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Emotional Asset Pricing

by Marc Gürtler* and Nora Hartmann**

Abstract. Since the equity premium as well as the risk-free rate puzzle question the concepts central to financial and economic modeling, we apply behavioral decision theory to asset pricing in view of solving these puzzles. U.S. stock market data for the period 1960-2003 and German stock market data for the period 1977-2003 show that emotional investors who act in accordance to Bell's (1985) disappointment theory – a special case of prospect theory – and additionally administer mental accounts demand a high equity premium. Furthermore, these investors reason a low risk-free rate. However, Barberis/Huang/Santos (2001) already showed that limited rational investors demand a high equity premium. But as opposed to them, our approach additionally supports dividend smoothing.

Key words: Behavioral Finance, Equity Premium Puzzle, CCAPM, Dividend Smoothing

JEL-Classification: G12, G35

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1. Introduction

Since [28] challenged economists with the observed high historical U.S. equity premium many sophisticated approaches have been developed to answer why the average real stock return exceeds the average short-term real interest rate by more than six percent over the ninety-year period 1889-1978.[1] But none of these approaches explicitly involve optimal dividend policy in the framework of asset pricing. The classical framework to estimate the adequacy of a high equity premium in a theoretical context is the consumption-based asset pricing model (CCAPM) by [26]. In principle, the model postulates a relationship between consumption preferences and the equity premium. Securities that facilitate the smoothing of consumption over time, because they pay off when consumption is generally low, are preferred and thus more valuable. For this reason, the return of such a security will be lower than that one which pays off when consumption is already high. Generally, investors with time-separable power utility functions are assumed. Then on the whole, the degree of risk aversion together with the interrelation between return and consumption

[1] See for an overview of these approaches [23] or [29].

(measured by its covariance) positively determine the equity premium. However, various empirical studies have shown that this covariance is usually low.[2] Therefore, the CCAPM can explain the high equity premium only if investors are extremely risk averse and – what puzzles – much more risk averse than plausible.[3] Furthermore, if we assume that the degree of risk aversion is going far beyond the usual limits, another puzzle automatically arises in the scope of the CCAPM, because then time preferences have to be strange to guarantee a reasonable risk-free rate. While the first is known as 'equity premium puzzle', the second is called 'risk-free rate puzzle'.[4]

Analyzing stock market data of 11 countries [10] shows the equity premium puzzle to be a global phenomenon. We confine ourselves to analyzing U.S. and German data and observe an average equity premium of 5.719 % (for the logarithm of returns of the S&P 500 from 1960-2003) and 4.862 % (for the DAX from 1975-2003), respectively. Thus, the 'standard' CCAPM cannot explain this return together with an average risk-free rate amounting to 3.526 % and 3.938 %, respectively. Therefore, we develop a behavioral framework with emotional investors to justify the high equity premium together with the low risk-free rate.

Our approach is related to models with habit formation where utility from consumption depends on deviations from past consumption or from consumption of a social reference group.[5] Similar to these models, we modify the consumption definition. However, we do not consider past consumption, but current consumption including emotions. Basically, we are affected by [8] and [5]. As them we tie up to the ideas of behavioral finance. [8] assume preferences in accordance to *Kahneman/Tversky's* prospect theory (see [21]) together with mental accounting in terms of time-dependent accounts. A frequent evaluation of the stock and bond engagement leads to 'myopic loss aversion': since stocks fluctuate more than bonds investors more frequently feel losses when they evaluate stocks. Therefore risk as well as losses have to be rewarded which leads to a higher risk premium. Thus, myopic loss aversion may explain the high equity premium. But in this framework, the low risk-free rate remains a puzzle.[6] Similarly, the approach of [5] is based on an extension of prospect theory. Concretely, investors' loss aversion depends on their prior investment performance. The variability of loss and therewith risk aversion leads to a high volatility of returns. This in turn causes loss averse investors to demand a high equity premium for holding stocks. On the whole, [5] may explain the equity premium, but do not explicitly consider corporate dividend policy which

[2] See for example [28] and [10].
[3] [28] quote many studies that argue the coefficient of relative risk aversion to be between zero and two, for example [18]. On the basis of these results [28] restrict the value of this coefficient to be less than ten.
[4] The equity premium puzzle goes back to [28] and the risk-free rate puzzle to [41].
[5] See [15] or [11].
[6] See [10], p. 7.

may become important in the presence of limited rational investors.[7]

Concerning investor anomalies we explicitly consider a capital market equilibrium. Concretely, we suppose mental accounting between dividend and stock price growth. Furthermore, we assume investors to be emotional, i.e. they have preferences according to *Bell's* disappointment theory (see [6]): Out of a stock investment an investor gets his straight return to finance consumption, and additionally, he will feel disappointment if the dividend or the stock price growth of his bought stocks is worse than expected. Otherwise, he will feel elation. Therefore, total consumption is composed of a 'real' component (the consumption of goods) and an 'emotional' component (elation or disappointment from the stock engagement) each with measured in dollars and euros, respectively. Since the emotional extend depends on deviations from a reference point (i.e. expectations) disappointment theory can be regarded as a special case of *Kahneman/Tversky's* prospect theory (see [21]).

Based on these anomalies we show that emotional investors demand a very special dividend policy. As a first result, dividend policy becomes important so that dividends should optimally be smoothed relative to earnings. Thus, the solution of a further puzzle (i.e. dividend smoothing) is a side product of our investigation. But primarily the inclusion of emotional investors leads to an emotional CCAPM where the interrelation between *total* consumption and returns is a crucial determinant of the equity premium. Applied to U.S. and German stock market data the theoretical dividend is a suitable estimator for actual distributed dividends. But particularly, a reasonable coefficient of relative risk aversion can explain the equity premium of 5.719 % (4.862 %) together with the average U.S. (German) risk-free rate of 3.526 % (3.938 %).

The remainder of the paper is organized as follows: section 2 concretizes the framework and investor preferences. Then, we deduce optimal dividend policy and asset pricing within the context of emotional investors. Section 3 empirically tests the theoretical results concerning dividend policy and the equity premium for German stock market data. Finally, section 4 concludes.

2. The Model[8]

2.1. *The Setting*

In what follows, we consider a perfect[9] and complete capital market with an infinite time horizon where time is discrete with a set of dates indexed $t \in \mathbb{N} := \{1, 2, ...\}$. At each date t every firm $i \in \{0, \ldots, I\}$ offers its $n^{(o)}_{t,i,j}$ stocks for sale at the price

[7] [34] already remarked the importance of dividend policy in the presence of limited rational investors.

[8] As a guidance, Table 1 of Appendix 3 gives an overview of relevant mathematical symbols of the model.

[9] The capital market is perfect except for investor anomalies.

$p^{(ex)}_{t,i,j}$ ex dividend[10] where $j \in \{1, \ldots, J\}$ denotes the current state of the world. All assets are risky besides that one of firm 0. For this reason, its next period's return $r_{t+1,0}$ is the risk-free rate. There is only one investor with available income $w_{t,j}$ who must decide how much to spend for consumption $c_{t,j}$ and how much to invest in assets where $a_{t,j} := \sum_{i=0}^{I} n^{(d)}_{t,i,j}\, p^{(ex)}_{t,i,j}$ denotes the amount of investment and $n^{(d)}_{t,i,j}$ the number of stocks of firm $i \in \{0, \ldots, I\}$ demanded by the investor. Since the investor has no labor income nor other funds, his periodical budget constraint is given by

$$w_{t,j} \geq c_{t,j} + a_{t,j} \quad \text{for all } t \in \mathbb{N}, j \in \{1, \ldots, J\}. \tag{2.1}$$

Due to the fact that each firm i generates earnings and makes investments from date t to date $t+1$, the stock 'purchase' price $p^{(ex)}_{t,i,j}$ of date t becomes $\tilde{p}^{(cum)}_{t+1,i} \in \{p^{(cum)}_{t+1,i,1}, \ldots, p^{(cum)}_{t+1,i,J}\}$ at the beginning of date $t+1$. The concrete realization of $\tilde{p}^{(cum)}_{t+1,i}$ depends on the revealed state of the world of that date. We assume that each future state q occurs with probability ϕ_q and that future returns $p^{(cum)}_{t+1,i,q}/p^{(ex)}_{t,i} - 1 =: r_{t+1,i,q} \in \{r_{t+1,i,1}, \ldots, r_{t+1,i,J}\}$ are identically and independently distributed over time. We thereby assume (without loss of generality) $r_{t,i,J}$ to be the minimum of all possible returns. Since the investor is limited liable we suppose $r_{t,i,J}$ to be close to minus one ($r_{t,i,J} > -1$) to guarantee that he cannot loose more than he invested. Due to the fact that the investment program and consequentially the earnings of all firms are assumed to be exogenous, firms cannot influence their stock price cum dividend $\tilde{p}^{(cum)}_{t+1,i}$ nor their return $\tilde{r}_{t+1,i}$. In the following, $y_{t,i,j}$ denotes the fraction of $a_{t,j}$ that the investor spends for stocks of firm i at date t where $\sum_{i=0}^{I} y_{t,i,j} = 1$ for all $t \in \mathbb{N}$ and $j \in \{1, \ldots, J\}$. His next period's portfolio return $\tilde{r}_{t+1,M}$ is then given by

$$\tilde{r}_{t+1,M} = \sum_{i=0}^{I} y_{t,i,j}\ \tilde{r}_{t+1,i} = r_{t+1,0} + \sum_{i=1}^{I} y_{t,i,j}\ (\tilde{r}_{t+1,i} - r_{t+1,0}) \qquad \text{for all } t \in \mathbb{N}, j \in \{1, \ldots, J\} \tag{2.2}$$

and his wealth at any date $t+1$ by

$$\tilde{w}_{t+1} = (1 + \tilde{r}_{t+1,M})\ a_{t,j}. \tag{2.3}$$

As is customary, we assume that the investor decides between spending and consumption to maximize his expected present value of discounted utility of consumption over his entire (infinite[11]) lifetime. Thus, his objective function at any date

[10] A stock trades ex dividend when it no longer carries the right to the most recently declared dividend. For transactions during the ex dividend period, the seller, not the buyer, will receive the dividend.

[11] See [2] for a justification of this assumption. He argues that investors have bequest motives, because they derive utility from the utility of their descendants.

$t \in \mathbb{N}$ is given by

$$E_t\left(\sum_{\tau=t}^{\infty} \beta^{\tau-t}\, U(\tilde{c}_\tau, \tilde{w}_\tau)\right) \tag{2.4}$$

where $\tilde{w}_t = w_{t,j}$ is given and E_t denotes the expectation operator given all information at date t. In addition, $\beta \in (0;\, 1)$ is the (exogenous) discount factor and U the (time-separable) period (limited rational) utility function with $U_c > 0$ and $U_{cc} < 0$.[12]

So far our framework resembles that one of the classical consumption based capital asset pricing model (CCAPM).[13] The maximization of (2.4) over the consumption plan $\{\tilde{c}_\tau\}_{\tau=t}^{\infty}$ and the plan for the portfolio weights $\{\tilde{y}_\tau\}_{\tau=t}^{\infty}$ with $\tilde{y}_\tau := \{\tilde{y}_{\tau,0},\ ...,\ \tilde{y}_{\tau,I}\}$ subject to the investor's budget constraint (2.1) yields to the following first order conditions for all $t \in \mathbb{N}$, $i \in \{0,\ ...,\ I\}$, $j \in \{1,\ ...,\ J\}$:[14]

$$\begin{aligned} U_c(c^*_{t,j}, w_{t,j}) &= \beta\ E_t(U_c(\tilde{c}^*_{t+1}, \tilde{w}_{t+1})\ (1 + \tilde{r}_{t+1,i})) \\ \Leftrightarrow \quad p^{(ex)*}_{t,i,j} &= \beta\ E_t(\tilde{p}^{(cum)}_{t,i}\ U_c(\tilde{c}^*_{t+1}, \tilde{w}_{t+1})/U_c(c^*_{t,j}, w_{t,j})) \end{aligned} \tag{2.5}$$

and

$$E_t(U_c(\tilde{c}^*_{t+1}, \tilde{w}_{t+1})\ \tilde{r}_{t+1,i}) = E_t(U_c(\tilde{c}^*_{t+1}, \tilde{w}_{t+1}))\ r_{t+1,0}. \tag{2.6}$$

Equation (2.5) is the well-known *Euler* equation, which requires that the marginal utility loss of consuming a little less at date t and spending it in stock i should equal the marginal utility gain of consuming a little more of the payoff at date $t+1$. Otherwise, the investor should buy more or less stocks of firm i. Equation (2.6) states that the marginal utility of a firm's payoff equals the marginal utility from a risk-free investment.

In equilibrium, we further have market clearing

$$n^{(o)}_{t,i,j} = n^{(d)}_{t,i,j} \tag{2.7}$$

so that the investor owns all stocks of every firm. And it must be true that

$$c^*_{t,j} = \sum_{i=0}^{I} d^*_{t,i,j} \tag{2.8}$$

where $d^*_{t,i,j} := p^{(cum)}_{t,i,j} - p^{(ex)*}_{t,i,j}$ denotes the optimal dividend per share distributed by firm $i \in \{0,\ ...,\ I\}$. Thus, in equilibrium the investor consumes all dividends according to his consumption preferences. In the following, we call this desired payout *private dividend policy.* The actual dividend policy, which is made before the (private) consumption decision, is contrary termed *entrepreneurial dividend policy.*

[12] Due to the strict concavity of U we can replace the unequal sign in (2.1) with the equal sign. In addition, U_c represents the first partial derivative of U and U_{cc} stands for the second partial derivative of U according to c.
[13] See for the CCAPM for instance [10].
[14] See [33], pp. 92. See for mathematical details [37], pp. 239.

Ignoring (for a moment) any kind of investor anomalies entrepreneurial dividend policy is irrelevant due to the assumption of a complete and perfect capital market: If a firm i distributes a dividend that is less than preferred ($d_{t,i,j} < d^*_{t,i,j}$), the stock price ex dividend is relatively too high ($p^{(ex)}_{t,i,j} > p^{(ex)*}_{t,i,j}$) because of the interrelation

$$p^{(ex)}_{t,i,j} + d_{t,i,j} = p^{(cum)}_{t,i,j} \tag{2.9}$$

together with the fact that $p^{(cum)}_{t,i,j}$ is exogenous. Under this dividend policy equation (2.5) cannot hold and the investor sells some shares of firm i to get more cash (i.e. a higher 'private' dividend) which causes the stock price $p^{(ex)}_{t,i,j}$ to drop until it equals $p^{(ex)*}_{t,i,j}$. If the originally distributed dividend is too high (with $d_{t,i,j} > d^*_{t,i,j}$ and consequently $p^{(ex)}_{t,i,j} < p^{(ex)*}_{t,i,j}$), the investor demands more stocks producing a stock price enhancement up to $p^{(ex)*}_{t,i,j}$. Hence, the investor calls off any entrepreneurial dividend policy that he does not prefer (i.e. $d_{t,i,j} \neq d^*_{t,i,j}$) via stock purchase or sale.

Thus, the classical theorem of *Miller/Modigliani* (see [30]) holds in the context of the standard CCAPM: entrepreneurial dividend policy is irrelevant for any rational investor. For this reason approaches about asset pricing can ignore an explicit analysis of corporate dividend policy in the framework of the CCAPM. This is true while investors are fully rational. In the following, we would like to investigate the influence of limited rational investors who demand a special entrepreneurial dividend policy. Therefore, we have to enlarge the setting by explicitly involving the firms' dividend decisions. On account of this, we insert entrepreneurial dividend policy as an intermediate step between state revelation and the investor's stock trading as illustrated in Figure 1.

**** Figure 1 about here ****

As in the classical CCAPM firms make investments, produce, and realize cash flows resulting in the stock price cum dividend.[15] In contrast to the classical CCAPM an intermediate step of corporate dividend policy follows before stock trading on the capital market: Each firm $i \in \{0, \ldots, I\}$ announces its dividend payout $\hat{d}_{t,i,j}$ by a split-up of its stock price cum dividend $p^{(cum)}_{t,i,j}$ into a dividend $\hat{d}_{t,i,j}$ and stock price ex dividend $\hat{p}^{(ex)}_{t,i,j}$ (where $\hat{d}^{(ex)}_{t,i,j} + \hat{p}^{(ex)}_{t,i,j} = p^{(cum)}_{t,i,j}$ for all t, i, and j). Subsequently, the investor decides about his personal cash distribution and with it about his periodical consumption and saving. According to his preferences he purchases and sells stocks resulting in the (balanced) stock price $p^{(ex)*}_{t,i,j}$ and the actual consumed dividend $d^*_{t,i,j}$ (where again $d^{(ex)*}_{t,i,j} + p^{(ex)*}_{t,i,j} = p^{(cum)}_{t,i,j}$ for all t, i, and j). The differences between the classical CCAPM and the CCAPM expanded by entrepreneurial

[15]The investment program and production are exogenous and therefore in the background of consideration.

dividend policy are illustrated in Figure 2. Due to the further specified anomalies we call this enlarged CCAPM *emotional CCAPM* (or E-CCAPM).

**** Figure 2 about here ****

2.2. *Investor Anomalies*

To analyze the effects of limited rationality on (entrepreneurial) dividend policy and on balanced stock prices we have to concretize investor anomalies first. Unlike the '*Modigliani-Miller*-world' the announced dividend may cause emotions. We thus suppose an emotional investor, i.e. he is pleased or disappointed with certain (corporate) dividend policies. Though the investor can undo the firm's dividend policy by selling or buying shares and for this reason consume according to his preferences, he cannot cancel his emotions regarding the firm's dividend policy. [34] already remarked that the secondary capital market is a desiderative substitute for a firm's dividend policy in the presence of limited rational investors.[16] As mentioned earlier we concretely assume that the investor has preferences in accordance to a special case of prospect theory, i.e. *Bell*'s disappointment theory.

The role of disappointment in decision making was primarily formalized independently by [6] and [25]. In their theory, individuals not only experience disappointment and elation as a consequence of making decisions, but also anticipate them and take them into account when making decisions. Thus, decisions are partly based on disappointment aversion or, in other words, the tendency to make choices in such a way as to minimize the future experience of disappointment. As defined by [25], disappointment is a psychological reaction to an outcome that does not match up against prior expectations. Consequently, an individual compares the outcomes within a given prospect, giving rise to the possibility of disappointment (elation) when the outcome compares unfavorably (favorably) with what it might have been. The satisfaction that an individual is assumed to feel after a lottery has been run can be split into two elements: the satisfaction due to the ownership of the realized prize, which is generally identified to the utility of wealth and elation (or disappointment) which depends on the difference between the level actually reached by the utility of wealth and its expected value. Basically, disappointment is assumed to be in direct proportion to the difference between what was expected and what has actually been got. There is a lot of empirical evidence that support this assumption in the psychological literature ([39], [40], [42]). In addition, an axiomatic foundation of a modified version of *Bell*'s disappointment theory is presented by [19] which in turn was generalised by [32]. An axiomatisation of *Bell*'s disappointment theory is given by [13].

To integrate these thoughts into the model under consideration we assume that the investor does not only benefit from periodical (actual) consumption $c_{t,j}$, but

[16] Compare as well [17], [35], and [36].

also from emotions stemming from his stock engagement via an 'emotion function' $e_{t,j}$. Thus, total consumption $C_{t,j}$ is the sum of actual consumption plus emotions measured by $e_{t,j}$:

$$C_{t,j} = c_{t,j} + e_{t,j} \qquad \text{for all } t \in \mathbb{N}, j \in \{1, ..., J\}. \tag{2.10}$$

Concerning emotions, the investor differentiates between dividend and stock price driven emotions. In addition, he separately values each stock: He does not offset emotions of stock i with emotions of stock $\iota \neq i$. According to [38], the investor thus administers mental accounts between different stocks as well as between the dividend and the stock price of a single stock.[17] Therefore, total emotions are consolidated stock accounts where a stock account ($e_{t,i,j}$) itself is composed of a dividend ($e^{(d)}$) sub-account and a stock price ($e^{(p)}$) sub-account.

Empirical studies[18] show that investors are geared to the difference between the current and the previous dividend and less to the absolute dividend. In the following $\delta_{t,i,j}$ denotes the entrepreneurial dividend growth rate $\hat{d}_{t,i,j}/d^*_{t-1,i} - 1$ at date t and state j and $\pi_{t,i,j}$ indicates the stock price growth rate $\hat{p}^{(ex)}_{t,i,j}/p^{(ex)*}_{t-1,i} - 1$, respectively. Elation or disappointment in one mental account then emerges from differences between the actually realized (dividend or rather stock price) growth rate and the former expectations about it. Interpreting expectations as reference points the linkage to prospect theory is obvious. To consider the unequal (absolute) extent of dividends and stock prices the investor weights each dividend account with its former dividend and each stock price account with its former stock price. Under consideration of these aspects the emotion function is given by

$$\begin{aligned} e_{t,j} &= \sum_{i=0}^{I} e_{t,i,j} \\ &= \sum_{i=0}^{I} \{d_{t-1,i}\, e^{(d)}(\delta_{t,i,j} - E_{t-1}(\tilde{\delta}_{t,i})) + p^{(ex)}_{t-1,i}\, e^{(p)}(\pi_{t,i,j} - E_{t-1}(\tilde{\pi}_{t,i}))\} \end{aligned} \tag{2.11}$$

for all $t \in \mathbb{N}$ and $j \in \{1, ..., J\}$. Corresponding to [25], the disappointment functions $e^{(d)}$ and $e^{(p)}$ are assumed to be strictly monotonic increasing, so that the degree of emotion rises with increasing distance from the reference point. But, as opposed to [25] we do not act on the premise the functions to be symmetric to the origin. For the purpose of simplification the disappointment functions are assumed to be concave.[19]

For the concrete modeling we introduce so-called measures of absolute disappointment aversion that (analogous to the *Arrow/Pratt* measure of absolute

[17] See [4] who analyze mental accounts between stocks in the context of asset pricing.
[18] See [24] or recently [9].
[19] Concerning the stock price account we follow [5] who also abstain from a convex characteristic of their value function in the range of negative values. In addition, relating to the dividend account, [1] show that markets positively react to dividend enhancements and strongly negatively react to dividend decreases. See also [22] or [7].

risk aversion) can be expressed by $\lambda^{(d)} := -e^{(d)''}/e^{(d)'}$ for dividends and by $\lambda^{(p)} := -e^{(p)''}/e^{(p)'}$ for stock prices. For simplification, these measures are assumed to be constant. For this reason we call the constant parameters $\lambda^{(d)}$ and $\lambda^{(p)}$ coefficients of emotion aversion.[20] This implies the emotion functions to be exponential:[21]

$$e^{(d)}(\delta_{t,i,j} - E_{t-1}(\tilde{\delta}_{t,i})) = c_i^{(d)}\ [1 - \exp(-\lambda_i^{(d)}\ (\delta_{t,i,j} - E_{t-1}(\tilde{\delta}_{t,i})))] \text{ and}$$
$$e^{(p)}(\pi_{t,i,j} - E_{t-1}(\tilde{\pi}_{t,i})) = c_i^{(p)}\ [1 - \exp(-\lambda_i^{(p)}\ (\pi_{t,i,j} - E_{t-1}(\tilde{\pi}_{t,i})))]. \quad (2.12)$$

In the special case of $\lambda_i^{(d)} = \lambda_i^{(p)} = 0$ for all $i \in \{0, \ldots, I\}$, we have fully rational investors with no emotions. As realizations above expectations lead to elation and realizations beneath expectations to disappointment, both emotion functions are monotonically increasing and equal zero when realized values coincide with their expectations. Further, the parameter $h_i := \lambda_i^{(p)}/\lambda_i^{(d)}$ characterizes the relationship between the different degrees of 'absolute emotional aversion' felt by the investor in the i^{th} stock price and in the i^{th} dividend account. For convenience we assume, that the ratio $c_i^{(p)}/c_i^{(d)}$ equals $1/h_i$. Thus, we have the following interrelation between the dividend and the stock price account:

$$e^{(p)}(x) = e^{(d)}(h_i\ x)/h_i \qquad \text{for all } i \in \{1, ..., I\}, j \in \{1, ..., J\}. \quad (2.13)$$

Beyond, it is true that[22]

$$1 + r_{t,i,j} = \frac{p_{t,i,j}^{(ex)} + d_{t,i,j}}{p_{t-1,i}^{(ex)*}} = (1 + \pi_{t,i,j}) + (1 + \delta_{t,i,j})\ \vartheta_{t-1,i}$$
$$\Leftrightarrow \qquad \pi_{t,i,j}(\delta_{t,i,j}) = r_{t,i,j} - (1 + \delta_{t,i,j})\ \vartheta_{t-1,i} \quad (2.14)$$

where $\vartheta_{t-1,i} := d_{t-1,i}/p_{t-1,i}^{(ex)}$ denotes the dividend yield at date $t-1$. Choosing a firm's dividend growth rate for a given return, the management automatically determines the stock price growth rate. Taking these aspects into consideration, emotions are given by

$$e_{t,j} = \sum_{i=0}^{I} d_{t-1,i}\ e^{(d)}\left(\delta_{t,i,j} - E_{t-1}(\tilde{\delta}_{t,i})\right)$$
$$+ \sum_{i=0}^{I} p_{t-1,i}^{(ex)}\ e^{(d)}\left(h_i\ (\pi_{t,i,j}(\delta_{t,i,j}) - E_{t-1}(\tilde{\pi}_{t,i}(\tilde{\delta}_{t,i})))\right)/h_i \quad (2.15)$$

for all $t \in \mathbb{N}$ and $j \in \{1, ..., J\}$.

[20]Relating to prospect theory these are the coefficients of loss aversion. They measure the investor's aversion against emotions in the respective mental account.
[21]The emotion functions are designed to fulfill $e(0) = 0$. $c^{(d)}$ and $c^{(p)}$ represent initially not specified constants.
[22]The interrelation in the first line becomes obvious by using the definition of $\pi_{t,i,j}$, $\delta_{t,i,j}$ *and* $\vartheta_{t-1,i}$.

2.3. *Optimal Dividend Policy in the Presence of Emotional Investors*

In practice, a lot of managers behave optimally only for a short period of time.[23] Though the management of each firm is fully rational, it acts myopically. Therefore it maximizes the investor's one period utility from consumption over dividend policy, but ignores all effects on future periods.[24] Thus, after state revelation the management's maximization problem at each date $t \in \mathbb{N}$ is given by:

$$U(C_{t,j}(c_{t,j},\, e_{t,j}(\delta_{t,0,j},\, ...,\, \delta_{t,I,j})),\, w_{t,j}) \;\rightarrow\; \max_{\delta_{t,i,j}}.! \tag{2.16}$$

for all $i \in \{1, ..., I\}$, $j \in \{1, ..., J\}$, and with

$$\begin{aligned} C_{t,j} = c_{t,j} + \sum_{i=0}^{I} d_{t-1,i}\; e^{(d)} \left(\delta_{t,i,j} - E_{t-1}(\tilde{\delta}_{t,i})\right) \\ + \sum_{i=0}^{I} p_{t-1,i}^{(ex)}\; e^{(d)} \left(h_i\; (\pi_{t,i,j}(\delta_{t,i,j}) - E_{t-1}(\tilde{\pi}_{t,i}(\tilde{\delta}_{t,i})))\right) / h_i \end{aligned} \tag{2.17}$$

subject to[25]

$$\delta_{t,i,j} \geq -1 \quad \text{and} \quad \pi_{\mathrm{t,i,j}} \geq -1 \Leftrightarrow \delta^{*}_{\mathrm{t,i,j}} \in (-1; \delta^{(\max)}_{\mathrm{t,i,j}}). \tag{2.18}$$

The latter line has to hold because we do not admit negative dividends nor stock prices. From this maximization problem follows that the optimal dividend growth rate $\hat{\delta}_{t,i,j}$ of firm $i \in \{1, ..., I\}$ is given by[26]

$$\hat{\delta}_{t,i,j} = \hat{\delta}_{t,i,J} + \psi_{t,i}\; (r_{t,i,j} - r_{t,i,J}) \tag{2.19}$$

where $\psi_{t,i} := h_i/(1 + h_i\; \vartheta_{t-1,i})$ and $\hat{\delta}_{t,i,J} \in\; (-1;\; \delta^{(\max)}_{t,i,J})$. Transforming this result into the optimal dividend $\hat{d}_{t,i,j}$ we get

$$\begin{aligned} \hat{d}_{t,i,j} &= (1 + \hat{\delta}_{t,i,J} + \psi_{t,i}(h_i)\; (r_{t,i,j} - r_{t,i,J}))\; \hat{d}_{t-1,i} \\ &= \hat{d}_{t,i,J} + \Psi_{t,i}\; (p^{(cum)}_{t,i,j} - p^{(cum)}_{t,i,J}) \end{aligned} \tag{2.20}$$

where $\Psi_{t,i} := \psi_{t,i}(h_i)\; d_{t-1,i}/p^{(ex)}_{t-1,i}$ and $\hat{d}_{t,i,J}\; \in\; (0;\; p^{(cum)}_{t,i,J})$. The optimal dividend at date t consists of a solid base-dividend $\hat{d}_{t,i,J}$, even paid out at the worst state of the world J, and a risky part $\Psi_{t,i}\; (p^{(cum)}_{t,i,j} - p^{(cum)}_{t,i,J})$ dependent on the firm's current profitability. From a date $t-2$ point of view even the share $\tilde{\Psi}_{t,i}$ in the stock price (cum dividend) enhancement between state j and J is uncertain besides the future stock price $\tilde{p}^{(cum)}_{t,i}$. This share $\tilde{\Psi}_{t,i}(h_i)$ is increasing in h_i and thus decreasing

[23] See [20].
[24] Due to incomplete contracts the investor cannot give incentives to the management to act optimally in the long run. In the following, we do not dwell on these kinds of incomplete contracts.
[25] The parameter $\delta^{(\max)}_{t,i,j}$ stands for the quotient $((1 + r_{t,i,j})/\vartheta_{t,i,j} - 1)$.
[26] See Appendix 1 for a proof.

with the investor's emotion aversion in the dividend account making the dividend payments more stable between different states and with it over time.

To provide a better insight into this kind of dividend policy we draw on [24]. He was one of the first who empirically confirmed the stability of dividend payments over time. He especially arrives at the (still observable) conclusion that management aims at realizing a target payout ratio, and gradually adjusts the firm's dividend to it resulting in a stable dividend over time relative to earnings.[27] Based on his interviews, [24] proposed the following dividend payout rule:

$$\hat{d}_{t,i,j} - d_{t-1,i} = \gamma_i \ (\zeta_i \ x_{t,i,j} - d_{t-1,i}) \quad \text{for all } t \in \mathbb{N}, i \in \{0, ..., I\}, j \in \{1, ..., J\} \tag{2.21}$$

where $x_{t,i,j}$ denotes current earnings, γ_i the coefficient of dividend adjustment over time, and ζ_i the target payout ratio. In the case of $\gamma_i < 1$ firm i only partially adjusts its dividends to current earnings. In our setting, we get (with $\hat{d}_{t,i,J} = 0$)[28]:

$$\hat{d}_{t,i,j} = \Psi_{t,i}(d_{t-1,i}) \ (p^{(cum)}_{t,i,j} - p^{(cum)}_{t,i,J}). \tag{2.22}$$

Thus, the previous paid dividend determines the current level of payout, whereby stock price (cum dividend) enhancement is used for it (and not current earnings). Since the share $\Psi_{t,i}$ (< 1) (positively) depends on $d_{t-1,i}$ it is a kind of dividend adjustment coefficient. If the former dividend level is low, the current paid out fraction $\Psi_{t,i}$ of stock price enhancement is also relatively low. In the case of a former high dividend, the share $\Psi_{t,i}$ is relatively high. So if we define an average value of $\Psi_{t,i}$ as the target payout ratio, former low dividends yield to an under-adjustment and former high dividends to an over-adjustment concerning the share $\Psi_{t,i}$. This in turn reduces deviations from the past dividend level even if the current state of the world strongly differs from the past state of the world. Therefore, the share itself is volatile with the consequence that dividends are slowly adjusted to abrupt changes in stock prices cum dividend and therewith profitability. For this reason, we expect a steady-going, not strongly fluctuating dividend over time. Even if [24] already predicted such a dividend behavior, he just presumed it due to his empirical observations and did not give a theoretical foundation for it.

2.4. *Asset Prices in the Presence of Emotional Investors*

In the following, we analyze the consequences of emotions on asset prices, especially on the equity premium. As in the 'classical' CCAPM the (emotional) investor maximizes his expected present value of discounted utility of total consumption.

[27] Altogether, *Lintner's* results still seem valid for a bigger part of firms. In 2001 *Baker/Veit/Powell* asked managers how they determine dividends, too. About half of their respondents replied that they set an explicit target payout ratio. [31] also confirms a partial adjustment policy with a long-term dividend payout target in management's mind.

[28] Concerning dividend fluctuations the amount of $\hat{d}_{t,i,J}$ does not matter. Therefore we can simplify analysis by the assumption $\hat{d}_{t,i,J} = 0$ for all $t \in \mathbb{N}$ and $i \in \{0, ..., I\}$ – a behavior that is close to reality.

But in contrast, consumption now consists of a real and an emotional component. Therefore, we have to replace $\tilde{c}_\tau$ in the objective function (2.4) by $\tilde{C}_\tau$:

$$E_t\left(\sum_{\tau=t}^{\infty}\beta^{\tau-t}\ U(\tilde{C}_\tau(\tilde{c}_\tau),\tilde{w}_\tau)\right) \tag{2.23}$$

with[29]

$$\tilde{C}_t(\tilde{c}_t)=\tilde{c}_t+\sum_{i=0}^{I}\Big((d_{t-1,i}+p_{t-1,i}^{(ex)}/h_i)\ e_{t,i,j}^{(d)}(\psi_{t,i}\ (\tilde{r}_{t,i}-E(\tilde{r}_{t,i})))\Big) \tag{2.24}$$

provided that dividend policy is always optimal in the sense of equation (2.20). Consumption does not influence the corporate dividend decision due to the myopic behavior of the management. Therefore, the investor treats dividend policy and with it emotions as exogenous. He can only influence his total consumption $\tilde{C}_\tau$ via the choice of the consumption plan $\{\tilde{c}_\tau\}_{\tau=t}^{\infty}$ and the plan for the portfolio weights $\{\tilde{y}_\tau\}_{\tau=t}^{\infty}$ subject to (2.1)-(2.3). This leads to the following necessary and sufficient conditions[30]:

$$\begin{aligned}U_c(C_{t,j}^*,w_{t,j})&=\beta\ E_t[U_c(\tilde{C}_{t+1}^*,\tilde{w}_{t+1})\ (1+\tilde{r}_{t+1,i})]\\ \Leftrightarrow\quad p_{t,i,j}^{(ex)*}&=\beta\ E_t[\tilde{p}_{t,i}^{(cum)}\ U_c(\tilde{C}_{t+1}^*,\tilde{w}_{t+1})/U_c(C_{t,j}^*,w_{t,j})]\ \text{ and}\end{aligned} \tag{2.25}$$

$$E_t(U_c(\tilde{C}_{t+1}^*,\tilde{w}_{t+1})\ \tilde{r}_{t+1,i})=E_t(U_c(\tilde{C}_{t+1}^*,\tilde{w}_{t+1}))\ r_{t+1,0}. \tag{2.26}$$

These are the same conditions as in the standard CCAPM except that consumption now includes emotions. Under consideration of equations (2.25) and (2.26) we get as equilibrium condition for the market return:

$$U_c(C_{t,j}^*,w_{t,j})=\beta\ E_t[U_c(\tilde{C}_{t+1}^*,\tilde{w}_{t+1})\ (1+\tilde{r}_{t+1,M})] \tag{2.27}$$

A further transformation of equation (2.25) and accordingly (2.27) yields:

$$E_t[\tilde{\theta}_{t+1}\ (1+\tilde{r}_{t+1,i})]=1 \tag{2.28}$$

for all $t\in\mathbb{N}$, $i\in\{1,\ldots,I;\ M\}$ and with the notation $\tilde{\theta}_{t+1}:=\beta\ U_c(\tilde{C}_{t+1}^*,\tilde{w}_{t+1})/U_c(C_{t,j}^*,w_{t,j})$. In the classical context the (discounted) ratio of marginal utilities $\tilde{\theta}_{t+1}$ is known as stochastic discount factor or pricing kernel. Furthermore, $\tilde{\theta}_{t+1}$ is equivalent to the intertemporal marginal rate of substitution – here the substitution of total consumption (including emotions) today against total consumption (including emotions) tomorrow. For this reason emotions are relevant for intertemporal substitution. Even if the current consumption of goods is low, an investor may be all set to transfer consumption into the future due to a high current elation and with it a relatively high current total consumption.

[29]The following immediately arises from putting (2.19) in (2.17).

[30]Because of $\partial C_{t,i,j}/\partial c_{t,i,j}=1$ we get the same necessary and sufficient conditions as in the standard CCAPM. We only have to replace actual consumption c_t by total consumption C_t in equation (2.5) and (2.6).

By calculating the expected market return $E_t(\tilde{r}_{t+1,i})$ of a risky security from (2.28) as well as the risk-free rate $r_{t+1,0}$ and by computing the difference we get – analogously to the standard CCAPM – the following equity premium:

$$E_t(\tilde{r}_{t+1,i}) - r_{t+1,0} = -Cov_t(\tilde{r}_{t+1,i}, \tilde{\theta}_{t+1})\ (1 + r_{t+1,0}). \tag{2.29}$$

In the standard CCAPM, the equity premium will be large if the covariance between the security's return and the stochastic discount factor is significantly negative and high. Therefore, stocks that do not support consumption smoothing must pay high expected returns relative to the risk-free security. Due to the fact that total consumption also includes emotions the 'emotional' CCAPM intensifies this train of thoughts: a stock where high returns $r_{t+1,i}$ coincide with (already) high actual consumption c_{t+1} (i.e. low marginal utility) causes elation and boosts total consumption C_{t+1} in (already) good times, but it causes disappointment and lowers total consumption in (already) bad times. Therefore, consumption smoothing is even more difficult and the equity premium has to be higher for emotional than for rational investors. In section 3 we empirically test this statement.

3. Empirical Study

3.1. *Dividend Policy*

Below, we test the validity of the derived dividend policy (2.20) for the U.S. as well as the German stock market to assess the empirical relevance of investor's emotions on dividend policy. The chosen sample consists of annual dividends, annual earnings, and the total return index of the S&P 500 for the period 1960-2003 and of the DAX for the period 1975-2003.[31] We assume that the investor holds the respective index like a single stock, and use the following equation to test (2.20):

$$\hat{d}_t(h) = (1 + \hat{\delta}_{t,J} + \psi_t(h)\ \ (r_{t,j} - r_{t,J}))\ \hat{d}_{t-1}. \tag{3.1}$$

Provided that state J occurred during the period 1960-2003 and 1975-2003, respectively, and that $r_{t,J} = r_J$ as well as $\hat{\delta}_{t,J} = \hat{\delta}_J$ for all $t \in \mathbb{N}$, we set r_J appropriate to the lowest observable value for $\tilde{r}_j$ (i.e. $r_{S\&P,J} = -0.30$ and $r_{DAX,J} = -0.45$).[32] Concerning the dividend growth rate $\hat{\delta}_J$ we choose the value corresponding to r_J (i.e. $\hat{\delta}_{S\&P,J} = 0.03$ and $\hat{\delta}_{DAX,J} = -0.24$).

In addition, we need some reasonable specifications for the parameter $h = \lambda^{(p)}/\lambda^{(d)}$ to test (3.1). Since the parameters $\lambda^{(p)}$ and $\lambda^{(d)}$ are not analyzed in the

[31] Source: Datastream.

[32] Applying the *Dickey-Fuller*-Test to total returns leads to a t-value of –6.315 for the S&P 500 and –4.95 for the DAX. The relevant critical value for the S&P 500 is –2.94 (relating to 40 observations) and for the DAX is –1.95 (relating to 29 observations). For this reason, we can reject the null hypothesis of non-stationarity at the 5 % significance level. Furthermore, the requirement of non-autocorrelated residuals is fulfilled, because the regression's *Durbin-Watson*-value is 1.856 (S&P 500) and 1.876 (DAX). Thus, the total return is sufficient stationary which suggests that its J-value does not vary from date to date.

literature we have to provide the empirical study with some reasonable constraints for h. By definition we have $h > 0$. Furthermore, as dividends are spent for current consumption, but stock price enhancements serve for retirement savings,[33] a more pronounced dividend than stock price disappointment aversion (and thus $h \leq 1$) is plausible. Over the long run, risk becomes less important, and therefore, chances for stock price enhancement take center stage. Thus, we only consider parameter specifications $0 \leq h \leq 1$.

Concretely, we estimated dividends in dependence of 12 different values for $h \in \{0, 0.05, 0.1, \ldots, 1\}$. To rank these values according to their quality of description we calculated the mean quadratic deviation between the empirical and the theoretical dividend for each h:

$$\sum_{k=1}^{K} (d_{t,k}^{(emp)} - \hat{d}_{t,k}(h))^2 / K. \tag{3.2}$$

We computed this quality measure for the whole period 1960-2003 (1975-2003) as well as the two sub-periods 1960-1981 (1975-1989) and 1982-2003 (1990-2003). K denotes the number of observations. As a first result we get the lowest value of the quality measure for $h_{S\&P} = 0.05$ and $h_{DAX} = 0.5$. Since these values are distinctly below one there is a clear tendency for dividends to be much more stable at higher emotion aversion levels in the dividend account which particularly holds true for the U.S. stock market[34]

*** Figure 3 about here ***

Figure 3 presents earnings and dividends as well as estimated dividends for $h_{S\&P} = 0$, 0.05, and 1 and $h_{DAX} = 0$, 0.5, and 1, respectively. The charts show that, in the case of $h_{S\&P} = 0.05$ and $h_{DAX} = 0.5$, respectively, estimated and actual dividends run in the same way over time. Furthermore, we can confirm dividend smoothing, because the variance of actual dividends amounts to 27.29 (for the S&P 500) and 10.43 (for the DAX) and that one of estimated dividends similarly amounts to 27.79 (for the S&P 500) and 10.20 (for the DAX).[35] In contrast, the variance of earnings is with 212.90 (S&P 500) and 109.91 (DAX) a good deal bigger. Taken together, the results suggest that investor's emotions cause firms to smooth dividends.

3.2. *The Equity Premium Puzzle*

In section 2.4 (equation (2.28)) we generally presented the relation between security returns and the stochastic discount factor. In the following we empirically test this

[33]See [34].
[34]Panel A in Table 2 of Appendix 3 reports the quality measures for all $h \in \{0, 0.05, 0.1, \ldots, 1\}$.
[35]Panel B in Table 2 of Appendix 3 shows the dividend mean, variance, and standard deviation for all $h \in \{0, 0.05, 0.1, \ldots, 1\}$.

relationship for the considered stock market data.[36] We combine these data with Datastream macroeconomic data on consumption expenditure, the U.S. and the German inflation rate, the number of population. In addition, we use a Treasury Bill and a German benchmark bond to estimate the return of the riskless asset. At first, we have to concretize the utility function. As is customary in examining empirical implications of the CCAPM,[37] we assume a utility function with constant relative risk aversion in the following way:[38]

$$U(C_t) = \frac{C_t^{1-\alpha} - 1}{1-\alpha}, \quad \text{with}\, \alpha \neq 1, \tag{3.3}$$

where α denotes the coefficient of relative risk aversion.[39] The stochastic discount factor then becomes

$$\tilde{\theta}_{t+1} = \beta\ \frac{U_c(\tilde{C}_{t+1})}{U_c(C_t)} = \beta\ \frac{\tilde{C}_{t+1}^{-\alpha}}{C_t^{-\alpha}} = \beta\ (1+\tilde{\chi}_{t+1})^{-\alpha} \tag{3.4}$$

where $\tilde{\chi}_{t+1}$ denotes the growth rate of (total) consumption $\tilde{C}_{t+1}/C_t - 1$. Inserting this result in equation (2.28) for $i = M$ leads to

$$\beta\ E_t\left((1+\tilde{r}_{t+1,M})\ (1+\tilde{\chi}_{t+1})^{-\alpha}\right) = 1. \tag{3.5}$$

In line with [10] as well as [27] we make some additional assumptions:[40] The growth rate of consumption $\tilde{\chi}_{t+1} := \tilde{C}_{t+1}/C_t - 1$ and the market return $\tilde{r}_{t+1,M}$ are each with identically and independently distributed.[41] Beyond, the following assumption is usually made:[42]

$$\ln[(1+\tilde{r}_M)\ (1+\tilde{\chi})] \sim N(\mu_M + \mu_\chi,\ \sigma_M^2 + \sigma_\chi^2 + 2\ \sigma_{M\chi}) \tag{3.6}$$

where N denotes the normal distribution, $\mu_x := E(\ln(1+\tilde{x}))$ the expected value, $\sigma_x^2 := Var(\ln(1+\tilde{x}))$ the variance, and σ_{xy} the corresponding covariance. Since the assumption of this normal distribution is contradictory to our setting with discrete distributed returns, we can only postulate a normal distribution by approximation. Because the number J of states of the world is allowed to be arbitrarily high we are able to approximate the normal distribution for any given error bound. For this

[36] Source: Datastream. As [10] we took quarterly data and calculated the annual rates to enlarge our sample for statistical reasons.
[37] See for example [12], pp. 304.
[38] See [12], p. 305.
[39] As α converges to one, the utility function in (3.3) approaches $U(C_t) = \ln(C_t)$.
[40] These assumptions are not part of the original paper [28] of *Mehra/Prescott*, but facilitate the exposition of the classical puzzle and our further investigations.
[41] Originally, [10] and [27] assume dividends to be i.i.d. As we explicitly model dividend policy, we have to assume returns to be i.i.d. The application of the *Dickey-Fuller*-test shows that we can reject the null hypothesis of non-stationarity at 5 % significance for the return as well as the consumption growth rates in dependence on $\lambda^{(d)}$.
[42] The *Kolmogoroff-Smirnov*-test for the term $\ln[(1+\tilde{r}_t)\ (1+\tilde{\chi}_t)]$ (dependent on $\lambda^{(d)}$) shows that we cannot reject the null hypothesis of normal distribution. For this reason, we suppose $\ln[(1+\tilde{r}_t)\ (1+\tilde{\chi}_t)]$ to be normal distributed.

reason, it is assumed that condition (3.6) (approximately) holds. Then, we obtain from (3.5):[43]

$$(\mu_M + 0.5\ \sigma_M^2) - \ln(1 + r_0) = \alpha\ \sigma_{M\,\chi}. \tag{3.7}$$

This equation states that the adjusted[44] equity premium equals the coefficient of risk aversion multiplied by the covariance of the continuous market return with the continuous consumption growth rate. As mentioned earlier, the (adjusted) average U.S. (German) equity premium amounts to 5.719 % (4.862 %). Thus, it is easy to determine the risk aversion parameter α on the basis of (3.7) if we know the covariance of the market return with consumption growth.

To estimate the latter parameter, we firstly consider only rational investors without emotions, i.e. $\tilde{\chi}_{t+1} = \tilde{c}_{t+1}/c_t - 1$. In this special case the (empirically) estimated covariance of the market return with consumption growth is approximately –0.0605 % (for the USA) and 0.0581 % (for Germany). Thus, equation (3.7) implies $\alpha_{US} = 0.05719/(-0.000605) = -94.53$ and $\alpha_{Ger} = 0.0486/0.000581 = 83.65$. This parameter specification implies implausible risk-seeking behavior for the U.S. stock market. But also for Germany the α-value is not perspicuous, since [28] set forth, feasible values for α are positive and below ten. This quantitative problem is known as equity premium puzzle, i.e. the equity premium of stock markets cannot be explained by plausible risk aversion parameters α.

But, even if one refrains from the equity premium puzzle and accepts the above calculated values for α, a new problem arises, since (3.5) implies the following equation:[45]

$$\ln(1 + r_0) = -\ln(\beta) + \alpha\ \mu_\chi - 0.5\ \alpha^2\ \sigma_\chi^2. \tag{3.8}$$

The empirical estimation of the expectation value and the variance of the consumption growth rates leads to $\mu_{\chi,US} = 6.208$ %, $\sigma^2_{\chi,US} = 0.0533$ %, $\mu_{\chi,Ger} = 3.947$ %, and $\sigma^2_{\chi,Ger} = 0.0382$ %. Thus, using the above calculated parameter specifications for α together with the empirically observed average risk-free rate amounting to 3.526 % (for the USA) and 3.938 % (for Germany) we are able to determine the discount factor β on the basis of (3.8). The resultant discount factors are ineligible for both markets since $\beta_{US} = 0.00025$ implies implausible high preferences for current cash flows and $\beta_{Ger} = 6.86 > 1$[46] stands for non-reasonable high preferences for future cash flows. Thus, besides the equity premium puzzle the high equity premium implies a risk-free rate that extremely diverges from empirically existent values. This is the already mentioned risk-free rate puzzle.[47] In short, the equity premium and the risk-free rate puzzle exist on the U.S. and on the German stock market (if we emanate from fully rational investors).

[43] See Appendix 2 for a detailed calculation.
[44] The adjustment arises due to expectations of log returns.
[45] See Appendix 2 for the derivation of this equation.
[46] $\beta > 1$ leads to a negative (and consequently absurd) discount rate for future cash flows.
[47] See [41].

In the following, we draw our attention to emotional investors and therewith total consumption. Since $h_{S\&P} = 0.05$ and $h_{DAX} = 0.5$ lead to reasonable description of actual dividend policies, we act on this assumption in the subsequent analysis and calculate emotions for various $\lambda^{(d)}$. Adding emotions to (actual) consumption (according to (2.24)) leads us to the (continuous) ('total') consumption growth rate of emotional investors' per capita consumption. On this basis we are again able to calculate α (by equation (3.7)) and β (by equation (3.8)). Table 3 of Appendix 3 reports covariances of the market return with (total) consumption growth, the expectation values as well as the variance of consumption growth subject to different degrees of emotion aversion and the corresponding values for α and β which are calculated on the basis of (3.7) and (3.8).[48]

The results show that in USA values for $\lambda^{(d)} \geq 100$ lead to plausible values of $\alpha \in (0, 10)$. But in these cases the discount factor β is relatively low since $\beta \leq 84,99$ % implies a discount rate higher than $1/0.8499 - 1 = 17.66$ %. A disappointment parameter $\lambda^{(d)} = 93$ implies $\alpha = 11.09$ which nearly corresponds with the plausible upper bound 10. Simultaneously, $\lambda^{(d)} = 93$ leads to $\beta = 0.9249$ which in turn entails a plausible discount rate of $1/0.9249 - 1 = 8.12$ %. Thus, the disappointment parameter $\lambda^{(d)}_{S\&P} = 93$ is able to explain the equations (3.7) and (3.8) for the U.S. market with plausible parameter constellations for α and β.

The result for the German stock market is alike but for other parameter specifications. According to Table 3 parameter specifications $2 \leq \lambda^{(d)} \leq 6$ imply a plausible small α. A reasonable discount factor β results in the case $\lambda^{(d)} = 5$ since this factor corresponds with a discount rate of $1/0.9352 - 1 = 6.93$ %. Consequentially, the acceptable disappointment parameter for the German market is $\lambda^{(d)}_{DAX} = 5$.

In addition, the elected parameters $h_{S\&P} = 0.05$ and $h_{DAX} = 0.5$ immediately imply disappointment parameters for the stock account $\lambda^{(p)}_{S\&P} = h_{S\&P}\lambda^{(d)}_{S\&P} = 4.65$ and $\lambda^{(p)}_{DAX} = 2.5$. In short, the model is able to explain the equity premium puzzle and the risk free rate puzzle, simultaneously, since we obtain reasonable risk and time preferences for both markets. If we accept these preferences the U.S. stock market seems to prefer a much lower relationship between the degrees of absolute emotional aversion in the dividend and in the stock price account than the German market. Thus, in USA people seem to lay more stress on current consumption and less stress on retirement savings than people in Germany do.

4. Conclusion

Recently, evidence about limited rational behavior on capital markets concerning investors' purchase and evaluation decisions is integrated in the field of capital market theory for purposes of pricing. Far uncommon, the connection of asset pricing

[48] As already mentioned an analysis of plausible values $\lambda^{(d)}$ is still missing in the literature . Thus, the elected values in the analysis under consideration seem arbitrary at first glance. But since we search for parameter constellations that explain the above mentioned puzzles this analysis can serve as a first foundation of plausible values $\lambda^{(d)}$.

and limited rationality together with corporate finance, especially dividend policy, is studied. However, this may lead to new insights in terms of asset pricing. Furthermore recommendations for management – in this context about optimal dividend policy – can be given. Moreover, empirical observations can theoretically be described and explained.

Concretely, we developed an emotional CCAPM that can justify dividend smoothing as well as a high equity premium without raising the risk free rate puzzle for U.S. and German stock market data. For these purposes, we basically assumed that investors do not only consume, but also have emotions concerning their stock engagement. They mentally divide dividends and stock prices, and feel and anticipate disappointment and elation in evaluating dividend and stock price growth rates. Thus, total consumption is the sum of actual consumption and emotions. This 'widened' view of consumption changes the 'classical' CCAPM, because emotions complicate the realization of the investor's desire of consumption smoothing. As standard theory, we conclude that stocks are riskier than bonds and should consequentially generate a higher return. However, compensation has to be higher than so far thought, because the investor also has to balance emotions. On the whole, we wish to encourage further research in the area of 'behavioral (corporate) finance'.

Appendices

Appendix 1: Optimal Dividend Policy

The maximization problem (2.16) under consideration of equation (2.17) and subject to (2.18) leads to the following necessary and sufficient conditions for all $t \in \mathbb{N}$, $i \in \{0, ..., I\}$, and $q \in \{1, ..., J\}$:[49]

$$\frac{dU(C_{t,q}, w_{t,q})}{d\,\delta_{t,i,q}} = \frac{\partial U(C_{t,q}, w_{t,q})}{\partial\, C_{t,q}}\;\frac{d\,C_{t,q}}{d\delta_{t,i,q}} \overset{!}{=} 0 \overset{\partial U/\partial C_{t,q}>0}{\Leftrightarrow} \frac{d\,C_{t,q}}{d\delta_{t,i,q}} = 0. \qquad \text{(A.1)}$$

Having regard to $\delta_{t,i,q} \in (-1, \delta_{t,i,q}^{(\max)})$ and using the abbreviation $\partial e^{(d)}/\partial \delta_{t,i,q} =: e^{(d)\prime}$ as well as $\partial^2 e^{(d)}/\partial \delta_{t,i,q}^2 =: e^{(d)\prime\prime}$ we get:

$$\begin{aligned}\frac{dC_{t,q}}{d\delta_{t,i,q}} &= d_{t-1,i}\; e^{(d)\prime}\left[\delta_{t,i,q} - \sum_{i=0}^{J}\phi_j\;\delta_{t,i,q}\right]\;(1-\phi_q)\\ &\quad + e^{(d)\prime}[h_i\;\;(r_{t,i,q} - (1+\delta_{t,i,q})\;\vartheta_{t-1,i}) \qquad\qquad \text{(A.2)}\\ &\quad - \sum_{i=0}^{J}\phi_j\;h_i\;\;(r_{t,i,j} - (1+\delta_{t,i,j})\;\vartheta_{t-1,i})]\;p_{t-1,i}^{(ex)}\;(-1+\phi_q)\;\vartheta_{t-1,i} \overset{!}{=} 0\end{aligned}$$

[49] Wealth $w_{t,q}$ is realized and cannot be influenced by any dividend policy. Thus, we have $\partial w_{t,q}/\partial \delta_{t,i,q} = 0$ for all $t \in \mathbb{N}$, $i \in \{0, ..., I\}$, $q \in \{1, ..., J\}$.

$$\underset{\substack{d_{t-1,j}>0,1>\phi_q>0 \\ e^{(d)\prime\prime}<0}}{\Leftrightarrow} \quad \delta_{t,i,q} - \sum_{j=1}^{J} \phi_j \ \delta_{t,i,j} = h_i \ \left(r_{t,i,q} - (1+\delta_{t,i,q}) \ \vartheta_{t-1,i}\right) - \sum_{j=1}^{j} \phi_j \ h_i \ \left(r_{t,i,j} - (1+\delta_{t,i,j}) \ \vartheta_{t-1,i}\right)$$

$$\Leftrightarrow \delta_{t,i,q} - \sum_{j=1}^{j} \phi_j \ \delta_{t,i,j} = \frac{h_i}{1+h_i \ \vartheta_{t-1,i}} \ \left(r_{t,i,q} - \sum_{j=1}^{j} \phi_j \ r_{t,i,j}\right) \quad \text{(A.3)}$$

for all $t \in \mathbb{N}$, $i \in \{0, ..., I\}$, $q \in \{1, ..., J\}$. Due to $\phi_J = 1 - \sum_{j=1}^{J-1} \phi_j$ and with $E_{t-1}(\tilde{r}_{t,i}) = \sum_{j=1}^{J} \phi_j \ r_{t,i,j}$ as well as $\psi_{t,i} := h_i/(1+h_i \ \vartheta_{t-1,i})$ equation (A.3) can be rewritten as

$$\sum_{j=1}^{J-1} \phi_j \ (\delta_{t,i,j} - \delta_{t,i,J}) - (\delta_{t,i,q} - \delta_{t,i,J}) = -\psi_{t,i} \ (r_{t,i,q} - E_{t-1}(\tilde{r}_{t,i})) \quad \text{(A.4)}$$

for all $t \in \mathbb{N}$, $i \in \{0, ..., I\}$, $q \in \{1, ..., J\}$. Defining

$$\Delta_{t,i} := \begin{pmatrix} \delta_{t,i,1} - \delta_{t,i,J} \\ \vdots \\ \delta_{t,i,J-1} - \delta_{t,i,J} \end{pmatrix}, \quad P := \begin{pmatrix} \phi_1 & \cdots & \phi_{J-1} \\ \vdots & \ddots & \vdots \\ \phi_1 & \cdots & \phi_{J-1} \end{pmatrix} - \begin{pmatrix} 1 & \cdots & 0 \\ \vdots & \ddots & \vdots \\ 0 & \cdots & 1 \end{pmatrix},$$

$$R_{t,i} := \begin{pmatrix} r_{t,i,1} - E_{t-1}(\tilde{r}_{t,i}) \\ \vdots \\ r_{t,i,J-1} - E_{t-1}(\tilde{r}_{t,i}) \end{pmatrix} \quad \text{(A.5)}$$

then, equation (A.4) is equivalent to

$$P \ \Delta_{t,i} = -\psi_{t,i} \ R_{t,i} \quad \Leftrightarrow \quad \Delta_{t,i} = -\psi_{t,i} \ P^{-1} \ R_{t,i}, \quad \text{(A.6)}$$

where P^{-1} is given by

$$P^{-1} = \begin{pmatrix} \varphi_{1,1} & \cdots & \varphi_{1,J-1} \\ \vdots & \ddots & \vdots \\ \varphi_{J-1,1} & \cdots & \varphi_{J-1,J-1} \end{pmatrix} \quad \text{(A.7)}$$

with $\varphi_{j,j} = -\phi_j/\phi_J - 1$ and $\varphi_{q,j} = -\phi_j/\phi_J$ for $j \neq q$. It results from (A.6) for all $t \in \mathbb{N}$, $i \in \{0, ..., I\}$, and $q \in \{1, ..., J\}$:

$$\begin{aligned} \delta^*_{t,i,q} &= \delta^*_{t,i,J} - \psi_{t,i} \ \sum_{j=1}^{J-1} \varphi_{q,j} \ (r_{t,i,j} - E_{t-1}(\tilde{r}_{t,i})) \\ &= \delta^*_{t,i,J} + \psi_{t,i} \ \left(\frac{1}{\phi_J} \ \sum_{j=1}^{J-1} \phi_j \ (r_{t,i,j} - E_{t-1}(\tilde{r}_{t,i})) + (r_{t,i,q} - E_{t-1}(\tilde{r}_{t,i})) \right) \\ &= \delta^*_{t,i,J} + \psi_{t,i} \ \left((r_{t,i,q} - E_{t-1}(\tilde{r}_{t,i})) - (r_{t,i,J} - E_{t-1}(\tilde{r}_{t,i}))\right) \\ &= \delta^*_{t,i,J} + \psi_{t,i} \ (r_{t,i,q} - r_{t,i,J}), \end{aligned} \quad \text{(A.8)}$$

where $\delta^*_{t,i,J}$ is given and $\delta_{t,i,q} \in (-1,\ \delta^{(\max)}_{t,i,q})$ holds for all $t \in \mathbb{N}$, $i \in \{0, ..., I\}$, $q \in \{1, ..., J\}$. If the postulated border condition $\delta^*_{t,i,q} \in (-1,\ \delta^{(\max)}_{t,i,q})$ is fulfilled for $q = J$, the 'remaining' (locally) optimal dividend policy will fulfill the border conditions, too, and thus will be globally optimal as shown in the following:

$$\delta^*_{t,i,q} \underset{(A.8)}{=} \underbrace{\delta^*_{t,i,J}}_{>-1} + \underbrace{\frac{h_i}{1 + h_i\ \vartheta_{t-1,i}}}_{\geq 0} \underbrace{(r_{t,i,q} - r_{t,i,J})}_{\geq 0} > -1\,,$$

$$\begin{aligned}
\delta^*_{t,i,q} &\underset{(A.8)}{=} \underbrace{\delta^*_{t,i,J}}_{<(1+r_{t,i,J})/\vartheta_{t-1,i}-1} + \frac{h_i\ (r_{t,i,q} - r_{t,i,J})}{1 + h_i\ \vartheta_{t-1,i}} \\
&< \frac{1 + r_{t,i,J}}{\vartheta_{t-1,i}} - 1 + \frac{h_i\ (r_{t,i,q} - r_{t,i,J})}{1 + h_i\ \vartheta_{t-1,i}} \\
&= \frac{1 + h_i\ \vartheta_{t-1,i} + r_{t,i,J} + h_i\ \vartheta_{t-1,i}\ r_{t,i,q}}{\vartheta_{t-1,i}\ (1 + h_i\ \vartheta_{t-1,i})} - 1 \\
&\underset{r_{t,i,J}<r_{t,i,q}}{<} \frac{(1 + h_i\ \vartheta_{t-1,i})\ (1 + r_{t,i,q})}{\vartheta_{t-1,i}\ (1 + h_i\ \vartheta_{t-1,i})} - 1 = \frac{1 + r_{t,i,q}}{\vartheta_{t-1,i}} - 1
\end{aligned} \tag{A.9}$$

for all $t \in \mathbb{N}$, $i \in \{0, ..., I\}$, $q \in \{1, ..., J\}$.

The maximum at $\delta^*_{t,i,q}$ is global, because the utility function is monotonically increasing and consumption $C_{t,q}$ is globally maximal at $\delta^*_{t,i,q}$ since

$$\begin{aligned}
\frac{d^2 C_{t,q}}{d\,\delta^2_{t,i,q}} &= d_{t-1,i}\ e'' \left[\delta_{t,i,q} - \sum_{j=1}^{J} \phi_{t,j}\ \delta_{t,i,j}\right]\ (1 - \phi_q)^2 \\
&\quad + p^{(ex)}_{t-1,i}\ e''[h_i\ \ (r_{t,i,q} - (1 + \delta_{t,i,q})\ \vartheta_{t-1,i}) \\
&\qquad - \sum_{j=1}^{J} \phi_j\ h_i\ \ (r_{t,i,j} - (1 + \delta_{t,i,j})\ \vartheta_{t-1,i})] \\
&\quad (-1 + \phi_q)^2\ \vartheta^2_{t-1,i} \underset{e''<0}{<} 0.
\end{aligned} \tag{A.10}$$

Appendix 2: The Equity Premium (3.7)

Taking logs of equation (3.5) leads to

$$\ln(\beta) + \ln\left(E_t\left((1 + \tilde{r}_{t+1,i})\ (1 + \tilde{\chi}_{t+1})^{-\alpha}\right)\right) = 0 \tag{A.11}$$

for all $t \in \mathbb{N}$, $i \in \{0, ..., I; M\}$, $q \in \{1, ..., J\}$. In consideration of $\ln[(1+\tilde{r}_M)\ (1+\tilde{\chi})] \sim N(\mu_M + \mu_\chi,\ \sigma^2_M + \sigma^2_\chi + 2\ \sigma_{M\chi})$ it is imperative that[18]

$$\begin{aligned}
&E_t\left((1 + \tilde{r}_{t+1,M})\ (1 + \tilde{\chi}_{t+1})^{-\alpha}\right) \\
&\quad = \exp((\mu_M - \alpha\ \mu_\chi) + 0.5\ ({\sigma_M}^2 + \alpha^2\ {\sigma_\chi}^2 - 2\ \alpha\ \sigma_{M\chi}))
\end{aligned} \tag{A.12}$$

[18]See [16], p. 223.

and we get from (A.11) for the market return ($i = M$):

$$\ln(\beta) + (\mu_M - \alpha\ \mu_\chi) + 0.5\ (\sigma_M^2 + \alpha^2\ \sigma_\chi^2 + 2\ \alpha\ \sigma_{M\chi}) = 0$$
$$\Leftrightarrow \mu_M = \alpha\ \mu_\chi - 0.5\ (\sigma_M^2 + \alpha^2\ \sigma_\chi^2 + 2\ \alpha\ \sigma_{M\chi}) - \ln(\beta) \quad \text{(A.13)}$$

and for the risk-free rate, respectively:

$$\ln(1 + r_0) = \alpha\ \mu_\chi - 0.5\ \alpha^2\ \sigma_\chi^2 - \ln(\beta). \quad \text{(A.14)}$$

Subtracting (A.13) from (A.14) directly yields the equity premium postulated in (3.7).

Appendix 3: Tables

**** Table 1 about here****

**** Table 2 about here****

**** Table 3 about here****

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Figure 1: Time Flow within a Period

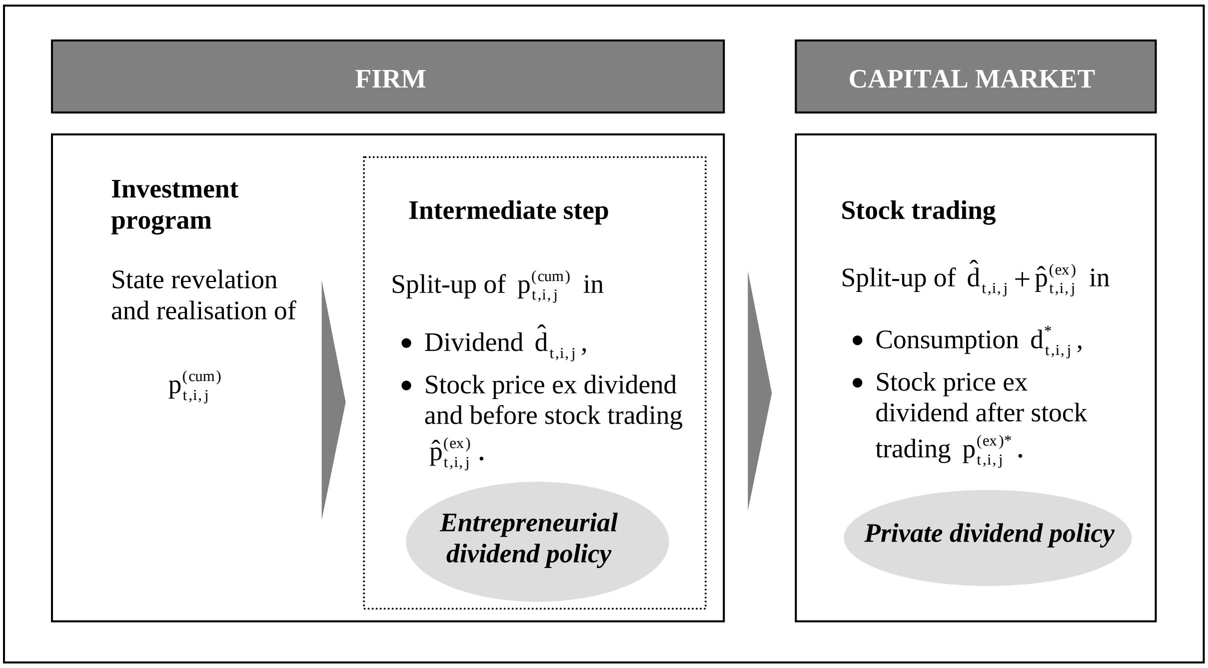

Figure 2: Differences Between the CCAPM and the E-CCAPM

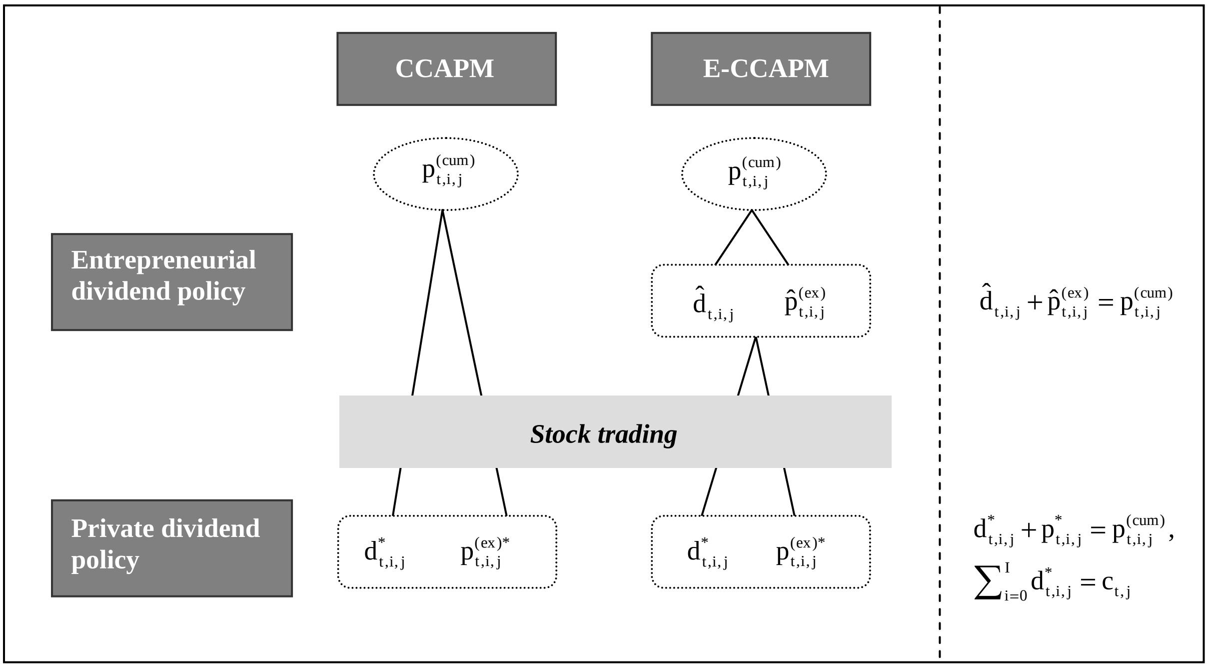

Figure 3: S&P 500 and DAX-Earnings and -Dividends Over Time

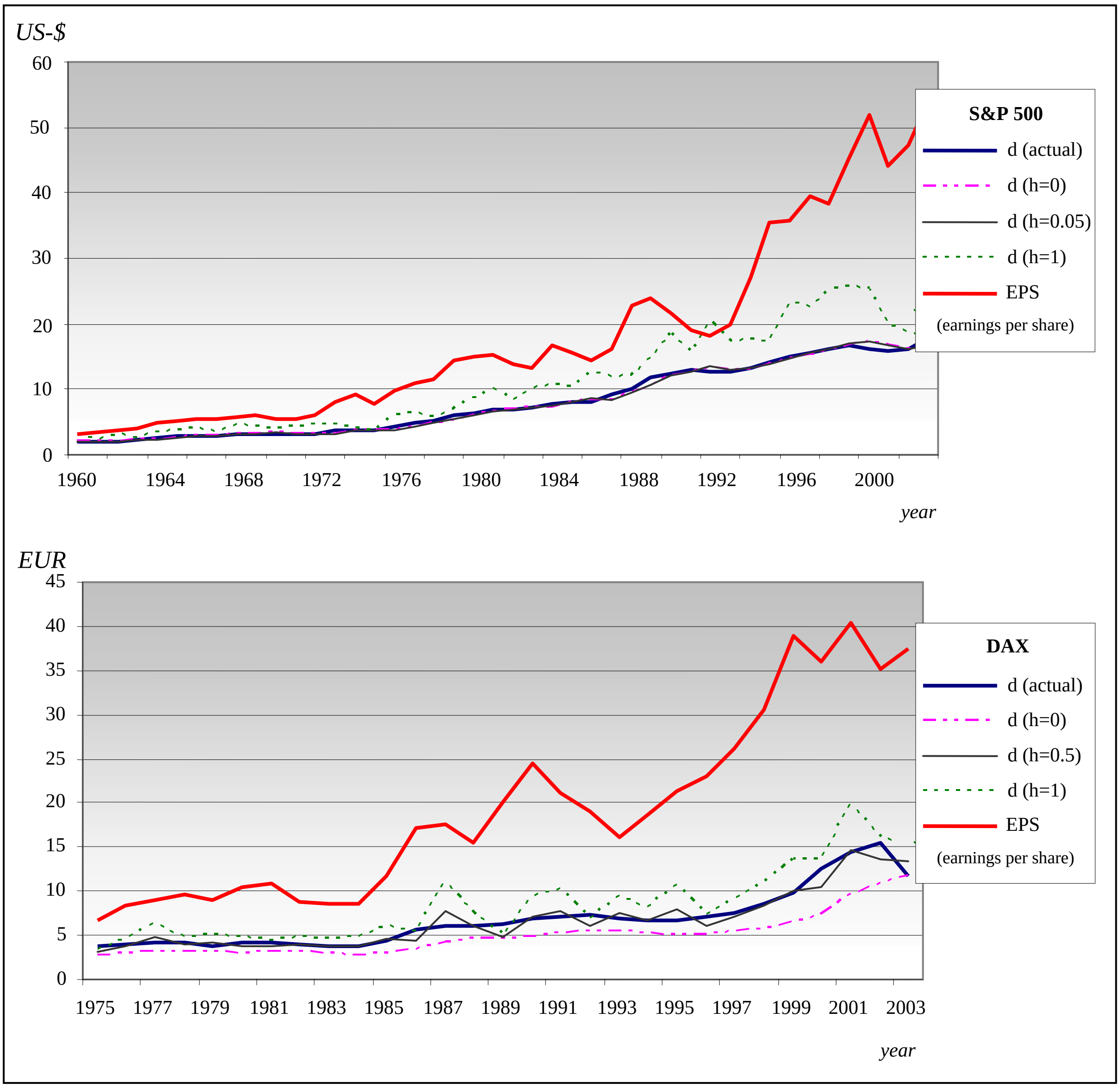

Table 1: Synopsis of Relevant Symbols

Stock price characteristics:

$p_{t,i,j}^{(ex)}$: stock price ex dividend of firm *i* at date *t* and state *j* in the CCAPM,
stock price ex dividend of firm *i* at date *t* and state *j* after stock trading in the ECAPM,

$\hat{p}_{t,i,j}^{(ex)}$: stock price ex dividend of firm *i* at date *t* and state *j* before stock trading in the ECAPM,

$p_{t,i,j}^{(cum)}$: stock price cum dividend of firm *i* at date *t* and state *j*,

$\pi_{t,i,j}$: stock price growth rate of stock *i* in the period from *t*–1 to *t* (state *j*) ($= \hat{p}_{t,i,j}^{(ex)} / p_{t-1,i}^{(ex)*} - 1$),

$r_{t,i,j}^{(cum)}$: return of stock *i* in the period from *t*–1 to *t* (state *j*) ($= p_{t,i,j}^{(cum)} / p_{t-1,i}^{(ex)} - 1$),

$r_{t,0}$: risk-free rate in the period from *t*–1 to *t* = return of the riskless stock *i* = 0.

Dividend characteristics:

$d_{t,i,j}$: dividend per share distributed by firm *i* at date *t* and state *j* in the CCAPM ($= p_{t,i,j}^{(cum)} - p_{t,i,j}^{(ex)}$),
dividend per share of firm *i* at date *t* and state *j* after stock trading in the ECAPM,

$\hat{d}_{t,i,j}$: dividend per share distributed by firm *i* at date *t* and state *j* before stock trading in the ECAPM ($= p_{t,i,j}^{(cum)} - \hat{p}_{t,i,j}^{(ex)}$),

$\delta_{t,i,j}$: entrepreneurial dividend growth rate of stock *i* in the period from *t*–1 to *t* (state *j*) ($= \hat{d}_{t,i,j} / d_{t-1,i}^{*} - 1$),

$\vartheta_{t-1,i}$: dividend yield of stock *i* at date *t* ($= d_{t-1,i} / p_{t-1,i}^{(ex)} - 1$).

Preference characteristics:

α : constant relative risk aversion (of utility function *U*),

$e^{(d)}$: dividend sub-account,

$e^{(p)}$: stock price sub-account,

$e_{t,i,j}$: total emotions from stock account *i* at date *t* and state *j*,

h_i : relationship between the degrees of absolute emotional aversion of the *i*th stock price and the *i*th dividend account ($= \lambda_i^{(p)} / \lambda_i^{(d)}$),

$\lambda_i^{(d)}$: measure of absolute disappointment aversion for dividends of firm *I* ($= -e_i^{(d)}{}'' / e_i^{(d)}{}'$),

$\lambda_i^{(p)}$: measure of absolute disappointment aversion for stock prices of firm *I* ($= -e_i^{(p)}{}'' / e_i^{(p)}{}'$).

Investor characteristics:

$a_{t,j}$: amount the investor invests in stocks at date *t* and state *j*,

$c_{t,j}$: amount the investor consumes at date *t* and state *j*,

$C_{t,j}$: total consumption under considerations of emotions ($= c_{t,j} + e_{t,j}$),

χ_t : growth rate of consumption for the period from *t*–1 to *t* ($= C_t / C_{t-1} - 1$),

$n_{t,i,j}^{(d)}$: number of stocks of firm *i* demanded by the investor at date *t* and state *j*,

$U(C)$: utility function of the investor,

$w_{t,j}$: available income of the investor at date *t* and state *j*,

$y_{t,i,j}$: fraction of $a_{t,j}$ the investor spends for stocks of firm *i*.

Other symbols:

β : (exogenous) discount factor,

ϕ_j : probability of the occurrence of state *j*,

$n_{t,i,j}^{(o)}$: number of stocks offered by firm *i* at date *t* and state *j*,

θ_t : stochastic discount factor or pricing kernel,
intertemporal marginal rate of substitution of total consumption in *t*–1 against total consumption in *t*,

$\psi_{t,i}$: $= h_i / (1 + h_i \ \vartheta_{t-1,i})$,

$\Psi_{t,i}$: $= \vartheta_{t-1,i} \ d_{t-1,i} / p_{t-1,i}^{(ex)}$.

Optimal values are generally characterized by an asterisk (“*”). Tildes (“~”) denote random variables.

Table 2: Quality Measures (Panel A) and moments of estimated dividends (Panel B)

S&P 500	**Panel A**			**Panel B**		
h	**1960-2003**	**1960-1981**	**1982-2003**	**mean**	**variance**	**std. deviation**
0.0	0.46	0.64	0.60	7.99	27.35	5.23
0.05	0.45	0.63	0.59	8.05	27.79	5.27
0.1	0.56	0.79	0.77	8.29	29.56	5.44
0.2	0.86	1.21	1.19	8.59	31.89	5.65
0.3	1.21	1.71	1.68	8.88	34.34	5.86
0.4	1.58	2.23	2.18	9.17	36.92	6.08
0.5	1.95	2.76	2.69	9.47	39.63	6.29
0.6	2.33	3.29	3.21	9.76	42.45	6.52
0.7	2.70	3.82	3.73	10.05	45.39	6.74
0.8	3.08	4.35	4.24	10.33	48.45	6.96
0.9	3.45	4.88	4.75	10.62	51.62	7.18
1.0	3.83	5.41	5.27	10.90	54.91	7.41
DAX	**Panel A**			**Panel B**		
h	**1975-2002**	**1975-1989**	**1990-2002**	**mean**	**variance**	**std. deviation**
0.0	2.24	1.34	2.87	4.95	5.70	2.39
0.1	1.86	1.11	2.38	5.30	6.39	2.53
0.2	1.51	0.90	1.93	5.65	7.19	2.68
0.3	1.20	0.76	1.52	6.00	8.09	2.84
0.4	0.98	0.69	1.21	6.34	9.09	3.02
0.5	0.92	0.73	1.07	6.69	10.20	3.19
0.6	1.03	0.87	1.18	7.03	11.40	3.38
0.7	1.28	1.05	1.47	7.37	12.70	3.56
0.8	1.59	1.27	1.86	7.71	14.11	3.76
0.9	1.94	1.50	2.30	8.05	15.61	3.95
1.0	2.31	1.74	2.76	8.38	17.20	4.15

Table 3: Values for α and β depending on $\lambda^{(d)}$

	USA					Germany				
$\lambda^{(d)}$	$\sigma_{r\chi}$	μ_χ	σ_χ^2	α	β	$\sigma_{r\chi}$	μ_χ	σ_χ^2	α	β
0	-0,000605	0.06208	0.000533	-94.53	0.0003	0,000581	0,03947	0,000382	83.65	6.8597
1	-0,000562	0.06209	0.000528	-101.69	0.0001	0,004004	0,03797	0,001126	12.14	1.4032
2	-0,000520	0.06210	0.000525	-110.03	0.0000*	0,007391	0,03603	0,003203	6.58	1.1369
3	-0,000477	0.06211	0.000522	-119.85	0.0000*	0,010983	0,03344	0,007128	4.43	1.0396
4	-0,000435	0.06212	0.000521	-131.61	0.0000*	0,015080	0,02991	0,014454	3.22	0.9821
5	-0,000392	0.06213	0.000522	-145.93	0.0000*	0,020148	0,02490	0,030117	2.41	0.9352
6	-0,000349	0.06214	0.000524	-163.77	0.0000*	0,027206	0,01724	0,082883	2.41	0.8686
90	0,004810	0.06261	0.010596	11.89	0.9610	-0,024056	-2,16880	11,685959	-0.30	0.7441
93	0,005158	0.06262	0.011992	11.09	0.9249	-0,154350	-1,90480	17,451398	-0.32	0.7370
100	0,006092	0.06264	0.016236	9.39	0.8499	-0,166656	-1,86318	18,287015	-0.29	0.7603
110	0,007860	0.06265	0.026433	7.28	0.7565	-0,189215	-1,78535	20,292674	-0.26	0.7783

* The value is positive.