.00140**** (0.00000)**	**–0.04025*** (0.00700)**	**–0.06892 (0.01755)**	**647******	**0.001**
AXA	France	–0.00009	0.02221	0.00071**** (0.00002)	0.10334**** (0.01275)	0.12328**** (0.01313)	995****	0.239
Banco Bilbao Vizcaya Argentaria	Spain	0.00015	0.03721	0.00044**** (0.00001)	0.23315**** (0.00847)	0.27656**** (0.00942)	16,344****	0.184
Banco Santander Central Hispano SA	Spain	0.00003	0.01366	0.00043**** (0.00001)	0.09783**** (0.00715)	0.12353**** (0.00969)	1,962****	0.170
Barclays	Great Britain	–0.00005	0.02140	0.00064**** (0.00001)	0.06338**** (0.00767)	0.08913**** (0.00788)	1,041****	0.103
BNP Paribas SA	France	–0.00008	0.02817	0.00054**** (0.00002)	0.19136**** (0.01110)	0.24052**** (0.01356)	7,825****	0.256
Citigroup Inc.	United States	–0.00007	0.02858	0.00034**** (0.00000)	0.12347**** (0.00904)	0.14393**** (0.01203)	2,009****	0.070
Credit Suisse Group	Switzerland	0.00005	0.02583	0.00016**** (0.00000)	0.02422**** (0.00165)	0.63061**** (0.03561)	63,046****	0.116
Deutsche Bank AG	**Germany**	–0.00007	0.02446	**0.00110**** (0.00003)**	**–0.00717 (0.00966)**	**0.05199**** (0.00734)**	**205******	**0.133**
Fortis Group	Belgium	–0.00011	0.02264	0.00074**** (0.00001)	0.22255**** (0.01122)	0.09489**** (0.00668)	4,764****	0.045
HSBC Holdings PLC	Great Britain	–0.00001	0.03512	0.00108**** (0.00000)	0.07014*** (0.01141)	0.15401**** (0.00780)	754****	0.018
ING Groep NV	Netherlands	0.00012	0.03047	0.00061**** (0.00002)	0.10100**** (0.01047)	0.06382**** (0.00932)	889****	0.099
J.P. Morgan Chase & Company	United States	–0.00012	0.02287	0.00029**** (0.00000)	0.11414**** (0.00416)	0.16084**** (0.00913)	13,406****	0.902
Morgan Stanley	United States	–0.00022	0.03076	0.00030**** (0.00001)	0.17800**** (0.01296)	0.24758**** (0.01132)	5,315****	0.073
Swiss Re	**Switzerland**	–0.00001	0.01683	**0.00143**** (0.00002)**	**0.06556** (0.01175)**	**–0.01125 (0.00582)**	**168******	**0.053**
UBS AG	**Switzerland**	0.00036	0.02296	**0.00083**** (0.00001)**	**–0.06173**** (0.00465)**	**–0.01115 (0.04672)**	**237******	**0.021**
Health Care								
AstraZeneca	Great Britain	–0.00001	0.02219	0.00038**** (0.00001)	0.13192**** (0.01036)	0.07530**** (0.01092)	1,137****	0.012
Aventis SA	**France**	–0.00003	0.01801	**0.00067**** (0.00001)**	**0.03391 (0.00876)**	**0.12354**** (0.01114)**	**533******	**0.068**
Bristol-Myers Squibb	United States	–0.00340	0.05994	0.00017**** (0.00000)	0.11549**** (0.00421)	0.10695**** (0.00250)	19,897****	0.282
GlaxoSmithKline plc	Great Britain	0.00011	0.02256	0.00052**** (0.00001)	0.15370**** (0.00678)	0.19348**** (0.00880)	4,161****	0.118
Johnson & Johnson	United States	0.00003	0.02274	0.00018**** (0.00000)	0.09452**** (0.00652)	0.09406**** (0.00492)	3,532****	0.210
Merck & Co.	United States	0.00001	0.02269	0.00021**** (0.00000)	0.12220**** (0.00637)	0.11392**** (0.00632)	5,512****	0.016
Novartis AG	**Switzerland**	0.00003	0.01582	**0.00051**** (0.00000)**	**0.00592 (0.01646)**	**0.30208**** (0.00431)**	**7,489******	**0.017**
Pfizer, Inc.	United States	0.00009	0.02740	0.00022**** (0.00000)	0.15459**** (0.00938)	0.18541**** (0.01006)	4,792****	0.012

(continues)

TABLE 1
Continued

Sector/ company	Country	Expectation of return	Standard deviation of return	α_i	β_{i1}	β_{i2}	Wald	Q′ (8)
Industrials								
3M Company	United States	0.00004	0.01856	0.00015****	0.13080****	0.11876****	14,115****	0.133
				(0.00000)	(0.00601)	(0.00717)		
General Electric	United States	–0.00058	0.02211	0.00014****	0.08747****	0.08081****	990****	0.082
				(0.00000)	(0.00673)	(0.00726)		
Siemens AG	Germany	0.00000	0.02306	0.00016****	0.77132****	0.61815****	2,467,789****	0.067
				(0.00000)	(0.00273)	(0.00668)		
Tyco International	United States	–0.00003	0.01885	0.00028****	0.26419****	0.39674****	11,363****	0.126
				(0.00000)	(0.00696)	(0.01616)		
United Technologies	United States	0.00001	0.03533	0.00019****	0.08207****	0.08440****	5,404****	0.080
				(0.00000)	(0.00434)	(0.00459)		
Information Technology								
Alcatel SA	France	0.00005	0.07775	0.00060****	0.30588****	0.25369****	47,161****	0.280
				(0.00001)	(0.00612)	(0.00771)		
Canon Inc.	Japan	–0.00031	0.02662	0.00066****	0.14602****	0.19632****	6,279****	0.188
				(0.00001)	(0.00901)	(0.01151)		
Dell Computer	United States	–0.00019	0.02396	0.00479****	0.81167****	0.95914****	34,505****	0.183
				(0.00008)	(0.02512)	(0.02298)		
EMC Corporation	United States	0.00013	0.04702	0.00043****	0.44653****	0.28426****	14,998****	0.016
				(0.00000)	(0.01611)	(0.01456)		
Ericsson	Sweden	0.00005	0.03012	0.00147****	0.48846****	0.68216****	98,733****	0.062
				(0.00002)	(0.01891)	(0.01747)		
Hewlett-Packard	United States	0.00003	0.01989	0.00039****	0.17399****	0.15131****	4,449****	0.029
				(0.00001)	(0.00951)	(0.00694)		
Hitachi	Japan	0.00004	0.01844	0.00025****	0.20396****	0.19169****	35,119****	0.934
				(0.00000)	(0.00552)	(0.00392)		
Intel Corporation	United States	–0.00016	0.01979	0.00035****	0.15976****	0.10235****	3,828****	0.112
				(0.00001)	(0.00929)	(0.00611)		
International Business Machines	United States	0.00017	0.04064	0.00030****	0.26215****	0.17736****	10,794****	0.009
				(0.00000)	(0.00930)	(0.00786)		
Lucent Technologies	United States	–0.00001	0.01908	0.00023****	0.78997****	0.26133****	493,484****	0.320
				(0.00001)	(0.04122)	(0.00245)		
Microsoft Corporation	United States	–0.00008	0.02061	0.00023****	0.18543****	0.12073****	13,142****	0.004
				(0.00000)	(0.00861)	(0.00259)		
NEC Corporation	Japan	0.00012	0.03338	0.00050****	0.24986****	0.29736****	51,842****	0.332
				(0.00001)	(0.00813)	(0.00820)		
Nokia Oyj	Finland	0.00009	0.02885	0.00317****	0.32047****	0.39059****	3,842****	0.118
				(0.00008)	(0.02442)	(0.02040)		

Information Technology								
Nortel Networks Corporation	Canada	0.00009	0.03391	0.00029****	0.08160****	0.13147****	16,956****	0.036
				(0.00000)	(0.00274)	(0.00330)		
Samsung Electronics	Korea	–0.00007	0.03601	0.00023****	1.17956****	2.14352****	30,350,042****	0.963
				(0.00001)	(0.01074)	(0.02469)		
Texas Instruments	United States	–0.00037	0.02738	0.00041****	0.27196****	0.19749****	7,294****	0.046
				(0.00001)	(0.01069)	(0.00901)		
Toshiba Corporation	Japan	–0.00013	0.02872	0.00042****	0.13680****	0.16632****	5,013****	0.022
				(0.00001)	(0.00663)	(0.00854)		
Materials								
Alcan Inc.	Canada	–0.00024	0.02632	0.00035****	0.08459****	0.07390****	2,172****	0.199
				(0.00001)	(0.00509)	(0.00583)		
BASF AG	Germany	0.00000	0.02310	0.00044****	0.30207****	0.10808****	81,232****	0.007
				(0.00000)	(0.00238)	(0.01037)		
Bayer AG	Germany	–0.00024	0.03183	0.00056****	0.02881***	0.03249****	519****	0.101
				(0.00002)	(0.00476)	(0.00326)		
BHP Billiton Ltd.	Australia	–0.00001	0.02740	0.00033****	0.12192****	0.12332****	2,905****	0.010
				(0.00001)	(0.00651)	(0.00724)		
Dow Chemical	United States	0.00014	0.02112	0.00025****	0.08833****	0.09209****	3,293****	0.486
				(0.00000)	(0.00488)	(0.00526)		
Du Pont (E.I.)	United States	0.00153	0.02692	0.00025****	0.18506****	0.15917****	10,217****	0.088
				(0.00000)	(0.00928)	(0.00784)		
Telecom. Services								
AT&T Corporation (New)	United States	0.00003	0.01997	0.00019****	0.35790****	0.22348****	102,308****	0.080
				(0.00000)	(0.00896)	(0.00298)		
Deutsche Telekom AG	Germany	0.00008	0.01744	0.00135****	0.28920****	0.29505****	5,011****	0.307
				(0.00005)	(0.01758)	(0.01587)		
France Télécom SA	**France**	–0.00002	0.03646	**0.00211******	**0.05342**	**0.28866******	**844******	**0.041**
				(0.00008)	**(0.04088)**	**(0.01801)**		
Telefonica SA	Spain	0.00011	0.02821	0.00047****	0.20549****	0.19199****	7,159****	0.106
				(0.00001)	(0.01009)	(0.00904)		
Telecom								
Vodafone Group PLC	Great Britain	–0.00014	0.03094	0.00069****	0.24293****	0.25932****	10,241****	0.166
				(0.00001)	(0.01195)	(0.01034)		
Utilities								
Suez SA	France	0.00002	0.01406	0.00035****	0.12477****	0.18563****	2,285****	0.082
				(0.00001)	(0.00849)	(0.01081)		

Notes: Standard errors are shown in parentheses; beta parameters with p-value > 0.05 are shown in boldface type. * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$; **** $p < 0.0001$.

Miller and Bromiley (1990) used a stock risk measure, which included both systematic and unsystematic risk, but 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 variance of the stock returns. Therefore, the paradox evidence with stock market data is still too weak.

In addition to the weak evidence with stock market data, it has also been pointed out that the "paradox" could result from managerial manipulation of accounting information (Bowman, 1980: 25). Therefore, a direct way to avoid this problem is to use market measures, which are free from such manipulation.

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

$$R_{it} = \frac{P_{it} - P_{it-365}}{P_{it-365}}, \tag{7}$$

where R_{it} is the annual return for a common stock of firm i at day t; P_{it} is the adjusted closing price for a common stock of firm i at day t; and P_{it-365} is the adjusted closing price for that stock on the same date of the previous year. If the stock did not quote on that date in the previous year, the nearest previous price was used. Both prices were adjusted for eliminating capital variations and dividends. This return measure was calculated for each day between January 1, 1992, and December 31, 2000. The reason for selecting daily prices was to get a larger number of observations to validate the model.

Expected return. The function described in Equation (1) must be calculated to estimate the expected return. The procedures followed for selecting the time-series model were as follows. First, for assuring that the series were stationary, the Dickey–Fuller test was performed. (The results of these tests are not reported in the paper but are available from the authors.) The results indicated that some series are not stationary if the return measure is used, but all the series become stationary after taking first differences. By uniformity, we employed an integrated model of first order for each company.

Second, to avoid autocorrelation, we included eight lags of the return variable (Pagan & Schwert, 1990; Schwert, 1989). The results of estimating the expected return demonstrated that there were no autocorrelations of order eight or lower. Ljung–Box's Q'-test values for each firm are also reported in Table 1. Thus, Equations (1) and (2) can be rewritten as follows:

$$R_{it} - R_{it-1} = a_i + \sum_{j=1}^{8} b_{ij} \cdot \left(R_{it-j} - R_{it-j-1}\right) + \varepsilon_{it} \tag{8}$$

$$E_{t-1}\left(R_{it} - R_{it-1}\right) = a_i + \sum_{j=1}^{8} b_{ij} \cdot \left(R_{it-j} - R_{it-j-1}\right), \tag{9}$$

where the subscript t denotes time, i denotes the selected company, and j denotes the number of the lag of the return variable. The estimation of model (9) offers values for the parameters a_i and b_{ij}, which permit the estimation of the expected return for each firm individually at any period.

Risk measure. The right risk measure for our model, discussed above, is empirically calculated as defined in Equation (6).

Aspiration point. As noted above, the aspiration point selected for this work has been the historical aspiration level. The reasons are its firm-specific nature and its coherency with the status quo interpretation of the reference point made by prospect theory (Kahneman & Tversky, 1979: 286; Lee, 1997: 62).

Statistical Methodology

With all the measures developed above, the final model is

$$E_{t-1}\left(R_{it}\right) - R_{it-1} = a_i + \sum_{j=1}^{8} b_{ij} \cdot \left(R_{it-j} - R_{it-j-1}\right) \tag{10}$$

$$\begin{aligned} \sigma_{t-1}^2\left(\varepsilon_{it}\right) = \alpha_i + d_{it} \cdot \beta_{1i} \cdot \left[E_{t-1}\left(R_{it}\right) - R_{it-1}\right] \\ + \left(1 - d_{it}\right) \cdot \beta_{2i} \cdot \left[R_{it-1} - E_{t-1}\left(R_{it}\right)\right], \end{aligned} \tag{11}$$

where R_{it} is the only real variable at period t; R_{it-1} is the value of the aspiration level; d_{it} is an artificial variable to design the sign function; and a_i, b_{ij}, β_{1i}, β_{2i}, and α_i are the parameters of the model to be estimated.

The most relevant characteristic of this model is its heteroskedasticity; that is, the variance of the error term is not constant for all time periods, but changes over time depending on the difference between the expected return and the aspiration (R_{it-1}). In this paper, we employ a two-stage estimation method (Greene, 1993: 570–574). First, using ordinary least squares, we obtain estimates for the parameters of the expectation equation and from these calculated regression residuals. Finally, parameters of the variance equation are estimated by maximizing the log-likelihood of the whole model. In the second stage, the values of the expectation equation are recalculated based on the results obtained for the variance. The statistical program used was the Large-Scale GRG Solver Engine of Frontline Systems.

The Wald statistic is calculated to test if the global model and the parameters are significant. The Wald test has an advantage over alternative tests (e.g., likelihood ratio or Lagrange multiplier) because the log-likelihood is maximized only once. The formulation of the Wald statistic is presented in Greene (1993: 379–381). The BHHH (Berndt, Hall, Hall, & Hausman, 1974) method is used 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: 115–116).

RESULTS

As explained above, the estimation of the beta parameters establishes whether the behavioral theories are supported. Thus, if the estimates of both beta parameters are significantly greater than zero, the behavioral perspective on risk taking is supported. If β_{1i} is positive and β_{2i} is negative, the positive relationship between risk and return is obtained.

Table 1 also shows the estimations of the parameters and their standard errors (in parentheses), as well as the Wald test for the whole model and the Ljung–Box test values. Because our interest is centered in the risk, only the variance parameters are reported (although estimates for the expectation parameters are available from the authors).

These results show that the econometric model is significant for all the firms (p-value of the Wald statistic is less than 0.0001 for all the companies), supporting the general validity of the models and indicating that they do not have autocorrelation problems because the value of the Q'-statistic is close to 0 (p-value $\approx$ 1).

The estimates for β_{1i} and β_{2i} are positive for the majority of the firms. In fact, the β_{1i} estimates are significantly positive (at the 0.05 level) for 90 out of 97 cases. This suggests that there are only seven exceptions to this positive value. However, only two of them (Assicurazioni Generali and UBS) strongly contradict prospect theory, because they have values that are significantly lower than zero.

On the other hand, the β_{2i} estimates are significantly greater than zero for 93 of the 97 companies. Nevertheless, the four exceptions present values that are not significantly different from zero, and, contrary to β_{1i} and what would be expected if a permanent risk-aversion attitude was shown, there are no significant negative values.

Curiously, the two companies that obtained negative estimates for β_{1i} have also obtained no significant estimates for β_{2i}, and they belong to the financials sector. In this sense, Diageo constitutes another major exception to the model, because both parameters beta are not significantly different from zero for this company. The remainder of the firms (94) have significant positive estimates for β_{1i} or β_{2i}, or for both beta parameters.

On the other hand, prospect theory (Kahneman & Tversky, 1979: 279) postulates that the value function for decision makers is steeper for losses than for gains. This was interpreted by Fiegenbaum (1990: 191), as there is a steeper risk–return relationship when the expected outcomes do not reach the aspiration point. However, our results do not systematically support different relationships between losses and gains.

Finally, the constant of the variance equation (α_i) has highly significant estimates for all the firms, including the former exceptions. Because this value is significantly different from zero, it indicates that there is a portion of risk that is not explained by the difference between the expectation and the reference point.

In summary, we have obtained significant estimates in every case, with only three major exceptions (3.09 percent) in which beta estimates did not follow the double behavioral relationship. These results allow us to conclude that the model can be applied using market measures in studies of risk taking by firms, independently of the chosen country and industry.

DISCUSSION AND CONCLUSIONS

The research on Bowman's paradox has two important gaps: the identification problem and the lack of evidence at the market level. To solve the first problem, we provide a heteroskedastic time-series model that is an econometric translation from prospect theory. With regard to the second problem, we test this new model with market measures. With these contributions, we obtain support for prospect theory independently of the country or the industry. That is, in spite of overcoming the previous criticisms, the changing risk attitude follows the behavior of decision makers, as prospect theory indicates: there is a positive risk–return relationship between risk and return when the expected return exceeds the reference level and a negative relationship when the expected return falls below that reference level.

These results permit two main conclusions. First, prospect theory may be an explanation for the behavior of the relation between return and risk. Second, there is no paradox at the individual firm level, because, when market measures are used, a negative relationship is not found, as shown in traditional financial economics.

Nevertheless, in our opinion, the empirical results indicate two more important aspects. First, the value of the independent term α_i is always positive and significant. That is, there exists a portion of the variance (risk in prospect theory terminology) that does not depend on the difference between the expectation and the aspiration point. In other words, there are other sources of risk. These sources could be identified with those other theories found in the previous literature about

Bowman's paradox, especially those related to the strategic position of the firm, which were discussed in the introduction: the product or consumer orientation (Bettis & Mahajan, 1985; Bowman, 1980), market power (Cool et al., 1989), and the diversification strategy (Bettis & Hall, 1982; Bettis & Mahajan, 1985; Kim, Hwang, & Burgers, 1993). In this sense, an interesting line of research is the analysis of how the values of the coefficients of the model could be interchanged by different variables from firm-specific, industry-specific, or country-specific characteristics. Second, the differences between the beta parameters of our heteroskedastic model among firms are important. These differences can also provide some interesting lines of future investigation. As the previous literature suggests (Lee, 1997; MacCrimmon & Wehrung, 1986), the degree of risk avoidance or risk propensity is firm specific, as the different estimates obtained for the beta parameters demonstrate. Therefore, it is worth studying why some firms exhibit more extreme attitudes toward risk than others (and so their beta values are greater)—that is, what manager-specific, personal-specific, or firm-specific characteristics determine the slope of the risk–return relationship, and in what measure they determine it. The interrelationship between both aspects is also of interest. For instance, the firms inside some economies or industries exhibit behavior that is more or less aversion or avoidance to the risk. That is, firms with their behaviors could try to remove other sources of risk. Perhaps their behavior depends on all these sources of risk.

We are aware that our work presents several limitations in relation to the model, to the sample, and, finally, to the market measures. The limitations of the model spring from the simplifications in its assumptions. Thus, the first aspect would be the independent term α_i. While it is considered to be constant, that does not imply that there is a constant risk over time but that there are other variables that influence the managerial risk taking, not included in the model and summarized by this independent term. Another simplification is to consider a linear function between the risk and the difference between return and the aspiration point. This assumption implies that the risk aversion or the risk seeking is equal independently of the value of the loss or gain. We consider that this is a very restrictive premise. It would be more reasonable if the risk aversion or the risk seeking were an increasing function of the loss or gain in relation to the reference point. That is, when there are more gains, there are more risk-averse attitudes, and when there are more losses, there are more risk-seeking attitudes. Perhaps a logarithmic function would have been more appropriate. In relation to the expectation equation, we have estimated only one a_i parameter and only one b_i parameter by each eighth lag for the entire historic period. This implies that the increment of the expectation is random and that this randomness depends on its more recent history (one week). If this recent history is different, there are different increments in the expectation. However, there is always a degree of temporal stability in each model. As with any time-series model, if a structural change of behavior exists, two different models have to be estimated, one before and one after this structural change.

Our work also presents several limitations in relation to the sample that should be solved in future research. First, although, theoretically, the proposed model could be applied to both market and accounting data, the estimation procedure requires a very large number of observations. This large number of observations is almost impossible to obtain with accounting data, because the periodicity of the data is, at best, quarterly. 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 noted above. Second, the S&P Global 100 index is composed of the largest firms around the world. It would be interesting to test this model with other databases to extrapolate the results of this paper.

Finally, because the model is tested with market data, an implicit assumption is that the returns of the common stocks are determined by managerial actions. Although this idea has been frequently employed in the strategic management literature (Ruefli et al., 1999: 173), it is much more difficult to justify when daily data are used. In addition, prospect theory links the relative position to the reference point to the risk attitude, but makes no direct link between risk and return. Therefore, implicitly, it is assumed that the risk the firm experiences is the risk the decision maker desired (Lee, 1997: 32).

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