

Alexander Buchberger

New Venture Cost of Equity and Risk Models

A Theoretical Analysis

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First Supervisor: Prof. Dr. Dietmar Grichnik

Second Supervisor: Prof. Dr. Christian Koziol

“Success is the result of countless failures you've done in order to attain it.”

by Mark Aaron Corrales

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Table of Contents

Acknowledgment	II
Table of Contents	III
List of Figures	VIII
List of Tables.....	VIII
List of Abbreviations.....	IX
List of Symbols	XI
1 Introduction.....	1
1.1 Motivation.....	1
1.2 Academic Approach and Research Contributions	6
1.3 Structure of Analysis.....	10
2 Key Definitions and Research Focus.....	13
2.1 Cost of Capital	13
2.2 New Ventures and Entrepreneurial Finance	15
2.3 Equity Financing and Venture Capitalists	17
3 Cost of Equity Models	19
3.1 Model Classification	19
3.2 Capital Asset Pricing Model	21
3.3 Factor Models	23
3.3.1 Single and Multi Factor Models.....	23
3.3.2 Arbitrage Pricing Theory.....	24
3.3.3 Fama French 3 Factor Model	26
3.4 Emerging Markets and Cost of Equity Models.....	26
3.4.1 Market Characteristics and Risk Adjustment.....	26
3.4.2 Emerging Market Models.....	28
3.5 Behavioral Finance and Cost of Equity Models	32

4	New Venture Cost of Equity and Risk	35
4.1	Risk and Return Profile.....	35
4.2	Idiosyncratic Risk	38
4.2.1	Relevance for the Venture Capitalist.....	38
4.2.2	Types of Idiosyncratic Risk.....	40
4.3	Applied Cost of Equity Models	42
4.4	Important Implications for this Study	47
5	New Venture Risk Factors	52
5.1	Internal and External Risk Factors.....	52
5.2	Investment Criteria as Risk Factors	54
5.2.1	The Entrepreneur	56
5.2.2	The Market	59
5.2.3	The Product and Services	60
5.2.4	The Financial Aspects	61
5.3	Reasons for Regional Differences	62
5.3.1	Institution-based Theory.....	63
5.3.2	Institutional Influences on Investment Criteria	66
5.4	Empirical Analysis.....	74
5.4.1	Relevance and Research Contribution.....	74
5.4.2	Selection of Studies and Empirical Methodology	78
5.4.3	Descriptive Statistics	85
5.4.4	Comparison of Regional Results	89
5.4.5	Limitations.....	91
6	New Venture Risk Assessment and Reduction	93
6.1	Relevance for Venture Capitalists	93
6.2	Financial Risk Theory.....	95

6.2.1	Risk Preference and Perceived Risk.....	95
6.2.2	Modeling and Measuring Financial Risk	98
6.2.3	Measurement of Downside Risk	101
6.2.4	Aggregation of Risk	103
6.3	Risk Reduction Strategies'	107
6.3.1	Venture Capital Contracts	107
6.3.2	Staging and Monitoring.....	109
7	Financial Decision Theory.....	113
7.1	General Decision Theory	113
7.2	Biases and Heuristics of VCs.....	114
7.3	Financial Decision Models	117
7.4	The Analytic Hierarchy Process	122
8	Development of a Risk Assessment and Cost of Equity Model	129
8.1	Relevance and Research Contribution	130
8.2	Single-Stage Risk Model Development.....	133
8.2.1	Assumptions	133
8.2.2	Input Variables	135
8.2.3	Determination of Risk Level	137
8.2.4	Correlation of Risk Factors	143
8.2.5	Risk Aggregation and Determination of Total Risk.....	145
8.3	Cost of Equity Model Development	150
8.3.1	The Downside Cost of Equity Model.....	150
8.3.2	Model Development	154
8.3.3	Adjustment for Diversification.....	158
8.4	Limitations	161
9	Development of a Multi-Stage Risk Reduction Model	165

9.1	Relevance and Research Contribution	165
9.2	Model Assumptions	168
9.2.1	Investment and Staging	169
9.2.2	Transaction Costs	171
9.3	Development of Multi-Stage Risk Factors	173
9.3.1	External Risk	174
9.3.2	Internal Risk	176
9.3.3	Capital Risk	179
9.3.4	Total Risk	180
9.4	Model Analysis	180
9.4.1	Propositions	180
9.4.2	Findings	183
9.5	Limitations	186
10	Conclusion	188
10.1	Summary	188
10.2	Theoretical Implications	192
10.2.1	New Venture Risk Assessment and Cost of Equity Model.....	192
10.2.2	New Venture Risk Reduction Model	195
10.3	Practical Implications.....	196
10.3.1	New Venture Risk Assessment and Cost of Equity Model.....	196
10.3.2	New Venture Risk Reduction Model	197
10.3.3	New Venture Investment Criteria.....	198
10.4	Research Outlook.....	199
10.4.1	New Venture Risk Assessment and Cost of Equity Model.....	200
10.4.2	New Venture Risk Reduction Model	202
10.4.3	New Venture Investment Criteria.....	203

Appendix 205

Subject Index..... 226

Affirmation – Statutory Declaration 228

References 230

List of Figures

Figure: 1 Institutions, organizations, and strategic choices	66
Figure: 2 Model of risk perception.....	97
Figure: 3 Risk aggregation I.....	106
Figure: 4 Risk aggregation II	107
Figure: 5 Subjective weighting function	128

List of Tables

Table: 1 Marketability discount, illiquidity premium, and control premium for private firms	45
Table: 2 Approaches to determine the beta in emerging markets	49
Table: 3 Dimensions of institutions	65
Table: 4 The institutionalization of venture capital	67
Table: 5 Studies of empirical analysis.....	79
Table: 6 Overview of grouped and detailed investment criteria	82
Table: 7 Descriptive statistics	85
Table: 8 Overview of the relevance of investment criteria	88
Table: 9 t-statistics	89
Table 10: Risk classes	142

List of Abbreviations

AHP	Analytic hierarchy process
APT	Arbitrage pricing theory
BA	Business angel
CAL	Capital allocation line
CAPM	Capital asset pricing model
CCR	Country credit risk
CI	Consistency index
CML	Capital market line
CR	Consistency ratio
D-CAPM	Downside capital asset pricing model
DCF	Discounted cash flow
EBSCO	Elton B Stephens COmpany
EHV	Erb-Harvey-Viskanta
ES	Effect size
GARCH	Generalized autoregressive conditional heteroscedasticity
GDP	Gross domestic product
HML	High minus low
I	Impact of risk
IPO	Initial public offer
IR	Interest rate
IRR	Internal rate of return
IV	Inverse variance
JSTOR	Journal Storage
LLSM	Logarithmic least squares method
LMS	Lee, Myers, & Swaminathan
M&M	Modigliani and Miller propositions
ME	Maximum eigenvalue
MP	Market portfolio
MRP	Market risk premium
No.	Number

PhD	Philosophiae doctor
R&D	Research and development
RP	Risk premium
S&P	Standard & Poors
SBDC	Small business development corporation
SMB	Small minus big
SML	Security market line
SNWI	Share of net worth invested
SR	Separable representations
SRF	Square root formula
SZ	Sample size
U.K.	United Kingdom
U.S.	United States of America
VC	Venture capitalist
WACC	Weighted average cost of capital

List of Symbols

\succ_R	Risk order
\mathbb{R}^+	Positive real numbers
∞	Infinite
a	Constant variable for moral hazard risk
\bar{A}	Average degree of risk aversion
$A = [a_{ij}]$	Response matrix A
A_i	Items i of a decision problem
a_{ij}	Decision maker's assessment of a comparison of the alternatives i and j
b	Constant variable for adverse selection risk
b_k	Coefficient parameter
\overrightarrow{BM}	Benchmark vector of semi variance of returns
bm_k	Benchmark value of firm k
c	Constant variable for hold-up risk
$capR(t)$	Capital risk function
$capRT_{eff}(t)$	Effective capital risk function
$C(\cdot)$	Copula function
$C = [c_{kl}]$	Response matrix C
$c(e_{ne}(t))$	Cost function of negotiation
$c(e_{mon}(t))$	Cost function of monitoring
$ck(t)$	Capital investment function
CCR_{it}	Country credit rating at half-year period t
c_l	Costs of liquidation for a illiquid asset
C_k	Firm k
c_k	Decision criterion k
c_{kl}	Relative riskiness of firm k and firm l with regard to an specific risk factor
c_L	Costs of liquidation for a liquid asset
Cov	Covariance
$Cov_D=Cov_{SV}$	Semi or downside covariance
C_P	Expected portfolio cash flow

CR_x	Country risk premium of country X
CR	Preference rights influence
$CS_{i,t+1}$	Semi-annual return in U.S. dollars for country i
CUR_i	Correction for unsystematic risk of asset i
C_V	Certainty equivalent of the venture
d	Coefficient determining external risk
D	Value of debt
D_{RI}	Measure of diversification of risk
DV	Downside variance
E	Value of equity
e_i	Impact on firm-specific events on asset i
e_{ij}	Multiplicative term for errors and inconsistencies in decision making of alternative i and j
e_{kl}	Adjustment term for error of w_k and w_l
e_p	Impact on firm-specific events on portfolio p
$E(r_i)$	Expected return on asset i (ex-ante)
$E(r_{iL})$	Expected return on asset i (ex-ante) using local (adjusted) CAPM
$E(r_{iX})$	Expected return on asset i (ex-ante) considering country risk of X
$E(r_m)$	Expected return on the market
$e_{ne}(t)$	Effort of the VC for negotiation
$e_{mon}(t)$	Effort of the VC for monitoring
eff_{mon}	Impact coefficient of applied monitoring on internal risk
$exRT(t)$	External risk function
$exRT_{eff}(t)$	Effective external risk function
F	Deviation of the common factor from its expected value
$f(c_i)$	Function of the trading costs measuring the effect of illiquidity premium
$F_i(x)$	Marginal distribution of risk factor i
F_j	Deviation of the factor j from its expected value
FM	Unanticipated components of a macro factor
F_{R1}	Function of risk 1
$G(u)$	Distribution function of u
h	Investment horizon

h	Coefficient determining external risk
HML_t	Return of a share portfolio with a high book-to-market ratio in excess of the return on a share portfolio with a low book-to-market ratio at time t
i	Internal risk coefficient
$\overrightarrow{I_{corr}}$	Adjusted impact of risk factor i vector
I_{Ai}	Absolute impact of risk factor i
$I_{corr\ i}$	Adjusted impact of risk factor i
I_i	Impact of risk factor i
$inRT(t)$	Internal risk function
$inRT_{eff}(t)$	Effective internal risk function
$inR_{mh}(t)$	Moral hazard risk function
$inR_{as}(t)$	Adverse selection risk function
$inR_{hu}(t)$	Hold-up risk function
Ln	Natural logarithm
Log	Logarithm
LPM_k	Lower partial moment with target z
K	Total investment needed by the new venture in order to become profitable
k_{t_0}	Initial investment commitment of the VC
m	Definition of investment occasion
m_{max}	Maximum of m which equals <i>exit</i>
M_3	Third central moment
M_4	Fourth central moment
M_5	Fifth central moment
m_i	Impact on macro events on asset i
n	Eigenvalue
p	Coefficient determining monitoring effort
PFP	Pay-for-performance influence
$\text{Pr}(s)$	Probability of an outcome s
PV	Present value
q	Coefficient determining monitoring effort
r_{Assets}	Return on assets
r_{cf}	Country adjustment factor for the global risk-free rate

r_{Debt}	Return on debt
r_{Equity}	Return on equity
\overrightarrow{RF}_k	Factor risk vector of firm k
$r_f = r_{fG}$	Global risk-free rate
RF_{ki}	Factor risk i of the new venture or firm k
r_{fL}	Local risk-free rate
\tilde{r}_i	Return on asset i (ex-post)
R_i	Return on asset i including excess return
r_i	Return on asset i (ex-ante)
RI_{SD}	Risk measure based on semi standard deviation
RI_{SSV}	Risk measure based on systematic risk and semi variance
r_{it}	Rate of return on asset i (ex-ante) at time t
RI_{TSV}	Risk measure based on total risk and semi variance
RI_{TV}	Total downside risk of the new venture V
RI_{USV}	Risk measure based on unsystematic risk and semi variance
$RI: X$	Risk value of X
RL_{ki}	Risk level of risk factor i of the new venture or firm k
R_M	Return on the market portfolio including excess return
r_M	Return on the market portfolio (ex-ante)
r_{ML}	Return on the local market portfolio (ex-ante)
R_P	Return on portfolio p including excess return
r_P	Return on portfolio p
RP_{GDP}	Risk premium of gross domestic product
RP_{ij}	Risk premium of factor j of asset i
RP_{IR}	Risk premium of interest rate
r_Q	Rate of return on portfolio q
rr_0	Regression residual 0
$r(s)$	Return for outcome s
$RT(t)$	Total risk function
$RT_{eff}(t)$	Effective total risk function
\overrightarrow{RT}	Total downside risk vector of companies compared

RT_k	Risk measure of total risk of firm k considering risk factor correlation
r_V^E	Required rate of return of the new venture for the entrepreneur
r_V^I	Required rate of return of the new venture for the investor
r_X	Risk-free rate in local currency
$s(t)$	Share of the new venture of the entrepreneur
SCR_T	Total solvency capital required
SD	Semi standard deviation
SE_z	Shortfall expectation with target z
SMB_t	Return of a portfolio of small shares in excess of the return on a portfolio of large shares at time t
SP_z	Shortfall probability with target z
SR_i	Specific-risk of asset i
SV_μ	Semi variance with regard to target expected mean
SV	Semi variance
SV_z	Shortfall or downside variance with target z
s_X	Percentage exchange rate change of the base currency with respect to the local currency
T	Based on total risk
T	Set of positive time instants
t_0	Time of first investment by the VC
t_{exit}	Time of investment exit
tr	Tax rate
U	Utility value
Un	Unity matrix
W^{-1}	Inverse of a subjective weighting function W
$W(\cdot)$	Bounded function (subjective weighting function)
w	Coefficient determining negotiation effort
w	Principal eigenvector
$\vec{w}(C)$	m-dimensional priorities vector with regard to an specific risk factor
we_M	Wealth of the entrepreneur invested in a market index
w_i	Weight of a decision criterion i
w_k	Level of (absolute) riskiness of a firm k concerning a risk factor i

w_k	Share of a portfolio of asset k in %
X_{ki}	Notional function of real risk of new venture k with regard to risk factor i
x	Share of an asset in %
$\gamma^{(1)}$	Distribution function of asset 1
y	Coefficient determining negotiation effort
y	Average position in a risky portfolio
Y_{SC}	Adjustment factor capturing all the relevant risks of investing in a country C
z	Capital risk coefficient
α_i	Excess return of asset i
β_C	Country beta
β_i	Beta factor of asset i
β_{ie}	Beta factor for asset i with regard to a factor e
β_{iGDP}	Beta factor for asset i with regard to gross domestic product
β_{iIR}	Beta factor for asset i with regard to interest rate
β_{iM}	Beta factor for asset i with regard to the market portfolio
β_L	Beta factor of levered firm
β_M	Beta of the market
β_{SVi}	Downside beta factor for asset i with regard to market using only semi variance
β_U	Beta factor of unlevered firm
γ_1	Company's access to capital markets
γ_2	Susceptibility of the investment to political risk
γ_3	Financial importance of the project for the company
γ_{iX}	Beta of the risk free rate of the base currency with respect to the local currency exchange rate change to the base currency
$\gamma(t)$	Staging function
δ_i	Adjustment value for the relative impact of risk factor i
$\tilde{\varepsilon}$	Noise term
λ_{CCMij}	Correlation coefficient matrix of risk factors i and j
λ_{max}	Largest eigenvalue or Perron eigenvalue
λ_{VCM}	Variance covariance matrix
μ	Expected mean / consistency index in the AHP

μ_{AHP}	Consistency index AHP
ρ	Share exchange coefficient
$\varphi = [w_{C_i k}]$	Matrix of weights vectors $\vec{w}(C_i)$
$\phi(X_A)$	Preference function of an outcome X with regard to asset A
ψ	Psychophysical function of stimuli
θ	Coefficient of capital risk
κ	Constant cost factor of the VC
$\tau(t)$	Transaction costs of the VC
ρ_{I_i, I_j}	Correlation coefficient factor of impact i and j
ρ_{im}	Correlation coefficient between asset i and the market
ρ_{SBC}	Correlation coefficient between stock and bond market of country C
$\rho_{V, M}$	Correlation coefficient between the new venture returns and market returns
σ_V^E	Standard deviation of returns of the new venture based on the entrepreneur's equilibrium holding period
σ	Level of hidden information and characteristics of the entrepreneur
σ_i	Standard deviation of asset i
σ_V^I	Standard deviation of returns of the new venture based on the investor's equilibrium holding period
σ_M^2	Variance of the global market portfolio
$\sigma_{MG} = \sigma_M$	Standard deviation of the global market portfolio
σ_{SVi}^2	Semi variance of asset i
σ_{SVi}	Semi (downside) standard deviation of returns of asset i
σ_{SVM}	Semi (downside) standard deviation of returns of global market portfolio
ζ	Coefficient of staging influence
$\vec{\zeta}$	Levels of reliability of risk estimates for each relative total risk weight
ϑ_{ij}	Partial adjustment value due to the correlation between the i-th and j-th risk factor
$ex\phi(t)$	Function of risk influencing mechanism on external risk
$in\phi(t)$	Function of risk influencing mechanism on internal risk

1 Introduction

1.1 Motivation

Worldwide, entrepreneurship has a significant positive impact on growth and unemployment (Cumming, Johan, & Zhang, 2013). New ventures foster innovations, create jobs, and develop novel technologies, which contribute to social and economic wealth (Koellinger, 2008). However, it is also emphasized that access to financial resources is crucial to enhancing entrepreneurship (Cooper, Gimeno-Gascon, & Woo, 1991; Cumming et al., 2013; Ferrary, 2009). In 2012, US\$ 41,5 billion venture capital was invested worldwide in young and private firms during five thousand financing rounds. With 85% of the global venture capital money invested, the USA and Europe were the prevailing regions (Pinelli, 2013). Although the amount of investments seems to be very high at first glance, the scarcity, despite its relevance, becomes evident if it is analyzed on a national level. In Germany, the fourth largest economy, only € 520 million was invested in the seed and start-up stage in 2012 (Bundesverband deutscher Kapitalbeteiligungsgesellschaften e.V., 2013).

However, the asset class of new ventures is very risky. Weidig and Mathonet (2004) show that the risk profile of direct new venture investments is highly skewed with approximately 30% being a total loss and the probability of any loss on a direct investment is 42% (Weidig & Mathonet, 2004). The riskiness of new ventures centers on several characteristics caused by the immaturity of the firm. There is high risk in future revenues and lack of an operational track record. A sustainable market acceptance through customers of the product is often not proven. The product is either not developed or quality of serial production is still outstanding, which increases technology risk. Furthermore, the founding team might not be qualified to build a new company. Last, new ventures are vulnerable to economic crisis and larger competitors due to a shortage of internal financial means (Wang & Zhou, 2004).

In order to make such a risky investment attractive for investors, the potential gain must compensate for the risk. Hence, an investment decision is based on the evaluation of the underlying risk and the expected and required return. If the expected return equals or exceeds the required return and therefore counterbalances for the risk taken, the venture capitalist (VC) will make the investment (Damodaran, 1999a). However, if the reverse is true, the VC will reject the investment. In this context, the correct valuation of the company and the determination of the cost of equity, i.e., the required return that compensates for the underlying risk, are decisive in order to derive a profound and accurate investment decision (Messica, 2008). In literature, this new venture investment decision is analyzed from two perspectives. First, research develops cost of equity models and risk valuation methods, which are used to determine risk and return. Based on these models, the investment decision can be made. Second, scholars examine how VCs apply these models, how investment decisions are actually made in practice, and if they are correct.

The corporate finance community has established several conceptual and empirical models for pricing the cost of equity of companies. However, only a few are theoretically or practically accepted (Armitage, 2005). The prevailing ones are the capital asset pricing model (CAPM) (Lintner, 1965; Sharpe, 1964; Sharpe, 1963), the arbitrage pricing theory (APT) (Ross, 1976), and the Fama-French-3-Factor Model (Fama & French, 1993). Past research focused and still focuses primarily on mature public corporations. The models applied use historical data to predict future volatilities of returns or comparable listed companies are used as a proxy in cases in which private firms are analyzed (Damodaran, 1999a; Estrada, 2007a; Petersen, Plenborg, & Scholer, 2006). In this context, research has shown that the determination of cost of equity is especially difficult regarding new ventures (Damodaran, 1999a; Gompers & Lerner, 2003).

Taking into consideration entrepreneurship and entrepreneurial finance literature analyzing the characteristics of new ventures, it becomes evident that new ventures do not fulfill certain

criteria necessary for the application of existing models. Their applications are often difficult due to missing data (Damodaran, 1999a; Kerins, Smith, & Smith, 2004). Lacking historic information, the use of conventional models is afflicted with high uncertainty (Ruhnka & Young, 1991), which results in higher total risk (Mishra & O'Brien, 2005). Contrary to the dominant financial market assumption of normally-distributed returns, it has been empirically proven that the returns of young companies follow an asymmetric skewed curve of distribution (Estrada, 2004). Moreover, idiosyncratic risk matters for VCs (Jones & Rhodes-Kropf, 2004; Müller, 2010), whereas most models, such as the CAPM, only observe systematic risk (Abate, Grant, & Rowberry, 2006) and assume that investors are perfectly diversified (Damodaran, 1999b). Thus, it becomes necessary to consider total risk (Chiampou & Kallett, 1989; Gompers & Lerner, 1997; Moskowitz & Vissing-Jørgensen, 2002). Furthermore, VCs do not operate in efficient markets where securities are liquid, which is one important assumption of several cost of equity models (Boudreaux, Rao, Underwood, & Rumore, 2011).

Despite the drawbacks of the application of existing cost of equity models, almost no new models have been developed by scholars or practitioners to deal with the specific characteristics of new ventures in the early stage of business development (Damodaran, 1999a; Estrada, 2000; Petersen et al., 2006; Sabal, 2004). In practice, this problem is addressed by VCs in a non-scientific, but pragmatic ad-hoc manner. A subjectively pre-determined target rate of return is often used instead of relying on theoretical or empirical models (Dittmann, Maug, & Kemper, 2004; Timmons & Spinelli, 2009). These target benchmark returns are often applied based on internal governance (Wright et al., 2004; Wright & Robbie, 1997).¹ However, it has been noted that there is a gap between the required and realized rates of returns of formal (Bygrave & Timmons, 1992; Cochrane, 2005; Manigart et al., 2002) as well as informal venture capital investors (Mason & Harrison, 2002) due to

¹ For more details about the specific information in preparing a valuation used by venture investors and target rate of returns, the interested reader is referred to Wright & Robbie (1997).

these “gut feeling techniques” (Dittmann et al., 2004). Some theorists claim that this is solely the result of the human over-optimism of the entrepreneur (Landier & Thesmar, 2003) or the mathematical reduction of optimistically estimated future cash flows (Smith & Smith, 2003). Others argue that the VC needs compensation for the active involvement in the portfolio company (Bottazzi, Da Rin, & Hellmann, 2008). In addition, this study argues that this is the result of missing venture-specific models, which leads to these false investment decisions and therefore low return performances.

As shown, calculating the “real” cost of equity of new ventures, which should be required by investors as a compensation for risk and time value is a very complicated process. The decisive variable of cost of equity models is the underlying risk of the asset. Therefore, the prediction of risk involved is one of the most crucial challenges for VCs (Messica, 2008; Petersen et al., 2006). When risk assessment models are reviewed, a similar research gap arises in a new venture context as compared to cost of equity models (Keupp & Gassmann, 2009; Reid & Smith, 2007; Short, Ketchen, Combs, & Ireland, 2010). Although there are several quantitative risk approaches (Embrechts, Furrer, & Kaufmann, 2009), one reason for this shortfall is linked, again, to venture-specific characteristics. New ventures lack a financial history, which makes an estimation of future risk difficult. Even more important, most risk factors are intangible rather than tangible and not easily observed (Song, Podoyntsyna, van der Bij, & Halman, 2008). Qualitative risk factors, like management experience and skills, dominate risk and cannot be quantified without subjective and biased decisions. Hence, it is not clear how to incorporate these qualitative factors into a quantitative risk model (Jia & Dyer, 2009).

With no appropriate risk models or tools at hand, the selection and investment decision process of VCs becomes very complex in practice (Zacharakis & Shepherd, 2009). Venture

investors² try to address this complexity by identifying and assessing the tangible as well as intangible risk factors of new ventures (Macmillan, Siegel, & Narashima, 2002; Manigart et al., 2002). In this context, early studies have already shown that investors apply multiple investment decision criteria to predict expected risk (Fried & Hisrich, 1994; Shepherd, 1999a; Tyebjee & Bruno, 1981, 1984). The criteria applied are manifold and elaborately analyzed (Franke, Gruber, Harhoff, & Henkel, 2006). They can be collated into four main classes – product and services; the market and industry; the venture team and entrepreneur; and the financial aspects (Franke, Gruber, Harhoff, & Henkel, 2008). As most of the risk factors are not easy to quantify, VCs use ad-hoc heuristics and their “gut feeling”, which leads to incorrect decisions with regard to risk assessment (Shepherd, 1999b). With this problem in mind, decision theory offers further insights into the decision making process and into the risk factor assessment of new ventures. It offers VCs the ability to analyze their own financial decisions and originate decision aids to derive an objective investment decision (Astebro & Koehler, 2007; Zacharakis & Meyer, 2000). In particular, this is relevant when measuring the risk of new ventures (Khanin, Baum, Mahto, & Heller, 2008). However, despite its relevance for VCs, decision theory has neglected to address this topic in a new venture risk assessment context.

Moreover, when analyzing new venture risk and the required return, it is important to consider the risk-reducing strategies that are available to the VC (Manigart et al., 2002; Sahlman, 1990). These include staging (Hsu, 2010), monitoring and active involvement (Dai, 2011), and specific contractual rights (Kaplan & Stromberg, 2001). Multiple decisions incorporating these strategies are made at the conclusion of an investor’s assessments of a new venture (Campanella & Ribeiro, 2011). Deriving an optimal investment decisions requires analyzing the entire expected investment path. In reality, VCs can hardly handle this complexity (Bergemann, Hege, & Peng, 2009). However, the development of a multi-stage

² The term “venture investor” is used in order to refer to all types of investors committing money to new ventures, including business angels and venture capitalists.

sophisticated risk model that addresses this complex structure of multiple risk factors and multiple risk reduction instruments of the VC is neglected (Ferrary, 2009; Li & Mahoney, 2011; Wang & Zhou, 2004).

In conclusion, it can be summarized that, first, there is a research gap with regard to venture-specific cost of equity and risk assessment models that can be applied by VCs in order to improve investment decisions. Second, because of this lack of models, VCs do not understand their investment decision process and therefore use, misleading techniques to derive investment decisions. Therefore, research in the field of cost of equity and risk assessment models for new ventures is overdue. A development of a new cost of equity and risk model considering and analyzing venture-specific aspects would increase acceptance by VCs and concurrently enhance the investment decision performance. The intention of this study is to address the challenges and close the research gaps described above.

1.2 Academic Approach and Research Contributions

This study relies on an understanding of business administration, particularly entrepreneurial finance, as an applied and practice-oriented science (Grichnik, 2006). Its basis is the research strategy of solving an existing business problem, in this case, the correct determination of the cost of equity and the underlying risk of new ventures. This includes closing the research gaps described in the previous section, an extensive review of relevant literature, and the development of theoretical models for entrepreneurial ventures (Braun, 1993). Based on the dearth of existing research, the main objective of this dissertation is to address and answer the subsequent research questions:

- What are the assumptions of existing cost of equity models? Why are there challenges regarding the application of these models to new ventures?

- What kind of cost of equity models are used by VCs? How reliable is the underlying process? What is the risk profile of new ventures and what kind of risk is important for the VC?
- What are the main factors determining the risk of new ventures? Do regional influences have an impact on the relevance for VCs?
- What kind of theoretical insights are required in order to establish a new venture risk assessment and cost of equity model? What kind of specific characteristics of new ventures and VCs' behavior must be considered? How can a theoretical risk and cost of equity model, which comprises all relevant factors, be set up?
- What are the risk-reducing strategies of VCs, which impact risk and cost of equity? How can a multi-stage theoretical new venture risk model, which comprises all relevant factors, be set up?

This dissertation attempts to answer the research questions by using several research approaches. First, a secondary research methodology is applied. Relevant literature of two objects of research, namely existing cost of equity models and applications to entrepreneurial ventures, is analyzed. This includes a review of conventional finance as well as entrepreneurial finance theory. An extensive study of related literature is conducted in order to analyze the theoretical and empirical costs of equity models. The goal is to systematically derive arguments concerning the relevance as well as problems regarding new ventures. International and behavioral aspects are also considered. This deductive approach is necessary for the successive model-building section (Kornmeier, 2007). Furthermore, the literature review is directed at new ventures, their characteristics and VCs. As it becomes evident that risk of new ventures and risk measurement is decisive, financial risk theory is reviewed. This includes mathematical methods of risk modeling. With new venture risk determined by several qualitative factors (Lumpkin & Dess, 1996; March & Shapira, 1987; Miller & Leiblein, 1996), decision theory of the VC is important. General decision theory including

biases and heuristics are reviewed in this context to identify suitable financial decision models. The analytic hierarchy process (AHP) is described in more detail. Moreover, secondary research on multi-stage risk analysis and risk reduction strategies available to the VCs is accomplished through a profound literature review. In this context, important aspects of agency theory, transaction cost theory, and contract theory are emphasized.

Second, due to their relevance analyzed, the risk factors of new ventures are researched theoretically and empirically. A meta-analysis of primary studies with the goal of identifying all relevant risk factors of new ventures is conducted. Moreover, the risk factors are analyzed in an international context. An empirical meta-analysis of a total sample size of 2370 new venture investors from 16 countries on four continents is conducted and the results are presented. The purpose of the empirical analysis is to gain an overview of all risk criteria applied and to examine regional distinctions. T-statistics are used as a statistical method to confirm significant differences. Moreover, limitations of this study are considered.

Third, a new risk and cost of equity model for new ventures is theoretically developed based on the insights of the first academic approach from finance theory, entrepreneurial finance literature, decision theory, and risk theory. The theoretical model relies on profound methods of mathematical theory development. Several assumptions are determined in order to set limits. A relative risk assessment model for VCs is elaborated. It has static, multi-factor, and relative risk measurement attributes, which incorporate insights from investment decision theory and financial risk analysis. It integrates a decision support model and a risk model through the application of the analytic hierarchy process (Saaty, 1987; Saaty, 2008a) including the perception of the downside risk approach of ventures. The model developed is intended for use in business decision-making processes in a financial context (Steinmann, 1978). Afterwards, the relative risk model developed is integrated in a downside cost of equity model. Moreover, diversification is addressed and limitations highlighted.

Fourth, based on the findings of secondary research, a multi-stage risk model that considers risk-reducing strategies of staging, monitoring and contractual terms is developed. Theoretical and mathematical assumptions are incorporated. The notion of capital risk is introduced. Propositions relying on theoretical derivations are developed and mathematically proven. This research approach concludes with examining some limitations.

To complete the analyses of this study and fulfill the requirements of profound scientific research, this dissertation concludes with a summary of the findings. Moreover, theoretical and practical implications of this study as well as suggestions for future research are derived and highlighted.

By answering the research questions, the contributions of this study to current research are manifold. A short summary is presented in the next paragraphs, which gives the reader first insights gained from the subsequent analyses. The specific contributions are described in detail in the respective sections.

First, this dissertation contributes to research by reviewing the latest theoretical literature and empirical findings in the underdeveloped field of cost of equity and risk models for new ventures (Short et al., 2010; Smith & Smith, 2004), which establishes a basis for subsequent contributions. In this context, relevant specifics of new ventures and VCs are also analyzed and highlighted.

Second, general risk assessment models, which have been rarely applied in a new venture environment, are extended (Embrechts et al., 2009). Thereby, venture-specific characteristics are included and important insights about VC decision theory, risk assessment, and analytic hierarchy process are considered in order to develop a risk assessment model for new ventures. Moreover, this study adds to finance research. An alternative to conventional cost of equity models, which rely on quantitative input data only, is derived for new ventures (Lawrence, Geppert, & Prakash, 2007; Nagel, Peterson, & Prati, 2007). Moreover, this approach contributes to decision theory in the field of VCs. (Zacharakis & Meyer, 2000).

Further, the model has an important practical contribution. It improves the VC's investment decisions and prevents their having irrational expectations concerning future returns and risk of the new ventures evaluated (Zacharakis & Shepherd, 2009).

Third, a first model incorporating all relevant risk-reducing instruments of new venture investments is developed. Past research has only focused on one or two strategies simultaneously, e.g., Hopp and Lukas (2012) and Hsu (2010). Based on this study, an optimal policy setting for VCs analyzing all risk-reducing strategies is elaborated in a multi-stage context. This increases the accuracy of VCs' investment decisions and enhances the efficiency of available resources in order to reduce risk.

Fourth, this study contributes to an important international aspect of investment decision making of the VC. Investment risk criteria have been analyzed for several decades (Khanin et al., 2008); however, a detailed aggregation and comparison of the results and a theoretical basis for potential differences are still lacking (Zacharakis, McMullen, & Shepherd, 2007). An evidence-based approach is accomplished via a meta-analytic review of existing studies in this field to close the research gap described. More importantly, this analysis contributes to the risk and cost of equity model developed in this study as adjustments due to regional impacts of risk factors can be directly integrated.

1.3 Structure of Analysis

The research approach, the methodology, and the goals described above are accomplished by dividing this dissertation into ten sections. Detailed academic contributions are explained at the beginning of each section. Following a standard academic approach, the first section presents the motivation for this study and the relevant academic disciplines as well as the research gaps. Based on the goal of the dissertation, an overview of the academic approaches taken to derive an answer for the research questions is described. The first section concludes with the main research contributions and the structure of analysis.

The second section gives an overview of germane topics in the relevant academic disciplines. The terminology of cost of capital, cost of equity, and risk is explained. After defining the focus of research, namely the new venture and entrepreneurial finance, the relevance of equity financing and venture capitalists for this study is constituted.

The third section represents an overview of the existing cost of equity models and concludes with some alternative and international cost of equity models as well as behavioral finance aspects.

The fourth section turns its focus on new ventures, their risk profiles, VCs and the cost of equity models applied to venture-like companies. The required rates on equity investments in new ventures are revealed. Idiosyncratic risk and its relevance are derived. The costs of equity applied and the underlying models used in theory and practice are analyzed.

The fifth section represents the potential risk factors of new ventures. Institution-based theory is applied to explain international differences. Investment decision criteria applied by VCs are used to examine the influence of each risk factor in an international context. A meta-analysis of these criteria is elaborated. The samples, the methodology, and the results are presented and discussed before some limitations are analyzed.

All dissertation-specific theoretical aspects of financial risk theory regarding new ventures are discussed in the sixth section. This includes risk modeling and aggregation. Moreover, risk measurement represents a large percentage of this section. In this context, downside risk is analyzed. Lastly, the risk reduction strategies are briefly explained.

The seventh section leaves the pure financial context and turns to decision theory. It deals with financial investment decisions, biases and heuristics, and decision models. The analytic hierarchy process is analyzed as a decent method of relative measurement. Its general approach, the advantages as well as disadvantages, and adjustments to group decisions are presented.

The eighth section represents the third academic approach used in this dissertation. The risk and cost of equity models for new ventures are developed on a theoretically profound basis gained through the previous sections. The research gap and the contribution of the model are described, followed by a model overview. The assumptions and the general risk framework are illustrated. The risk model development is divided into sub-sections, which explain the input variables used, the determination of risk levels, correlation of risk factor, and the risk aggregation technique in order to determine total risk of a new venture. The risk model is extended to a new venture cost of equity model. In order to accomplish this, the downside cost of equity model is analyzed in detail beforehand. The eighth section concludes with some limitations of the models presented.

The ninth section centers risk optimization of VCs in a multi-stage setting. A theoretical model, which incorporates capital risk, internal risk, and external risk, is developed. It analyzes the entire investment path from initial investment until exit. By considering risk-reducing strategies available to a VC, such as monitoring, staging, and contractual terms, optimal investment policies are derived. This section concludes with an analysis of findings and a presentation of the limitations.

The tenth section concludes this dissertation with a summary, several theoretical and practical implications as well as future research perspectives.

2 Key Definitions and Research Focus

2.1 *Cost of Capital*

Cost of capital, also called required rate of return of total capital invested (Pratt & Grabowski, 2008), equals the rate at which each expected economic income is discounted back to its present value for valuation purposes. It refers to the cost of a company's funds, i.e., both debt and equity. It is also the expected return that is required by the market participants in order to raise funds for a certain investment (Scott, 1992). In economic terms, the cost of capital can be defined as an opportunity cost, i.e., the cost of forgoing the next best alternative investment. This relies on the principle of substitution, meaning that an investor will not invest in an asset if there is another asset (substitute) with a better risk-return profile, which is, therefore, more attractive (Pratt & Grabowski, 2008). From an investor's perspective, cost of capital can be defined by the shareholder's required return on a portfolio of all the existing securities of a firm (Brealey, Myers, Partington, & Robinson, 2000). The cost of capital is normally described in percentage terms, i.e., the annual amount of a certain currency the investor required, expressed as a percentage of the dollars invested (Kaufman, 1999). It is meant to always be a forward-looking figure and the competitive return available in the market. In this context, risk is the most important component of comparability (Pratt & Grabowski, 2008).

In a financial context, risk is related to the variability of the future value of a financial position. The underlying value is influenced by uncertain events. Thus, there is no need to determine the initial costs of the position as, only future values matter (Artzner, Delbaen, Eber, & Heath, 1999). Risk is only existent and interesting in an ex-ante perspective and has been primarily associated with the dispersion of the corresponding random variable of monetary outcomes (Szego, 2002). In this case, risk can be measured by the standard deviation. However, different distribution shapes can have the same variance, which makes

measurements like skewness as well as kurtosis important in order to adequately quantify all risk aspects. Although the definition of risk measure can be kept very general, risk measures themselves need to fulfill certain criteria in order to make them correct measures and to prevent inconsistencies (Embrechts et al., 2009).

There are at least three reasons that it is important to determine the cost of capital of a firm. Firstly, an analyst needs the cost of capital of a firm in order to determine the present value of the expected cash flows, which represents the intrinsic value of the company. Secondly, the cost of capital is needed to calculate the riskiness of a firm when investing money and comparing it to other firms. Thirdly, when analyzing new investment opportunities or financial projects, the cost of capital is used to determine the net present value of the endeavor. Thus, it is used as a minimum benchmark that a new project, like a new venture, has to meet (Colon-De-Armas, 2008).

When calculating cost of capital, the weighted average cost of capital (WACC) is often used. It can be determined or measured through the weighted average cost of capital formula (Modigliani & Miller, 1958):

$$WACC = r_{Assets} = r_{Equity} * \frac{Equity}{Total Assets} + r_{Debt} * \frac{Debt}{Total Assets} \quad (1)$$

with r_{Equity} representing the cost of equity and r_{Debt} representing the cost of debt. The cost of capital is based on market values, not book values (Pratt & Grabowski, 2008). At first glance, the formula implies that the cost of capital depends on the financial structure of the firm. However, this is not correct and is inconsistent with the theory of finance, which states that the value of a company and the related cost of capital are independent of its capital structure (Proposition I by Modigliani and Miller (M&M) (1958)). The WACC tries to determine the return required in order to invest in the assets of the company. Thus, it is the assets, which are important, not the source of financing. The WACC is only applicable if the systematic risk of the assets does not change. Therefore, the application of the WACC is only limited to the

estimation of the company value if the financing structure is not changed (Arditti, 1973; Colon-De-Armas, 2008).

As the cost of equity and the decisive models for new ventures will be analyzed and discussed in the subsequent sections, the description is limited to a formal definition here. When talking about the cost of equity, the required return to a share or partnership investor is meant. It is defined as the return, a firm must theoretically pay to its equity investors in order to account for the time value of funds and the risk taken (Damodaran, 2002). The cost of equity is an important input factor for decisions about the firm. As it affects the discount rate of expected cash flows, correct determination is important for the firm's investment decisions and valuation (Pastor & Stambaugh, 1999).

By contrast, the rate of debt is in general easy to compute by using the contractual rate of interest paid to the bank or an investor. It is composed of a risk-free rate component plus a risk premium (RP) component that accounts for the risk born by the creditor. For the risk-free rate a proxy of a risk-free bond is taken as a benchmark. The RP represents the compensation for a possible default. It is intended to depend on the firm-specific risk of default and will increase when the amount of debt relative to fully-liable equity increases (Pratt & Grabowski, 2008). As this study analyzes new ventures, which are rarely financed with debt (Gompers & Lerner, 2003), the cost of debt issue and its calculation are disregarded for further analysis. For more details on cost of debt, the reader can refer to reputable finance text books (Bodie, Kane, & Marcus, 2005; Brealey et al., 2000; Copeland, Weston, & Shastri, 2005).

2.2 New Ventures and Entrepreneurial Finance

It is important to define the scope and terms used in scientific research to allow others to understand and also critique the research conducted (Kornmeier, 2007). Therefore, a precise and circumstantial definition of the objects of research is a prerequisite for further steps. The

focus of this research is the new venture; therefore, to avoid any misunderstanding, the definition of new ventures in this dissertation is as follows:

A new venture is a young and private firm in the form of a legal entity or individual person, whose goal is to exploit business opportunities and to harvest potential profits. “Young” indicates the age of a firm in the early phase of its business life cycle, i.e., the nascent phase (Timmons & Spinelli, 2009).

When analyzing new firms, entrepreneurs are relevant. The term “entrepreneurship” must be adequately defined. Entrepreneurship is characterized as the pursuit of opportunities in order to combine and re-deploy resources. This is accomplished with no regard to ownership of resources. Firstly, the perception of an opportunity is necessary to create value. This is done by re-deploying resources. Secondly, the entrepreneur must gain control of necessary resources. Thirdly, he or she must plan actions in order to achieve the change and, finally, the rewards accruing from the innovation are harvested (Bryat & Julien, 2001).

The focus on entrepreneurship and new ventures changes the application of conventional finance theory. This is subject to the research field of entrepreneurial finance. The major differences between large corporations and early stage new ventures with regard to a financial context are enumerated by Smith & Smith (2003) as follows:

- The role of diversification of risk as a determinant of investment value.
- The degree of active involvement by external investors.
- The relevance of contracting to mitigate incentive problems.
- The importance of options as determinants of value.
- The effects of informational challenges with regard to the company’s capability to elaborate a project.
- The non-separability of investment decisions and financing decisions.
- The relevance of harvesting with regard to valuation and the investment decision.

- The focusing on the entrepreneur's value maximization versus on maximizing the value for shareholders.

This analysis relies on insights gained through entrepreneurial finance research. In this context, especially the four first differences between conventional and entrepreneurial finance listed above play an important role regarding the objectives and focus of this dissertation.

2.3 Equity Financing and Venture Capitalists

New ventures are often characterized by negative expected earnings for the first years, by a significant fraction of intangible assets, and by uncertain prospects. This leads to high risk. The high risk of the investment also relies on the agency problem between the entrepreneur and a potential investor (Jensen & Meckling, 1976). It affects the willingness of investors to provide capital. The intangible assets are considered to increase agency problems. When assets are more tangible, investors can recover more of their money in the case of liquidation. It is argued that investors can deal with the principal-agent aspect by intensively screening potential investments and continuing to monitor them (Sahlman, 1990). Banks have limits regarding the reduction of the agency problems. Firstly, their investment in new ventures is constrained to regulations. Secondly, the competitive markets in which banks operate are not able to finance high risk projects. Banks are unable to charge borrowers rates, which are high enough to indemnify for the riskiness of the firm (Petersen & Rajan, 1994). Moreover, new ventures would not be able to pay frequent and high installments. Thirdly, they do not possess the necessary skills to assess venture projects (Gompers & Lerner, 2003; Hoshi, Kashyap, & Scharfstein, 1990). Therefore, it is not likely that new ventures will receive bank loans or other debt financing (Cassar, 2004).

With no debt financing or internal profit available, new ventures can only be financed by equity financing, which does not require repayment of the capital invested. Equity capital can

be raised through business angels,³ family and friends, and VCs that finance these high risk and potentially high value new ventures (Gompers & Lerner, 2003). VCs play an important role in this context. They invest funds in equity-linked securities of new ventures. VCs are also actively engaged in the management of the new ventures in which they invest. Apart from their ownership in equity, they have important contractual rights, such as veto rights, board seats, and liquidation rights (Sahlman, 1990). Due to their relevance for new venture financing, it is focused on equity investments and VCs regarding the application of cost of equity models in this study.

³ Business angels are individual investors who finance private young firm by investing their own capital.

3 Cost of Equity Models

3.1 Model Classification

This section gives an overview of relevant cost of equity models. The brief formal descriptions of the CAPM, factor models, international aspects of emerging markets, and influence of behavioral finance are necessary in order to set the foundation for the subsequent research study.

In general, models regarding the determination of cost of equity can be categorized into two sections: explanatory and deductive models. The former ones can be further classified into conceptual and empirical models (Armitage, 2005; Pratt & Grabowski, 2008; Sabal, 2004). The theoretical or conceptual models rely on logical reasoning. They describe how the cost of equity should be determined given a set of assumptions. By contrast, empirical models are based on historical empirical results. They try to find specific factors, which had the greatest influence on actual returns in the past, which are then used to establish a general mathematical model. Thus, empirical models can be regarded as a combination of practical and conceptual models as relevant factors are determined with no theoretical foundation. In addition to that, deductive models derive the cost of equity from market valuation data (Sabal, 2004).

In general, the notion is that riskier investments should have higher expected returns than less risky investments (Abate et al., 2006). The common view of future risk is that it is defined in terms of variance around expected returns. As these expected returns are not known, variance of past actual returns is used (Damodaran, 1999a, 1999b). Alternatively, deductive models are used, which require neither historical data from stock markets or accounting nor corrections for country risk. However, they assume that the overall market is correctly priced. The main advantage is that it is driven by the current market and no historical data is used to predict future returns. The deductive models forecast implied equity premiums in any market. Nevertheless, these models are limited to the reliability and availability of the inputs to the

model (Damodaran, 1999b). This dissertation focuses on the explanatory models, i.e., theoretical and empirical models, for two reasons. The level of market data required by deductive models is not even close to achieving in a new venture context. Moreover, they are excluded as they do not contribute to further insights regarding the application to new ventures.⁴ The theoretical and empirical cost of equity models are briefly described in the subsequent sections. This dissertation investigates in detail the CAPM and its theoretical foundations in detail.

Apart from some authors, e.g., Claus & Thomas (2001) that use forecasts of analysts in order to determine a measure of expected returns with new techniques, the majority of cost of equity models involve historical returns. The main problem with this approach is the noise inherent to those returns (Fama & French, 1997).

Last, empirical comparisons are not considered. However, there are several studies, which analyze and compare cost of equity models with regard to empirical validity and different time periods and objects of research, e.g., Lawrence, Geppert and Prakash (2007) and Bostock (2004). Interestingly, several tests have concluded that the accuracy of cost of capital estimation methods does not depend on the level of sophistication; even the simplest approaches can determine correct required returns (Nagel et al., 2007).⁵

⁴ For further information on deductive models, the reader is referred to respective literature on this subject, e.g., Gordon (1963), and Gordon and Gould (1978).

⁵ Seven models regarding noise effects are analyzed by Nagel, Peterson, & Prati (2007). Six traditional models are compared to a naïve model in order to determine the cost of equity. The traditional models are the CAPM, the Fama and French (1993) three factor model, the four factor model (Carhart, 1997) which is based on the three factor model but adds a momentum factor, a co-skewness model (a version of the model by Harvey and Siddique (2000)), which relies on the CAPM model by adding a measure of risk associated with co-skewness, a co-kurtosis model (Dittmar, 2002) which extends the co-skewness model by a measure of risk regarding co-kurtosis, and finally a model which is based on a stock's own historical mean returns (for more details about this model refer to Nagel et al., 2007). The naïve model, called the LMS, assumes a fixed market premium and constrains the beta factor to one. It is also applied to large stocks (Lee, Myers, & Swaminathan, 1999). The findings of the comparison emphasize that the more sophisticated models typically increase forecasting errors. Interestingly, it is revealed that the simplest model, i.e., the LMS, has the best forecasting ability among commonly-used model for the estimation of cost of equity and generated the smallest forecast errors. Although previous studies (Fama & French, 1997; Ghysels, 1998; Lee et al., 1999) showed the poor performance of the traditional three models (CAPM, three, and four factor model) the study described here is the first to consider individual firms (Nagel et al., 2007).

3.2 Capital Asset Pricing Model

The capital asset pricing model (CAPM) is one of the basic pillars of modern financial theory. This section gives a brief overview of its assumptions and specifications. The CAPM explains the relationship between the risk of a share of a company and the expected return. Therefore, it serves as a benchmark rate of return (Bodie et al., 2005, p. 281). It was developed by Sharpe (1964), Lintner (1965), and Mossin (1966). The CAPM is based on certain assumptions that can be summarized as followed (Bodie et al., 2005, p. 282):

- Investors
 - + Many investors exist.
 - + Each investor has a certain level of money available that is insignificant compared to the existent populations of investors.
 - + Investors are price-takers.
 - + Perfect competition assumption: security prices are unaffected by investor's trades
 - + Myopic behavior
 - + Suboptimal behavior
 - + All investors have an identical holding period (single-period-horizon).
 - + Ignorance of future events
- Limited investment instruments
 - + Stocks
 - + Bonds
- Risk-free borrowing and lending
 - + Borrowing and lending of cash is unlimited at a bound risk-free rate.
 - + No non-traded assets like shares of private enterprises are available and traded.
- No taxes and no transaction costs
- All investors are rational mean-variance optimizers.

- Investors have homogeneous expectations about the future

Based on these assumptions, the equilibrium of this scenario of assets and investors can be described by an existing market portfolio (MP), a capital market line (CML) and a risk premium including a beta coefficient. All investors will hold proportions of assets, which duplicate the market portfolio. The value is derived by dividing the value of the assets hold by the market value of all assets. This market portfolio lies on the efficient frontier, i.e., the line on which all efficient portfolios are presented and is also the tangency portfolio regarding the optimal capital allocation line (CAL). The risk premium of the MP depends on its risk and risk aversion of the representative investor (Bodie et al., 2005; Lintner, 1965; Sharpe, 1964). It can be expressed through:

$$E(r_m) - r_f = \bar{A}\sigma_M^2 * 0,01 \quad (2)$$

with σ_M^2 equaling the variance of the MP and \bar{A} representing the average risk aversion across investors. The RP of individual assets can be determined by the beta factor. Beta measures the level of homogeneous movement of the returns of the share versus the returns of the MP (Bodie et al., 2005). It is expressed by:

$$\beta_i = \frac{Cov(r_i, r_M)}{\sigma_M^2} \quad (3)$$

Consequently, the RP on individual assets are defined as:

$$E(r_i) - r_f = \frac{Cov(r_i, r_M)}{\sigma_M^2} [E(r_M) - r_f] = \beta_i [E(r_M) - r_f] \quad (4)$$

Therefore, a portfolio is considered optimal, if it represents the MP (Lintner, 1965; Sharpe, 1964). The variance is used as the measure of risk for the portfolio. It is expected that the required RP of an asset or portfolio is a function of beta and MR, which is proportional to both factors. Thus, the security market line (SML) can be expressed by (Bodie et al., 2005; Mossin, 1966):

$$E(r_{asset A}) = r_f + \beta_{asset A}[E(r_M) - r_f] \quad (5)$$

According to the equation above, only covariance risk matters for pricing. Thus, the returns' variance as a risk measure for an asset matters only as far as it impacts the covariance of between asset and market. Therefore, total risk, also called stand-alone risk, can be split up into a covariance component, i.e., systematic risk, and an idiosyncratic risk component, i.e., non-systematic risk or firm-specific risk. In general, the standard CAPM model is an ex-ante pricing equation. It gives the equilibrium relationship of expected returns. However, realized returns might differ from expected returns. If the model is right, the deviation should be zero on average. Taking an ex-post perspective leads to the following equation (Sharpe, 1964):

$$\tilde{r}_i = r_f + \beta_i(\tilde{r}_m - r_f) + \tilde{\varepsilon} \quad (6)$$

3.3 Factor Models

3.3.1 Single and Multi Factor Models

In general, factor models are tools, which quantify and describe the different factors influencing the return on a security (Fama & French, 1996). The simplest form is a single factor model. In a cost of equity context, factor models rely on the following assumptions. First, as firms are influenced by similar economic forces, the covariance of returns is positive. If all these forces are aggregated to one factor, the entire market is moved by that factor. Second, it is assumed that all other factors are firm-specific and do not influence the covariance (Bodie et al., 2005; Sharpe, 1963). This relation can be expressed by:

$$r_i = E(r_i) + m_i + e_i \quad (7)$$

The first term represents the expected return on an asset i , m_i describes the influence of unexpected macro-economic events and e_i represents unexpected firm-specific events. The value of m_i and e_i is zero. Firms are differently influenced by macro-economic factors.

Therefore, the terms β_i and F are introduced. β_i represents the impact of the macro-economic events on the asset i and F describes the unexpected element of the macro-economic events leading to the following function of a single factor model (Bodie et al., 2005):

$$r_i = E(r_i) + \beta_i F + e_i \quad (8)$$

When an index of assets is used to estimate the macro-economic factor and considering excess return of an asset i , the following equation is derived:

$$r_i - r_f = \alpha_i + \beta_i(r_M - r_f) + e_i \quad (9)$$

with α_i representing the excess return leading to:

$$R_i = \alpha_i + \beta_i R_M + e_i \quad (10)$$

Hence, each asset possesses two elements of risk: market risk (R_M) and firm-specific risk (e_i) (Bodie et al., 2005). Systematic risk can be derived more explicitly by a multi factor model, which considers different risk factor. For example, a 2-factor model with GDP and interest rate as risk factors can be written as:

$$r_i = E(r_i) + \beta_{iGDP}GDP + \beta_{iIR}IR + e_i \quad (11)$$

The two systematic macro factors have zero expectation and represent changes in the variable having not already expected (Bodie et al., 2005, pp. 344-348). In general, multi-factor models do not have a theoretical basis; it is solely a description of factors that affect asset returns (Zhu, 2000), which makes a determination of the factors challenging.

3.3.2 Arbitrage Pricing Theory

Arbitrage is the exploitation of security mispricing by earning risk-free profits (Shleifer & Vishny, 1997). However, efficient capital market theory assumes arbitrage is impossible as the prices of assets are established by rational investors in equilibrium (Fama, 1970; Sharpe, 2000). The arbitrage pricing theory was developed by Stephen Ross in 1976 and links

expected returns to several systematic risk factors (Ross, 1976). The APT relies on three main assumptions:

- A factor model can describe the asset returns.
- Unsystematic risk can be diversified.
- Arbitrage opportunities are not sustainable in efficient asset markets.

Similar to the CAPM, the APT represents a benchmark for returns and differentiates between systematic and unsystematic risk. With no unsystematic risk, a well-diversified portfolio can be expressed by (Ross, 1976):

$$r_p = E(r_p) + \beta_p F \quad (12)$$

F is the factor analyzed. It is argued that the returns of diversified portfolios must be linked to the risk-free asset in the form of a straight line. Considered that the returns of all diversified portfolios are located there, an equation can be set up that reflects the expected returns. Based on that, a relationship between return and the beta is derived. The absence of the arbitrage opportunities assumption gives rise to the name of that approach. If the APT is compared to the CAPM, there is one main difference. The real MP is not required for the APT. This makes the model flexible as the real MP is not observable (Roll & Ross, 1980).

It can be argued that there are many sources of risk. The APT can be used in order to establish a multi-factor model, which takes all sources of risk into account. A two-factor model can be expressed through:

$$r_i = E(r_i) + \beta_{i1}F_1 + \beta_{i2}F_2 + e_i \quad (13)$$

e_i represents the firm-specific risk factor, which has an expected value of zero (Ross, 1976).

However, the APT has also disadvantages. Compared to the CAPM, the APT does not analyze, which risk factors and RPs are decisive. There are two limitations regarding the selection of the factors. First, they must account for systemic risk. Second, they must be relevant for the investor in terms of RP (Bodie et al., 2005). Using several factors leads to a

multidimensional security characteristic line. In this case, a multiple regression is used (Chen, Roll, & Ross, 1986).

3.3.3 Fama French 3 Factor Model

A special multi-factor model worth mentioning is the Fama French 3 factor model (Fama & French, 1993; Fama & French, 1996). Systematic risk factors in the form of characteristics of companies that significantly influenced past returns are chosen. It is expected that these factors explain the main RPs. Fama and French (1993) developed a factor model taking into account firm-specific features of size and book-to-market ratios. The developed factor model is defined as:

$$r_{it} = \alpha_i + \beta_{iM}R_{Mt} + \beta_{iSMB}SMB_t + \beta_{iHML}HML_t + e_{it} \quad (14)$$

with SMB_t represents small minus big, i.e., the return of a portfolio of small shares in excess of the return on a portfolio of large shares. HML_t is high minus low, i.e., the return of a portfolio of shares with a high book-to-market ratio in excess of the return on a portfolio of shares with a low book-to-market ratio. In this context, the market index β_{iM} is important as it reflects the macroeconomic factors. The disadvantage of the model is that the factors are determined empirically, with no theoretical foundation. It is assumed that the factors used are proxies for unknown variables, which can be explained theoretically. Moreover, their ability of explaining risk and return is based on past data (Bodie et al., 2005; Fama & French, 1993; Fama & French, 1996).

3.4 Emerging Markets and Cost of Equity Models

3.4.1 Market Characteristics and Risk Adjustment

This section presents cost of equity models, which account for regional or country-specific influences on the cost of equity. Only those models that provide relevant insights for the subsequent study are analyzed. The techniques described prove that adjustments due to

different international influences on risk-return profiles must be made. This is meant to be relevant for new ventures in an international context as well.

In general, it is argued that an additional risk premium should be added to the discount rate to account for country-specific risk factors (Damodaran, 2003). This premium depends on the country where the investment is made. Moreover, it depends on the relative volatility of its market index. Country risk is related to political risk. Political risk is especially evident in emerging markets with weak regulative institutions (Hail & Leuz, 2006; Sabal, 2004), and is dependent on the power of the government. The less reliable an institutional framework of a country is, the higher the specific risk will be. Moreover, different projects have different country risks. It is argued that certain industry sectors are more stable and less risky than others (Fama, French, & Brennan, 2001). As country risk is not regarded as entirely systematic, relying on the CAPM, which focuses on systematic risk only can pose a problem to investors (Erb, Harvey, & Viskanta, 1995). Research shows that the returns of shares in developing as well as developed regions are not extensively correlated. Only the portion of country risk, which is systematic and cannot be diversified, should be represented in an increase of the cost of equity. If country risk is diversifiable, no adjustments should be made for a systematic risk measure (Sabal, 2004). The drawbacks of the CAPM in an international context motivated researchers to seek and develop alternative measures of cost of equity. Apart from the APT (Ross, 1976) and the Fama-French three-factor model (Fama & French, 1993), several competitive models have emerged, which focus on regional adjustments.

In particular, emerging markets are faced with specific anomalies due to their specific characteristics, which make the development of alternative and adjusted cost of equity models necessary (Estrada, 2007a). In recent years, emerging markets have been subject to intense research with regard to cost of equity (Bekaert & Harvey, 2003; Estrada, 2007a; Mishra & O'Brien, 2005). There is no single stock market, which is efficient in transitional or emerging economies. Public markets are relatively small and the relevance of stock markets in the

economy is low. Data series available are extremely short, limited and have high volatile returns (Pereiro, 2001). Therefore, it is challenging to measure precisely average rates of return. Moreover, shares tend to be illiquid in emerging markets, meaning that the shares are traded infrequently. Therefore, the information on prices is also infrequently available, which leads to imprecise return calculations and determined returns deviating from real historical returns. Furthermore, in developing countries, only a few companies are traded at stock exchanges. This bias influences beta, which, as a consequence, does not reflect risk with regard to the market as a whole. In general, investors have assumptions about a hard currency. That means that a cost of equity model used in an international context must consider the risk derived from deviations of purchasing power parity (Sabal, 2004). Additionally, market segmentation plays a significant role in emerging markets. One aspect of segmented markets represents inefficiency caused by barriers, such as the inability of a country's citizen to invest in other countries, considerable gaps between prices of local and foreign assets, and limitations on foreign ownership. Hence, price differences would be quickly eliminated by arbitrageurs in efficient markets (Sercu & Uppal, 1995). The degree of market segmentation can be measured by the correlation of returns of international and local assets. If the correlation is high, the market is supposed to be integrated (Sabal, 2004).

3.4.2 Emerging Market Models

The Global CAPM relies on the assumption that asset valuation is uncorrelated to the various exchange rates. However, it is less plausible for emerging markets in light of conspicuous market imperfections (Solnik, Boucrelle, & Le Fur, 1996). Country or domestic risk is expressed through an aggregate of idiosyncratic risk components. These components involve currency risk, risk of inflation, sovereign risk, and probability of expropriation by the government. The country risk premium is normally calculated by the difference of global and local bonds. Therefore, the adopted CAPM was introduced:

$$E(r_{iX}) = r_f + \beta_i [E(r_M) - r_f] + CR_x \quad (15)$$

CR_x represents the adjustment premium for the country risk, which is determined by the difference of long-term bonds of the country and U.S. bonds. The main problem when adding a country-specific RP to the cost of equity is that a country is regarded as separate from additional business risks and considered the same for all endeavors. Moreover, the impact of the risk of a country is often included in the discount rate cash flows. Therefore, the degree of diversification at the investor level is neglected (Sabal, 2004; Solnik et al., 1996).

An alternative approach is the local CAPM model, which is recommended for segmented markets. Thus, the premium corresponds to the idiosyncratic risk of the local country (Keck, Levensgood, & Longfield, 1998). It can be defined through:

$$E(r_{iL}) = r_{fL} + \beta_{iL} [E(r_{ML}) - r_{fL}] \text{ with } r_{fL} = r_{fG} + r_{fC} \quad (16)$$

L stands for the respective country the model is applied. That means that risk-free rate, market portfolio for the beta and expected market return calculations are derived from the country. r_{fL} represents the local risk-free rate consisting of the global risk free-rate and a country adjustment factor. The main disadvantage is that every parameter relies on local market data, which contain errors. In particular, the drawbacks of inefficient capital markets in emerging markets, like high volatility, illiquidity, and a small group of comparable securities, play an important roles in this respect (Sabal, 2004).

The so-called international CAPM is a cost of equity model applicable to international and diversified investors. Apart from the assumptions of the CAPM, a hard currency basket is assumed to be owned by each investor. That means that the model deals with the risk arising from a deviation of a purchasing power parity. It is formulated by Sercu and Uppal (1995) through:

$$E(r_{iX}) - r_f = \beta_i [E(r_M) - r_f] + \gamma_{iX} * E(s_X + r_X - r_f) \quad (17)$$

where $E(r_{iX})$ is the expected rate of return determined in the country currency of investment i in a country x . r_X is the risk-free rate in local currency, γ_{iX} is the beta of the risk-free rate of the base currency regarding the local currency rate of exchange alteration to the base currency, s_X is the percentage exchange rate change of the base currency regarding the local currency, and r_f is the base currency risk free rate (Sabal, 2004; Sercu & Uppal, 1995). Due to the assumptions of diversified investors, the application of this model for segmented emerging markets, where idiosyncratic risk matters, is limited.

There is an ad-hoc beta model proposed by Godfrey & Espinosa (1996) in order to address the challenge of the conventional CAPM with regard to developing economies. The Godfrey-Espinosa approach has two adjustments with respect to the CAPM (Godfrey & Espinosa, 1996). It is based on total risk and incorporates country risk, but neglects industry risk. It is expressed through the following formula:

$$E(r_i) = r_{cf} + r_{fg} + \beta_i [E(r_{MG}) - r_{fg}] \text{ with } \beta_i = 0,6 * \left(\frac{\sigma_i}{\sigma_{MG}} \right) \quad (18)$$

The 0.6 factor decreases the equity premium and reduces the problem of overestimating risk. The adjusted beta implies that the correlation coefficient among markets is one. This adjustment relies on empirical findings of past research (Erb et al., 1995).

Moreover, the Harvey's Proposal is a hybrid model among integrated and segmented markets, which comprise the level of integration and segmentation and conditional skewness (Harvey & Siddique, 2000). The cost of capital is an equation of a covariance with global markets provided that the country is fully integrated where the security is traded. If the market of the country is entirely segmented, the covariance is replaced by the variance. The weight of each parameter is dependent on the degree of integration compared to all other countries. Weights may change (Harvey, 2001). Unfortunately, the model does not describe how the level of integration should be measured.

In particular, there are two methods analyzed in emerging markets. The first model is developed by Erb, Harvey and Viskanta (Erb, Harvey, & Viskanta, 1996a, 1996b). The Erb-Harvey-Viskanta (EHV) model is a model based on credit risk rating described as follows:

$$CS_{i,t+1} = rr_0 + rr_1 * \ln(CCR_{it}) + \varepsilon_{i,t+1} \quad (19)$$

with CS representing the biannual returns of country i in US dollars. CCR is the credit risk of the country. Moreover, t is a half-year period and epsilon is the regression residual. The model relies on a non-equity market risk assessment, i.e., the country credit rating, in order to determine the cost of equity. This risk measure comprises exchange risk, inflation risk, political risk, and additional country-specific risk factors (Erb et al., 1996a, 1996b). However, it has two problems. The model cannot be used on the company level as it calculates countrywide cost of capital. Additionally, it is highly subjective (Estrada, 2000).

The second model is the downside risk measure proposed by Estrada (2000), which can be described by:

$$E(r_i) = r_f + \beta_i [E(r_M) - r_f] \text{ with } \beta_i = \left(\frac{\sigma_{SVi}}{\sigma_{SVM}} \right) \quad (20)$$

with β_i representing the semi-standard deviation of returns of the stock divided by the same measure of market returns. The model reflects several aspects under which emerging markets operate. It describes reasonable results regarding the risk-return characteristics of stocks in emerging markets (Estrada, 2000). As this model is especially relevant for new ventures and the risk model developed, it is further described and analyzed in a subsequent section.

In conclusion, research activity in recent years has shown that investors should account for aspects of country risk, such as political and inflation risk, which depends on the country in which the asset is traded (Lessard, 1996). As, to a certain degree new venture markets can be compared to emerging markets, VCs are exposed to these risk factors as well. Therefore, it can be concluded that a cost of equity model for new ventures must also incorporate country-specific aspects. Models used for emerging markets represent an acceptable basis for this.

3.5 Behavioral Finance and Cost of Equity Models

It is analyzed that companies changing their name to a dotcom designation during the internet boom around 2000 gained abnormal returns compared to their counterparts in the same industry (Cooper, Dimitrov, & Rau, 2001). Similar effects are observed with mutual funds, which receive increased inflow (Cooper, Gulen, & Rau, 2005). Efficient market hypothesis claims that prices are usually “right” (Fama, 1970). By contrast, behaviorists stress that the two implications, namely correct prices and no profit opportunities, can be challenged. Prices can be wrong but still no profit opportunity may emerge. Therefore, if profit opportunities are scarce, it is not incrementally assumed that prices are calculated correctly. Behavioral finance claims that these financial insights might be analyzed by applying models, which include assumptions about non-fully rational agents. This academic discipline emerged because of the difficulties faced by conventional finance paradigms (De Bondt & Thaler, 1995).

Little classical finance research considers subjective risk factors during the decision-making process of financial risk assessment (Yazdipour, 2009). The viewpoint of risk in behavioral finance research is different. It is argued that the Assumptions of conventional decision theory are not correct, because investors act irrationally. Behavioral finance rejects the belief of choices reflecting the maximization of a rational utility function. An interesting finding is that the brain separately encodes the risk and the reward when confronted with financial decisions. It is analyzed that risk itself is encoded in the brain as a form of variance or deviation of an expected outcome including higher moment (Bossaerts, 2009; Hsu, Krajbich, Zhao, & Camerer, 2009). It tries to include behavioral characteristics of investors in order to calculate cost of equity in order to account for subjective behavior and puzzling earnings (Shleifer & Summers, 1990). Behavioral economics usually analyze the experimental evidence of cognitive psychologists on the biases, which emerge when human beings create beliefs or make preferences on decision making (Camerer, 1995; Gilovich, Griffin, & Kahneman, 2002; Kahneman, Slovic, & Tversky, 1982; Shleifer, 2000; Tversky, Kahneman, & Foundation,

2000). Beliefs are formed by overconfidence (Fischhoff, Slovic, & Lichtenstein, 1977; Gervais & Odean, 2001), optimism (Buehler, Griffin, & Ross, 1994), forecasting errors due to experience and memory bias (Kahneman & Tversky, 1973), representativeness and sample size neglect (Chopra, Lakonishok, & Ritter, 1992; Kahneman et al., 1982; Kahneman & Tversky, 1972), conservatism (Edwards, 1968; Mullainathan, 2002), belief perseverance (Lord, Ross, & Lepper, 1979), anchoring (Tversky & Kahneman, 1974), and availability biases (Tversky & Kahneman, 1974). Moreover, preference deals with prospect theory (Kahneman & Tversky, 1979; Tversky & Kahneman, 1992). This includes aspects of framing, mental accounting, and regret avoidance. Additionally, preference is influenced by ambiguity aversion (Ellsberg, 1961; Fox & Tversky, 1995). Barberis and Thaler give a good summary of these cognitive approaches of behavioral finance (Barberis & Thaler, 2002).

In the context of cost of equity models, affect plays an important role. It is regarded as characteristics of sentiments. For example, Statman (1999) includes utilitarian factors and expressive or affect factors, e.g., negative effect of tobacco companies or positive effect of prestigious hedge fund, in his development of a behavioral asset pricing model. Empirical studies investigate these factors (Hong & Kacperczyk, 2007). A behavioral finance model developed by Statman, Fisher, and Anginer (2008) reveals that when the objective risk is high, then the expected returns of the potential investors are high. Interestingly, similar results are analyzed with subjective risk. Moreover, if subjective risk is high, a negative affect is caused. If subjective risk is low, a positive affect emerges. Objective risk is determined by a beta factor, whereas subjective risk is calculated by affect. These two factors are the main, but not the only factors in the behavioral asset pricing model. If arbitrage is incomplete in a market, subjective risk must be considered. This is particularly prevailing in emerging markets and venture markets. If the effects of VCs on returns are disposed by arbitrage, then the level of subjective risk is zero (Statman et al., 2008). Additionally, the emotions of investors are examined. It is proven that emotional investors demand higher returns. Thus, a

consumption-based CAPM creates a link between consumption preferences and equity premiums (Gürtler & Hartmann, 2007).

Behavioral finance is still in its infancy. The major argument of full rationality within the investor's decision-making process has been rightfully criticized. However, the extent to which irrationality influences asset pricing is controversial (Fama, 1998).

4 New Venture Cost of Equity and Risk

4.1 Risk and Return Profile

Although investors lack diversification, the average annual return of private firms is not impressive. They average the returns on all publicly traded equity. Survival rates average around 34% during the first ten years of a firm's life. Even if only firms are considered, which survive the first years, distribution of returns across entrepreneurs is still very scattered. The standard deviation of private equity returns is about twice the amount of public equity returns (Moskowitz & Vissing-Jørgensen, 2002). There are several studies investigating the ex-post risk profile of young companies. In order to set up an ex-ante risk model, the distribution of past returns can demonstrate a general pattern. There are several studies analyzing the returns of new ventures on a direct or indirect fund level; findings are diverse, but reveal similar patterns.

Early studies determined that venture capital can generate very high average annual returns of 24,4%. The standard deviation of return is high at 51,2%. Therefore, venture capital investments were considered to be more risky than small to medium size stocks (Chiampou & Kallett, 1989). Venture capital funds analyzed by Bygrave and Timmons (1992) demonstrate an average IRR of 13,5% for 1974-1989 in the US. Barry et al. (1998) shows that venture capital is highly correlated with small company stocks, whereas the correlation with large stocks and bonds is low.

However, there are several downsides regarding the methodologies of these findings. Research demonstrates that if normality is imposed on venture capital investment returns, downside risk and kurtosis is understated due to the highly skewed risk profile. Thus, volatility or variance as an estimate of risk neglects the magnitude and frequency of large, negative returns of VC investments. Therefore, it is proposed that investors should consider additional moments and semi-variance or downside risk when an investment decision is made

(Ewens, 2009). The downside beta based on semi-variance proves to be a more appropriate measure of risk especially for diversified investors of small and private companies (Bali, Demirtas, & Levy, 2009; Estrada, 2004, 2007, 2008).

Furthermore, data concerning VC investments are very often reported on VC fund level which reduces statistical power and limits the analysis of single new venture investments. Valuations of single companies are observed only occasionally, and even then, data of well-performing new ventures are more frequently available, which distorts the empirical results of new ventures' actual risk (Cochrane, 2005; Korteweg & Sorensen, 2010).

Moreover, research often uses the funds allocated to the limited partners as a means to estimate the risk and return of business angel, VC, and private equity investments (Driessen, Lin, & Phalippou, 2008; Gompers & Lerner, 1997; Jones & Rhodes-Kropf, 2004; Kaplan & Schoar, 2005; Ljungqvist & Richardson, 2003; Phalippou & Gottschalg, 2009). One problem with this procedure is that the aggregated cash flows do not allow analysis on an industry, portfolio company, or shorter time periods than the typical investment periods of 10 to 13 years. Last, if data of young private firms are not available, information of transaction and trading figures of similar and young, yet more mature, firms is frequently the first approach used (Cochrane, 2005). However, there are exceptions regarding selection bias and detailed new venture data.

Cochrane (2005) measures the risk-return profile of VC investments by correcting the selection bias through a maximum likelihood estimation, which reduces biased results. Without the adjustment, the arithmetic rate of return of IPOs or acquisitions is 698%. The standard deviation is 3.282%. Moreover, the distribution of returns is expressed by significant skewness leading to a high number of total losses. Many firms have a modest return of around 100%, and only a few have return above 1.000%. This distribution can be explained by a lognormal distribution. However, the log returns are still high with a mean of 108% and a standard deviation of 135%. Using the CAPM in order to determine an arithmetic alpha leads

to 462%. If it is accounted for a selection bias, the findings are much lower. The estimated average log returns are 15% per year compared to the 108% determined by the previous sample. The mean rates of return are 59% rather than 698%. Moreover, the alpha is about 32% compared to 462%. Last, the standard deviation of arithmetic returns is 107%, which is much lower than the previous finding of 3.282% (Cochrane, 2005).

Korteweg and Sorensen (2010) use individual new ventures and address the dynamic selection problem, i.e., valuations are only observed if the new venture receives a new financing round or if there is an exit. These events occur more often when successful new ventures are analyzed. It is shown that correcting for this selection bias leads to much higher estimates of both systematic and idiosyncratic risk, and decreases the returns. Compared to Cochrane's (2005) betas of below 1.0, the betas found have an average of 2,8 and are permanently above 2,2.

Apart from returns to venture capital-backed young firms and VC funds, the investment returns to business angels can give an additional profound insight into the risk return relationship and figures of new ventures. Similar to venture capital investments, the returns of business angels are highly skewed, with 34% of the exits being a total loss and 13% with a break-even or fractional loss. Interestingly, 23% of all investments represent an IRR of 50% or above and only 10% exceed the 100% level (Lumme, Mason, & Suomi, 1998). A more recent study of business angel investments in young technology-based firms confirms that the performance is negatively skewed in a manner similar to general VC investment analyses. 32% of all technology investments result in a total loss; 4% are partial losses and 15% reach breakeven in nominal term or are lower than the required cost of capital of 10%. In contrast, only 13% generate an IRR over 100%. Thus, investments by business angels in technology firms are not expected to involve a higher risk of loss than new ventures in non-technology sectors. Interestingly, technology firms generate a marginally rate of success, i.e., investments with an IRR of 50% plus account for 28% within the group of technology firms versus only

21% within the group of non-technology new ventures (Mason & Harrison, 2004). Thus, investments made by business angels demonstrate parallels to risk-return profiles of venture capital investments (Mason & Harrison, 2002).

Based on this empirical evidence and the theoretical findings, it can be argued that a proper cost of equity model for new ventures must consider risk of the first kind and one-sided risk methods like downside risk based on semi-variance in order to represent the characteristics of the risk profile of new ventures (Ewens, 2009).

4.2 Idiosyncratic Risk

4.2.1 Relevance for the Venture Capitalist

When analyzing VCs and the exposure to idiosyncratic risk, it is important to not confuse with limited partners of venture capital funds, which are fully-diversified. VCs have a portfolio of new ventures. One risk reduction strategy is to diversify idiosyncratic risk through including several new ventures in a portfolio (Ruhnka & Young, 1991). Hence, there is a distinction between asset risk and portfolio risk. It is described by Bodie et al. (2005) as follows. Diversification can be quantified through covariance and correlation. The covariance determines to what extent the return on two risky assets move simultaneously, i.e., a positive covariance means that the assets move in the same direction (Bodie et al., 2005; Merton, 1973).

Although, portfolio diversification is a strategy of VCs in order to control risk exposure and reduce idiosyncratic risk, it is argued that VCs often invest in few new ventures and are less diversified. Therefore, risk-reducing instruments like specialization should be favored compared to portfolio diversification (Norton & Tenenbaum, 1993). The positive influence of specialization on VC success is also confirmed by more recent studies (Gompers, Kovner, & Lerner, 2009). Higher diversification by industry decreases the VC fund performance. By contrast, diversification by region increases performance (Cressy, Malipiero, & Munari,

2012). Last, diversification by stage does not have a significant influence on risk-reduction strategy (Manigart et al., 2002).

Hence, for this study, it is important to know if the VC is exposed to idiosyncratic risk. Research shows that private owners and investor are under-diversified and demand compensation for this higher risk taken (Müller, 2010; Pattitoni, Petracchi, & Spisni, 2010; Schivardi & Michelacci, 2010). Additionally, empirical research reveals that entrepreneurial ownership shares lower with firm risk and heighten with external wealth (Bitler, Moskowitz, & Vissing-Jørgensen, 2005).

VC can be compared partly to private investors. Investors of new venture funds want to align the incentives of VCs. VCs commit a significant part of their net wealth to their own funds raised. This leads to a personal portfolio, which is not well-diversified (Kaplan & Schoar, 2005). Their fixed compensations are also limited as they are incentivized by performance-dependent measures, such as carried interest (Jones & Rhodes-Kropf, 2004). Moreover, identifying and assessing potentially successful new ventures requires a significant amount of time from the VC. This means that he or she will only invest in a small number of new ventures, which creates a lack of diversification. In general, venture capital firms invest in less than two dozen firms per fund (Gompers & Lerner, 1999). This exposure to underdiversification is increased even, if VCs are specialized and only invest and participate in new ventures within a certain industry (Jones & Rhodes-Kropf, 2004). Based on these arguments, it can be assumed that VCs themselves are exposed to idiosyncratic risk, which requires compensation through higher costs of equity as no market participant is able to diversify this unsystematic risk. This leads to the relevance of total risk.

Empirical research also proves the exposure of VCs to idiosyncratic risk. On the venture capital fund level, there is proof that idiosyncratic risk is relevant for the required rates of return. The relation between unsystematic risk of a fund and the fees returns is positive. Compensation for the idiosyncratic risk taken is accomplished by contractual terms with the

investors of the fund. Therefore, a higher required rate of return is applied, if the VC invests in a new venture with high idiosyncratic risk (Jones & Rhodes-Kropf, 2004). Müller (2010) complements this insight by adding a direct measure of exposure to unsystematic risk.

4.2.2 Types of Idiosyncratic Risk

There are several risk factors contributing to idiosyncratic risk. The most important ones discussed and analyzed in financial research are briefly described in the subsequent paragraphs. Idiosyncratic risk influences the stock value as well as the cost of equity and is related to firm-specific attributes. One of these characteristics is the size of the company known as size effect. Alberts and Archer (1973) already hypothesizes and proves that the cost of equity of small industrial corporations is greater than that of their larger counterparts. They show that the relation riskiness and size is negative. This implies relation, which is negative between size and cost of capital (Alberts & Archer, 1973). Banz (1981) also proves that the size of a company estimated by market capitalization gives insights into the cross-section of expected rates of return, i.e., large companies have smaller returns than small companies. That effect is still evident after adjusting for systematic risk. Additional studies confirm this effect for stocks in the U.S (Chan, Chen, & Hsieh, 1985). The size effect was corroborated in 1996 by the three-factor model of Fama & French (1996), which challenges the validity of the classical CAPM. Size is also relevant for VCs. It is shown that they require higher rates of return when investing in new venture at an earlier stage (Manigart et al., 2002). The smaller size of the new venture might accompany other high risk factors at that stage.

Analyzing unsystematic risk, the effect of control is diversely discussed (Dyck & Zingales, 2004). A majority shareholding in a company bears less risk than a minority share as a major shareholder possesses privileges regarding control and restructuring. Thus, the control interest consists of a control premium compared to the minority interest (Pereiro, 2001). Due to the large stake and the contractual control rights acquired, the effect of control certainly also has an impact on the cost of equity demanded by the VC.

In addition to control, liquidity or marketability can play an important role. This means how easy an asset can be sold. There is evidence that illiquidity substantially reduces market prices (Keene & Peterson, 2007). An investor with a long-term investment approach requires a smaller premium for illiquidity than a short-term investor. This is analyzed via the bid-ask spread (Amihud & Mendelson, 1986; Eleswarapu & Reinganum, 1993). A turnover factor in the form of dollar volume of trading also proves that liquidity of stocks has a positive influence on stock prices and consequently cost of equity (Brennan, Chordia, & Subrahmanyam, 1998; Chan & Faff, 2005). Amihud (2002) and Pastor and Stambaugh (2001) use alternative empirical methods to analyze the different aspects of liquidity and the role of market liquidity risk. Amihud shows that expected excess returns are partly a premium for stock illiquidity. Pastor and Stambaugh prove that smaller stocks are less liquid as well as more sensitive to their measure of aggregate liquidity. Nevertheless, there are scholars that show that liquidity has no significant influence on costs of equity of listed firms or that find inconsistent results, i.e., no models capture the liquidity premium or stock characteristics do not serve as proxies for liquidity (Fama & French, 1993; Nguyen, Mishra, Prakash, & Ghosh, 2007). However, the distinct effect of liquidity and its independence with regard to other determinants of stock returns are non-controversial (Nguyen et al., 2007).

Similar results occur when investigating shares of private or public companies in emerging markets that are even less frequently traded. An owner of a private company faces difficulties finding new shareholders. Thus, the shares are less marketable or liquid that reduces their value compared to those of listed companies; in fact, market prices of closely held companies might be 30% less than public companies (Pratt, 1989). Liquidity or marketability poses a problem to the application of the CAPM as the level of liquidity of the asset is not considered (Chan & Faff, 2005; Lerner & Schoar, 2004; Scott, 1992). The CAPM presumes that there are no transaction costs. As, in reality, there are some transaction costs, illiquid assets have higher costs. Therefore, an illiquidity premium is demanded and comprised in the price of each asset

(Chan & Faff, 2005). The private market of venture financing is also considered illiquid, i.e., there is an exit risk. With only a few players and volatile trade sale and IPO situations, shares of new ventures cannot be easily sold by the VC. In this context, transaction costs play an important role (Lerner & Schoar, 2004). Moreover, it has been proven that illiquidity risk matters as VCs try to shift this risk. During periods with fewer IPO opportunities, VCs rather invest in early stage companies. If the IPO market situation improves, it is focused on later stage new ventures (Cumming, Fleming, & Schwienbacher, 2005). Therefore, the illiquidity of the new venture shares certainly influence the required rate of return of the VC.

As shown in a context with private firms, idiosyncratic matters. However, there are much more risk factors of a new venture than just size, illiquidity, and control, which account for idiosyncratic risk. Therefore, the risk factors of new ventures must be analyzed in detail.

4.3 Applied Cost of Equity Models

New ventures are risky and tie the money of investors for several years with no easy means of exit. It is therefore a widely accepted perception that the required returns must be very high due to the high risk borne. Target rates of return of 50% to 60% are not uncommon (Roberts & Stevenson, 1992). Others argue that risk is directly associated with required returns. That being the case, VCs require that young companies with a developed product and proven management team accrue a rate of return between 35% and 40%, and 60% of annual compounded returns for incomplete new ventures (Gumpert & Rich, 1999). Timmons (1994) gives a more detailed summary of expected rates of return according to stage. Nevertheless, the numbers reported by VCs do not greatly deviate from the previously described high results. However, it should be noted that when analyzing the actual average returns for investing in new firms, much lower rates of returns are found averaging around 13% (Smith & Smith, 2003). This is puzzling as the very high rates of return that VCs demand for the risks they are “apparently” taking deviate a great deal from the actual returns received (Cochrane, 2005). In an international comparison, in the Netherlands and Belgium, investors

apply the lowest required return rates for every development stage. The highest rates are applied in the Anglo-American countries, such as the U.S. and U.K. (Manigart et al., 2002; Manigart, Wright, Robbie, Desbrieres, & Waele, 1997).

Still, there has been little research on how these subjective required rates of return are determined by the investors. Corporate-wide benchmarks are often set as standard and then applied to all potential investments, but they lack a theoretical and procedure-orientated rationale (Smith & Smith, 2003). Moreover, were there a theoretical background, it would require historical information, which is difficult to obtain for young firms. In practice, rates of return are increased if the perceived subjective risk of a new venture increases (Manigart et al., 1997). This begs the question of, how these high required rates of return are calculated or derived from a methodical perspective.

Empirical studies have analyzed which cost of equity method is most frequently used by investors of private firms. The CAPM is applied by 71% of all investors, followed by 46% of investors who rely on personal experience from previous transactions or on estimation from their clients. To determine of the beta factor, the majority of investors (68%) estimate it from peers. Only 32% base their beta calculations on fundamental drivers expected to influence operational and financial risk. A large percentage (56%) determines the beta factor by considering previous experience. These results prove that investors do not solely rely on one single method; rather, they use two or more methods and compare or combine results (Petersen et al., 2006). Unfortunately, these studies lack an analysis of how the input variables, e.g., volatility or beta factors, are determined by the investors in order to calculate the rates of return. Cost of capital or equity models consist of parameters consolidated in a formula and input variables that are dependent on certain data. Therefore, each new venture is supposed to have its individual and customized cost of equity as a compensation for the risk assumed and time value of money (Brealey et al., 2000). However, as described above, VCs often apply pre-defined benchmark IRRs, target cost of equity values, or just “gut feeling”

estimations to potential investments without relying on any theoretical foundation (Manigart et al., 2002; Manigart et al., 1997; Smith, 2009; Smith & Smith, 2003; Wright & Robbie, 1997).

When discussing a theoretical rationale, it is assumed, for now, that the conventional CAPM is a reasonable estimation for the rates of return investors require for a new venture. This method is applied by the majority of investors of private firms (Petersen et al., 2006). Its assumption relies on a diversified portfolio of new venture investments. New ventures certainly bear high risk. As the CAPM deals only with systematic risk, i.e., non-diversifiable risk matters, it seems that a large part of the risk of new ventures might be related to firm-specific aspects and is therefore diversifiable. Thus, total risk might be high, whereas beta or systematic risk can be low. Beta risk depends on market wide fluctuations, whereas the firm-specific part of total risk does not. For example, research has shown that the beta of public biotechnology ventures was on average 0,75. Even with beta values between 1,0 and 2,0, CAPM would calculate rates of return between 13% and 22%. However, VCs apply rates in excess of 50% to biotechnology ventures. Even equity premiums such as illiquidity of new venture shares do not justify these discrepancies. This illustrates the contradiction between theoretical models and practical applications (Reid & Smith, 2003; Smith & Smith, 2003). VCs either apply the CAPM incorrectly including diversifiable, i.e., firm-specific risk, or only consider certain aspects of the new venture risk profile. Some investors might be more diversified than others, leading to different required rates of return. Specialization definitely plays an important role in this context (Norton & Tenenbaum, 1993). However, resource-based theory predicts an opposite result. The firm is characterized as a collection of intangible and tangible resources (Barney, 1991). By gaining detailed knowledge in a sector or industry, the VCs specialize. That reduces risk and results in a lower rate of return required. This is also confirmed by empirical evidence contradicting conventional finance theory (Manigart et al., 2002).

Moreover, it is argued that new venture investments cannot be compared to listed companies. There must be an adjustment to the cost of equity due to illiquidity and control. Research on the valuation of non-listed private firms recommends adjustments of the cost of equity for the lack of liquidity, i.e., marketability and ownership control (Pratt & Niculita, 2007; Pratt, Reilly, & Schweihs, 2000). A controlling interest is worth more than a small stake as it adds value, meaning that the company might be run more efficiently, resulting in higher returns (Damodaran, 2005b). A liquid financial asset is attractive as it can be sold quickly in exchange for money with minimum transaction cost. The illiquidity premium for private companies is determined to be 1,1% higher than for those of liquid stocks (Acharya & Pedersen, 2005). An alternative study analyzes that illiquid stocks have an excess annual return of 3,25% compared to their liquid counterparts (Datar, 1998). Latest research (Petersen et al., 2006) investigates these premiums and discounts for privately held companies and reaches to the following conclusions:

Table: 1 Marketability discount, illiquidity premium, and control premium for private firms

<i>Marketability Discount</i>			
	Average	Median	Std. Dev.
Dependent	25,0%	22,5%	8,9%
Independent	33,8%	30,0%	11,6%
Private equity	35,0%	30,0%	14,1%
Total	31,3%	30,0%	11,8%

<i>Illiquidity Risk Premium</i>			
	Average	Median	Std. Dev.
Dependent	2,6%	2,0%	1,6%
Independent	3,0%	2,0%	1,6%
Private equity	3,3%	4,0%	1,2%
Total	2,8%	2,0%	1,5%

<i>Control Risk Premium</i>			
	Average	Median	Std. Dev.
Dependent	25,0%	25,0%	7,1%
Independent	50,0%	50,0%	na
Private equity	27,0%	30,0%	4,5%
Total	29,4%	30,0%	9,4%

Apart from CAPM-based and non-CAPM-based cost of equity models applied to listed or private companies, there are some research approaches, which analyze new ventures in a different way. VCs and entrepreneurs very often rely on subjective assessments of the financial viability of their new ventures in which they invest (Cheung, 1999). Thus, scholars have mentioned that if a valuation of a new venture's cost of equity cannot be based on its output, it might be useful to calculate it based on its input. These inputs include different risk factors. For doing so, certain decision aid systems are recommended (Cotner & Fletcher, 2000; Ge, Mahoney, & Mahoney, 2005). An alternative suggestion is that the required return can be determined by the probability of success for similar businesses. These rates of return can be used as a minimum hurdle rate in order to value the viability of the firm under consideration. As this approach relies on risk neutrality, the rate of return derived shall be regarded as a minimum return required by risk-averse VCs (Cheung, 1999). Nevertheless, these few approaches lack a theoretical foundation of a comprehensive decision making model.

Furthermore, there is little research on methods regarding the determination of the level of risk of new ventures. Risk measures, like the beta factor of the CAPM, are the prevailing factors of influence in most cost of equity models. Instead of using a venture-specific approximation, rules of thumb methods, such as using the stock market volatility plus a fixed premium, or public market equivalents are applied (Long & Nickels, 1995). The accuracies of these substitute measures depends on the real comparability (Emery, 2003). Research shows that measuring new venture risk directly, i.e., analyzing a particular new venture and its prospective risk level, reveals that the true levels of risk are generally twice as high when compared to naïve measures (Woodward, 2009).

In conclusion, it is shown that VCs apply cost of equity models, which cannot lead to the high rates of return required as only systematic risk is often considered while the actual rates of return achieved cannot provide an explanation for the high rates of return required. If it is

implied that VCs shall use a CAPM-like method in order to calculate their actual costs of equity, further analysis with regard to risk and decision making is necessary.

4.4 Important Implications for this Study

Sections 3 and 4 have revealed several important insights for the development of a cost of equity and risk model for new ventures. The findings are discussed in this section.

Regarding conventional cost of equity models, the CAPM is certainly the most widely used model (Pratt & Niculita, 2007). However, there are several critical practical aspects when applying beta based models in order to determine the cost of equity of new ventures. There is evidence that the CAPM does not completely describe the returns. For example, the CAPM underestimates the returns of small firms (Banz, 1981; Reinganum, 1981, 1983), which is relevant for new ventures. Additionally, the return on value shares is greater than the return of growth shares if the CAPM is used as a benchmark (Lakonishok, Shleifer, & Vishny, 1994).

Liquidity poses also a problem to the CAPM approach (Chan & Faff, 2005; Lerner & Schoar, 2004; Scott, 1992). The level of liquidity of the asset is not considered in the CAPM. Venture investments are not traded on the stock exchange and are therefore illiquid (Sahlman, 1990). This influence on venture capital investments with regard to cost of equity needs further consideration. The beta factor, expressed through the standard-deviation and covariance, assumes symmetric distributions of return of the companies. With a high amount of losses and skewed return distribution, the risk profile of new ventures deviate from this notion (Korteweg & Sorensen, 2010).

The correct determination and application of the beta factor can be criticized. The beta factor as a measure of risk has several basic characteristics. The first is that it calculates the risk as additional factor to a diversified portfolio. That means it does not represent total risk, but only systematic risk. It is assumed that only systematic risk matters for the investor. This is true for the CAPM as well as the factor models described (Armitage, 2005). As shown, idiosyncratic

risk is relevant for VCs (Müller, 2010). Therefore, the level of diversification is decisive as an investment can be very high regarding individual risk, but low regarding market risk.

Another characteristic is that the beta factor determines the relative risk of an investment. Therefore, it is standardized around one (Damodaran, 2000). The practical measurement of the beta factor involves the choice of a market index. However, there are no indices, which include all assets traded and that might even come close to the market portfolio required by the theoretical assumptions of the CAPM. In emerging markets, these indices often include few stocks and tend to be even narrower. Moreover, the choice of time period can represent a problem. Risk and return models, like the CAPM, are silent on the time period used to estimate beta. If the investors uses periods further in the past, there are more observations for the regression model.

However, relying on historical data poses two problems in a new venture context. Firstly, an extrapolation of past data assumes that the future can be predicted based on the past. Secondly, if past data is not available due to missing information or a total lack of historical track record, this method cannot be applied. This is the case for new ventures. Betas cannot be easily observed or determined as the shares are not publicly and frequently traded (Damodaran, 2005b; Petersen et al., 2006). Moreover, the problem is that older data might not represent the current risk of the firm as its characteristics might have changed over time. This is especially true for new ventures (Timmons & Spinelli, 2009). New ventures adjust their business mix, i.e., they acquire new businesses, extend their product portfolio, and invest in new technologies. This leads to a change in their beta. Second, the financial leverage of new ventures alters with increasing maturity or environmental impact. This includes the paying off debt, buying back their own stocks or changing market values of equity or debt. Thirdly, new ventures grow over time. This leads to changes in their operating cost structures resulting in changes in the betas (Damodaran, 2000). Due to these changes, there are relative risk measures developed, which do not require historical prices and that focus on the future. They

are comprised of the relative volatility and the accounting beta. However, the drawback of the accounting beta is that accounting figures used do not correlate with the value of the firm. That is why simple bottom-up beta approaches are proposed (St-Pierre & Bahri, 2006). Furthermore, the choice of a return interval is challenging. Using shorter intervals increases the number of values in the regression model. However, as assets of new ventures are normally not traded continuously, the beta estimation can be affected (Smith & Smith, 2004). Interestingly, it is shown that the cost of equity models, which deliver reasonable results in developed stock markets, cannot be applied to segmented emerging markets. With high volatility, little liquidity, and few stocks traded, alternative cost of equity models adjusted for these conditions provide better risk-return estimations. There are several attempts to compute the beta factor of private companies in emerging markets, which have to deal with these challenges as well. The main approaches are summarized in the figure below (Pereiro, 2001).

Table: 2 Approaches to determine the beta in emerging markets

	There are listed comparables in the emerging market	There are no listed comparables in the emerging market
Maximum singular approximation approach	<p>A.</p> <ol style="list-style-type: none"> 1. Choose comparable company through detailed structural analysis of risk and cashflows 2. Obtain the levered company beta from a financial information service 3. Compute unlevered beta of comparable 4. Re-lever the beta with the D/E ratio of the target company 	<p>B.</p> <ol style="list-style-type: none"> 1. Compute the target company's accounting beta and test its statistical significance 2. Use comparable U.S. company <ol style="list-style-type: none"> 2.1. Choose company 2.2. Follow steps 2 to 4 in quadrant A
Maximum Sector Approximation Approach	<p>C.</p> <ol style="list-style-type: none"> 1. Choose sector 2. Obtain unlevered betas for companies in the sector 3. Compute sector beta <ul style="list-style-type: none"> - Sector median - Market cap-weighted average 4. Re-lever the beta with the D/E ratio of the target company 	<p>D.</p> <ol style="list-style-type: none"> 1. Compute sector accounting beta and test statistical significance 2. Use comparable U.S. sector <ol style="list-style-type: none"> 2.1. Choose comparable sector 2.2. Obtain unlevered sector beta 2.3. Re-lever the sector beta with the D/E ratio of the target company

Despite the four approaches, the problem remains that sectors or comparable companies are chosen as proxy for the company analyzed. The only firm-specific adjustment made is the capital structure. Therefore, firm-specific characteristics, which influence the beta factor, are

neglected. The underlying assumptions allow drawing parallels between the new venture markets and emerging markets. Therefore, with similarities expected, these models must be analyzed in more detail.

Apart from the beta factor, multi factor cost of equity models, such as the APT and the Fama French 3 Factor Model, incorporate several risk factor, but also concentrate on symmetric systematic risk only. This poses a problem to the application of new ventures. Moreover, a major disadvantage of these models is that the factors determining risk are not based on a theoretical foundation. Hence, the analysis of all risk factors of new ventures is important for this study in order to derive an appropriate cost of equity model.

Regarding the insights of behavioral finance, it can be concluded that it is necessary that cost of equity models of new ventures need to specify the type of irrationality of VCs. It is argued that subjective risk should be considered in incomplete markets, like emerging markets and venture markets (Statman et al., 2008). Regarding entrepreneurial finance and risk, a point is made that a behavioral finance approach is important and financial decision making should be analyzed from a behavioral perspective (Yazdipour, 2009). Venture markets are certainly not well functioning due to their opaqueness even in the most mature markets, as in the U.S. This opaqueness leads to increased risk for all actors involved and highlights the role of perception. Perception asymmetry as a counterpart to the traditional information asymmetry in standard finance is introduced (Yazdipour, 2009). It is claimed that the perception of risk of VCs are shaped by elements of prospect theory (Kahneman & Tversky, 1979) and affect theory⁶ (Mellers et al., 1997; Slovic, Finucane, Peters, & MacGregor, 2007). Based on these assumptions, total perceived risk comprises two objective and subjective components – residents risk plus/minus behavioral risk. Resident risk is considered as the risk that actually resides or natives in a given business opportunity, without which the risk of the opportunity

⁶ Affect theory claims that subjective impressions of goodness and badness can function as heuristic which cause fast perceptual judgments. For example, stocks which are perceived as good are judged as low risk and high return assets, whereas bad stocks are judged as low return and high risk assets (Mellers, Schwartz, Ho, & Ritov, 1997).

would be zero. The determinants of resident risk include market risk factors, management risk factors, and many more. By contrast, the behavioral risk element is determined by editing, evaluating, and affect processes. As described, it can either increase or decrease total risk. However, it is very difficult to be quantified as it is automatically and often unknowingly constructed by the decision maker involved. The determinants of behavioral risks are the framing processes, evaluation processes, affective processes, and other non-affect processes like overconfidence, availability and other biases (Yazdipour, 2009). In general, it can be argued that aspects, such as biases, risk perception, heuristics, affects, and emotions, should be included into appropriate risk and cost of equity models for VCs respectively. As this dissertation concentrates on entrepreneurial finance, behavioral criteria related to these fields of research are considered in the subsequent sections of decision theory.

Last, it can be argued that there are no venture-specific cost of equity and risk models developed and that the conventional cost of equity models are applied in an inappropriate way by VCs leading to incorrect results. These insights highlight the purpose and research contribution of this study.

5 New Venture Risk Factors

5.1 *Internal and External Risk Factors*

In general, new venture risk can be classified into agency risk, i.e., internal risk, and business risk, i.e., external risk.⁷ VCs must deal with four generic agency problems during their investment in a new venture:

(1) The VC is uncertain about the effort the entrepreneur contributes to the new venture after the investment is made. This causes moral hazard. Prior to the investment, the entrepreneur's effort cannot be observed and must be predicted. Therefore, the VC should link the entrepreneur's compensation to the performance of the new venture (Holmstrom, 1979).

(2) The entrepreneur has profounder insight into his or her own ability and quality than the VC. The VC can implement certain contractual terms, like greater pay-for-performance or liquidation rights, in order to screen for excellent entrepreneurs and bind them to the new venture (Diamond, 1991).

(3) After the investment, the VC might have to face disagreements with the entrepreneur. Control theory shows that in some cases the VC should have control, while in other cases, the entrepreneur should dominate the decision making (Dessein, 2005).⁸

(4) There is a hold-up agency problem for the VC. The entrepreneur can threaten to leave the new venture. Vesting is a common contractual term in order to deal with this issue (Hart & Moore, 1994) and elicit information ex-ante (Bouvard, 2010).

Therefore, agency risk results from an incomplete alignment of incentives between a principal and an agent (Reid & Smith, 2003). There is a relative lack of knowledge concerning observable business risk, as investors have tried to specialize and concentrate on the

⁷ Credit risk is regarded as the possible loss due to counter-party defaulting on a signed contract such as bonds and debt (Embrechts et al., 2009). This type of risk is not often relevant to venture investors in this study.

⁸ Disagreement risk is excluded from this analysis. It is assumed that the VC either enforces control or rejects the investment.

controllable area of risk – agency risk (Sapienza, Korsgaard, Goulet, & Hoogendam, 2000). In an VC-entrepreneur-relationship, the VC can be seen as principal and the entrepreneur as agent with facing the challenges of moral hazard and adverse selection, which can be observed in a principal-agent setting (Chen & Steiner, 2000; Kaplan & Stromberg, 2001; Sapienza et al., 2000). However, these challenges can be addressed through due diligence or contractual monitoring and control systems (Hand, 2005; Sapienza & Timmons, 1989). Although both parties will attempt to reduce agency risk in order to increase venture valuation (Reid & Smith, 2007), some level of information asymmetry will remain, increasing the difficulty of estimating the level of risk (Reid & Smith, 2008). Business risk arises as it is not possible to estimate the prospective value of a new product in the competitive marketplace. It includes operational risk, which is, in financial and banking contexts, the loss due to problems with people, internal processes, or external events (Embrechts et al., 2009). While neglecting agency risk, principal and agent have a common interest in dealing with business risk. Thus, if agency problems are efficiently managed, the interests of investor and entrepreneur are well-aligned (Reid & Smith, 2003). Business risk includes high innovation risk caused by the ignorance about the value new technologies can attain (Reid & Smith, 2001). As this type of risk is especially relevant for new ventures, it is briefly described in the next paragraph.

When examining high technology ventures in particular, they are considered as negative investments due to their complexity and high risk rather than as positive in terms of high potential returns to the investor (Lockett, Wright, Sapienza, & Pruthi, 2002; Murray, 1996). In general, the returns of these new ventures are highly skewed, with only 40% of the firms generating positive profits and a median realized return, which is negative (Astebro, 2003). Moreover, returns of technology ventures have consistently underperformed compared to those in non-technology ventures (Mason & Harrison, 2004). That is why technology is still considered a greater risk factor than stage of investment; it is considered to represent an unattractive risk-reward equation for the investor. Therefore, investors require a higher

projected return on investment (Murray & Lott, 1995). When analyzing the potential threat of technology ventures, several specific sources of risk can be identified (Mason & Harrison, 2004). Technological risk involves unexpected delays in R&D activities, non-functioning of the product itself, and better substitutes by competitors (Koellinger, 2008). In order to specify the relevance of single new venture risk factors for VCs, a detailed analysis of the risk factors impacting VCs during their investment decision is given in the next section.

5.2 Investment Criteria as Risk Factors

A closer look at the risk factors of new ventures and their relevance for VCs is taken by an analysis of the investment decision criteria of VCs. Risk factors can be derived by analyzing criteria influencing the performance of new ventures. Entrepreneurial firms have been subject to extensive research for decades and several studies about success and failure have been conducted, e.g., Roure and Keeley (1990) and Song, Podoyntsyna, van der Bij, and Halman (2008). Academics examining this topic come from these theoretical backgrounds and take the following approaches:

- Analysis of the pure product or degree of innovation (Cefis & Marsili, 2006; Koellinger, 2008; Robinson, 1990; Stuart & Abetti, 1987)
- Focus on the management process or the entrepreneur (Colombo & Grilli, 2005; Haber & Reichel, 2007; Hsu, 2007; Man, Lau, & Chan, 2002; Teal & Hofer, 2003; Van de Ven, 1980)
- Analysis from a strategic perspective (Ge et al., 2005; Keeley & Roure, 1990; Sandberg & Hofer, 1987; Shrader & Siegel, 2007)
- Exploratory studies (Mason & Harrison, 2004; Roure & Maidique, 1986)
- Indirect analysis of VCs' and BAs' investment criteria (Franke et al., 2008; Hall & Hofer, 1993; Kaplan & Stromberg, 2000; Khan, 1987; MacMillan, Zemann, & Narasimha, 1987; Ruhnka & Young, 1991; Shepherd, 1999a)

An indirect analysis shows that the risk factors of a new venture investment can be expressed through the investment decision criteria used by VCs (Riquelme & Rickards, 1992; Ruhnka & Young, 1991; Shepherd & Zacharakis, 2002). The criteria applied to assess potential investments have been the subject of research for more than forty years (Petty, 2009), an ongoing interest that is due to its relevance for entrepreneurs and VCs. First, knowing the evaluation criteria of investors increases the chance of obtaining funding and enables a better assessment of one's own venture project. Second, investors gain an aggregated insight into the most pertinent investment criteria and can compare their own criteria with that of their peers (Franke et al., 2008). Initially, lists of factors regarded important to investors were developed (Hoban, 1978; MacMillan, Siegel, & Subba Narasimha, 1985; Tyebjee & Bruno, 1984; Wells, 1974). Most recent research focuses on more detailed decision-making criteria and the use of decision aids (Zacharakis & Meyer, 2000; Zacharakis & Shepherd, 2005). The criteria assumed to be relevant in the assessment process of VCs are mainly categorized by (a) the company's entrepreneur or management team, (b) the product or service, (c) the market, and (d) the new venture's financial potential (Franke et al., 2008; Riquelme & Rickards, 1992; Zacharakis & Meyer, 2000). Each of these categories is further divided into more specific factors (Petty, 2009).

VCs weigh the investment criteria, i.e., the risk factors of a new venture, during their investment process. If risk factors are evaluated more generally without analyzing specific new ventures, the assessment is based solely on the past experience of the VCs (Ruhnka & Young, 1991; Shepherd & Zacharakis, 2002). This provides insights into the general relevance of risk factors without consideration of venture-specific influences. However, in this case, VCs rely on their own implicit theories with regard to success and risk factors of new ventures. The empirical results represent the impact perceived by the VC, which might not represent reality; hence, it is necessary to know these factors are similarly relevant to actual risk. Research has analyzed this issue and proven that the belief held by VCs as to

investment criteria are associated with the risk factors determining total risk (Riquelme & Watson, 2002). Previous studies on this topic also generally confirmed the importance of certain key investment decision criteria on new venture success and risk (MacMillan et al., 1987; Meyer, Zacharakis, & De Castro, 1993; Roure & Keeley, 1990; Sandberg & Hofer, 1987; Shepherd, Zacharakis, & Baron, 1998). Therefore, it is argued that analyzing the investment decision criteria of VCs is a valid approach⁹ to gaining insights into new venture risk factors and their impact on risk. Moreover, an international perspective is relevant as the impact of risk factors might differ from one region to another.¹⁰ To derive an overview of the risk factors of new ventures, a literature review is conducted and meta-analysis of the empirical results found is elaborated.

5.2.1 The Entrepreneur

Nearly without exception, the entrepreneur or start-up team are the prime focus of VCs when evaluating an investment proposal and its risk (Baum & Silverman, 2004; Franke et al., 2008). The appraisal becomes a challenging endeavor for the VC, made more so by the complexity of an ex-ante observation (Gorman & Sahlman, 1989). Its importance is related to the great influence the entrepreneur has on the new venture in the first phase of development and the new venture success (Churchill & Lewis, 2000). Founders of successful firms must possess the right experience and abilities, which reduce the risk for VCs (Feesser & Willard, 1990). As many studies analyzing the entrepreneur as an investment criterion of VCs are based on the study of MacMillan et al. (1985), the criteria described in the subsequent paragraphs are divided accordingly into personality and experience criteria.

⁹ This approach is chosen as the studies published in this field of research are often homogeneous in terms of empirical methods. Using the same investment evaluation criteria developed and applied to venture investors in the USA by MacMillan et al. (1985), several studies were replicated in other countries (e.g. Dixon, 1991; Pandey, 1995; Ray, 1991) which makes a comparison feasible. On a comparative and international level, the methodology and the objects of studies have not differed to a large extent until conjoint analysis was used more frequently (Franke et al., 2006, 2008; Shepherd, Ettenson, & Crouch, 2000).

¹⁰ There are studies such as Song et al. (2008), which elaborate a meta-analytic analysis of success or risk factors of new ventures. However, these investigations either do not focus on regional differences or concentrate on only one specific risk factor.

When taking a closer look at the entrepreneur as an investment criterion, personality theory confirms the importance of personal predispositions for new venture success (McClelland, 1965). Entrepreneurship theorists have shown that tenacity and proactive initiatives also foster new venture success (Chandler & Hanks, 1994; Chandler & Jansen, 1992). Smilor (1997) regards passion as one of the major factors in successful entrepreneurship. VCs have a similar perception (Sudek, 2006). When a VC assesses a new venture, they analyze several criteria with regard to the entrepreneur's personality.¹¹ They primarily analyze skills in the form of analytical competencies, managerial, technical and marketing skills as well as ability to interact with other people (Khanin et al., 2008). Good social skills require a degree of trustworthiness, which is also relevant to VCs (Baron & Tang, 2009). Levels of motivation, the ability to put forth intense effort, and attention to details are also evaluated. The criteria related to the entrepreneur's personality are perfected by the appropriate personality for business and the ability to react to and assess risk (Macmillan et al., 2002).

Apart from the entrepreneur's personality, scholars have argued that it is important to consider the "assets" and "liabilities" of an entrepreneur's past experience (Starr & Bygrave, 1991a, 1991b; Starr, Bygrave, & Tercanli, 1993). Track records are a valuable indication of the likelihood of future performance and include a variety of entrepreneurial and functional experiences gained through the previous endeavors of the entrepreneur (Mishra, 2005). Educational and leadership experience are linked to received financial resources (Hsu, 2007) and venture growth (Colombo & Grilli, 2005). Thus, it is shown that educational attainments are correlated to the amount of financial funds available new ventures (Bates, 1990; Robinson & Sexton, 1994). One reason for this is that acquired formal education ranks among the measurements of the entrepreneur's human capital; for example, an MBA degree proxies for general management training, while a PhD degree demonstrates proficiency in a scientific or specialized knowledge area (Colombo & Grilli, 2005). In turn, human capital is related to

¹¹ The following criteria are gained through an extensive literature review and make no claim to be complete with regard to the entrepreneur's personality as one of venture investors' decision criteria.

social capital (Coleman, 2007). Entrepreneurs with high educational capabilities increase industry and firm profitability (Shepherd et al., 2000). Prior founding experience has received little empirical attention so far. However, it is expected that this kind of experience is an indicator of success for VCs and should be advantageous for new venture funding (Hsu, 2007).. The existent experience of the entrepreneur relevant for the business of new ventures is crucial for their success. Industry-related expertise is frequently used by VCs for venture valuation. Experience in the same industry and in rapid growth firms are regarded as important indicators of expected success. VCs associate market and industry expertise with the level of appropriateness the entrepreneur's personality has for the new endeavor (Cooper, Dunkelberg, & Woo, 1988; Roure & Maidique, 1986). Spin-off entrepreneurs have particular expertise, and will have inherited organizational and industry specific routines from their corporate parents. This represents differential resources to founders and a reduced risk of failure (Agarwal, Echambadi, Franco, & Sarkar, 2004; Klepper, 2001). Thus, most experience criteria analyzed by scholars include educational level, industry and market experience, experience in leadership functions, and a successful track record. Nevertheless, with regard to agency risk, familiarity with the entrepreneur and their external references can play important roles in an investment decision (Osnabrugge, 2000).

Two additional criteria related to the entrepreneur analyzed by VCs are strategy and team match. Strategy is closely related to the skills and experience of the team members. For example, with profound industry experience and high analytical skills, the strategy utilized will be more sophisticated than one that lacks these characteristics. It is for this reason that only a few studies have analyzed this criterion separately with regard to investment decision criteria (Roure & Maidique, 1986; Sapienza & Grimm, 1997). Moreover, team match refers to the complementarity of the members of the entrepreneurial team (Macmillan et al., 2002). Skills and experiences can be diverse among different founders of one new venture. It is not very likely that one entrepreneur has all necessary requirements an investor demands.

Therefore, having the right team match in terms of skills and experience is essential for a successful new venture and investment (Amason, Shrader, & Tompson, 2006). This also involves the number of founders that are positively related to the success of the new venture (Cooper & Bruno, 1977).

5.2.2 The Market

Apart from criteria related to the entrepreneur and his personality, investment criteria regarding the market the new venture is or will be part of are important for investors during the assessment of a new investment proposal (MacMillan et al., 1985). Negative entrepreneurial aspects can be partly overcome with contractual agreements (Fiet, 1995b), especially market criteria that attracts attention of investors. Market assessment involves any elements external to the firm in the market (Porter, 1980; Porter & Millar, 1985). These market aspects differ from market barriers, via existing distribution channels to potential market size. High entry barriers can lengthen a new ventures lead time. This includes that a new venture's strengthening of its brand, expanding its product line, and realizing cost advantages before competitors enter the market (Shepherd, 1999a). The level of existing competition is also important for a VC. The greater the competition, the harder it is to gain market shares. Additionally, VCs try to judge the degree of market growth. A high market growth rate reflects customer demand and the opportunity to increase own market shares (Mishra & O'Brien, 2005). If investors assess an existent and familiar market, the risk factors are known through prior experience, but with no familiarity or experience, it remains a challenging endeavor (Baum, Locke, & Smith, 2001). If a new market is created through the product or service, competition is still low, but the potential size of the market as well as other potential risks are difficult to estimate. So, in emerging industries, investors face difficulties evaluating the key resources the new venture has to possess in order to survive due to the lack of experience and historic data (Christensen, Suárez, & Utterback, 1998; Utterback & O'Neill, 1994). Moreover, existing distribution channels can mitigate overall market risk. If there are

no proven distribution channels available, the risk of finding the right sales and marketing resources is higher and an additional investment must be made (MacMillan et al., 1987). In conclusion, the main market criteria prevailingly investigated by VCs during their investment decision-making process are existing distribution channels, expected market growth and size, competition, and if the market is stimulated by the product or if a new market is created.

5.2.3 The Product and Services

Less often, the focus of research into investment decision criterion involves the product and services of the new venture. In this context, VCs most frequently consider market acceptance of the product, existing prototype, degree of innovation, and intellectual property.

VCs analyze if the product is already accepted by customers, i.e., if there is an existing market. The product should be unique and fulfill a real need, which satisfies a certain group of customers. This reduces customer acceptance risk for the VC (Karakaya & Kobu, 1994). If the product is not yet in the market, the investor examines if there is a functioning prototype already developed and if there is still risk of research and development. The underlying technology might be unproven and the costs of further development cannot be estimated (Mason & Harrison, 2004); in this case, although of great importance, a precise assessment of product acceptance and its price is almost impossible (MacMillan et al., 1987).

In addition to potential competitive products already in the market, the VC must verify the degree of product innovation. Relevant innovations represent a competitive advantage and increase defensibility against imitations, which reduces the level of product risk. It must be also ensured that there is a long-term competitive advantage through constant innovation cycles. If innovation forecasts are missing, competition might overtake the new venture (Li & Atuahene-Gima, 2001). By contract, the degree of innovation prevailing in a particular industry is important. High-technology industries are mainly driven by innovations. Compared to traditional industries, innovation present additional uncertainties for entrepreneurs and investors alike in these industries (Hsu, 2007).

Intellectual property also plays a role during the investment decision process. Patents can protect a product against imitations (Oviatt & McDougall, 1994). Moreover, they serve as a signaling mechanism about the quality of the new venture. Patents are positively correlated with the number of financing rounds received by the VC and total investment. Interestingly, the performance of a new venture is significantly higher if it is the recipient at least one patent (Mann & Sager, 2007).

5.2.4 The Financial Aspects

VCS emphasize financial information in the form of revenue or profit forecasts and exit options during their investment decision process (Manigart et al., 1997).¹² The main financial criteria are liquidation flexibility, expected return, investment stage and size, as well as expected total investment. The relevance of these investment criteria are often fund- or VC-specific (Boocock & Woods, 1997), which also depends on market characteristics.

VCS evaluate the risk by analyzing how difficult it would be to liquidate the new venture investment in the market in which the firm operates. The higher the probability of exiting a new venture investment, the greater the flexibility for the investor and the willingness to invest. The secondary market in which the VC operates takes an important role in this context. With several VCS and enough money available, the risk of not selling the new venture is reduced. This is also positively related to financial returns (Keene & Peterson, 2007). Moreover, if enough exit channels in the form of potential acquirers in form of a trade sale or mature capital markets for IPOs are established, risk is also limited; whereas, IPOs are typically the preferred exit option. Regional market conditions and legal institutions are other important factor in this context (Cumming et al., 2005; Hellmann, 2006).

¹² Legal aspects between the venture investor and the new venture can represent important factors after the investment (Bengtsson & Sensoy, 2011b). The contract design depends on corporate governance (Hirsch & Walz, 2013) and the probability of enforcement of the contractual rights after the investment depends on the local legal system (Cumming, Schmidt, & Walz, 2010). As, at the beginning, contractual aspects are not in the primary focus when assessing a new venture, this analysis does not concentrate on this criterion.

Moreover, investors consider the expected return of the investment during their investment decision. It is regarded as a compensation for the risk taken (Korteweg & Sorensen, 2010); however, required return can often depend on inter-company requirements and compensation for additional services, such as active involvement in the new venture (Manigart et al., 2002). Nevertheless, if the expected return is low compared to the anticipated risk, the risk of a negative investment is high. Therefore, VCs frequently consider this criterion when making decisions about investments (Khanin et al., 2008).

Another VC-specific decision criterion is the size of the investment. Depending on the total funds available and risk diversification strategies, the amount of money needed for a potential investment is relevant (Sahlman, 1990). Closely related to this is the probability of syndication, which also depends on market circumstances (Ferrary, 2009). Similarly, it is important to determine if follow-on investments are required. If the VC has inadequate available funds, financial market conditions become more relevant. Within markets with few venture capital activities, the VC might have to undertake the next financing round alone, which increases risk (Silva, 2004) and, which therefore must be taken into consideration during the investment decision process. VCs investigate if there are previous investors as shareholders invested in the new venture for two reasons. First, previous investors offer an indication of the quality of the deal (Filatotchev, Wright, & Arberk, 2006); second, first-round investments reflect an earlier stage of the new venture with higher risk. This depends on the investment strategy of the VC and is therefore investor-specific (Carter & Van Auken, 1994).

5.3 Reasons for Regional Differences

An interpretation of the different impacts of risk factors according to regions is not easy. Relying purely on theories, e.g., agency theory, could lead to incorrect assumptions (Wright, Lockett, & Pruthi, 2002). Therefore, a more compelling theory is necessary to understand how private investors are influenced (Bruton, Fried, & Manigart, 2005). There is an increasing recognition of institution theory (North, 1990; Scott, 1995) as an decisive

explanation for cross-country differences. The conduct of business may be significantly influenced by differences in institutional systems (La Porta, Lopez-de-Silanes, Shleifer, & Vishny, 1998; La Porta, Lopez-de-Silanes, Shleifer, & Vishny, 1997). The level of new venture investment activity is dependent on formal institutions, like legal systems influencing political risk and corporate governance systems that prevail in a country (Bonini & Alkan, 2011). The venture capital market is spread from the U.S. via Europe to new markets beyond developed economies (Aylward, 1998). Despite some homogeneity of the business processes of private investors (Sapienza, Manigart, & Vermeir, 1996), industry itself is affected by differences in institutional factors regarding normative, regulative, and cultural rules of behavior in different countries (Lockett et al., 2002; North, 1990; Scott, 1995). Previous studies confirmed this assumption (Manigart, 1994). There is rising attention to research attempting to analyze VCs in an international context based on this theory (Bonini & Alkan, 2011; Bruton, Ahlstrom, & Puky, 2009; Cumming et al., 2010; Dai, Jo, & Kassicieh, 2011; Li & Zahra, 2011; Lockett et al., 2002; Manigart et al., 2007; Manigart et al., 2002; Schertler & Tykvová, 2010; Wright et al., 2004; Wright, Pruthi, & Lockett, 2005; Zacharakis et al., 2007). Therefore, it is concentrated on the institution-based theory for interpreting the empirical results found.

5.3.1 Institution-based Theory

Until recently, it was criticized that the task-environment, which concentrates on economic variables, has been the sole focus of research and that a market-based model based on institutions has been regarded as dominating. Therefore, institutions were considered as background conditions (Narayanan & Fahey, 2005). However, if the market does not work smoothly, the lack of formal institutions, such as laws and regulations, becomes obvious (McMillan, 2007). Such institutions shape a system by determining a structure for political, economic, and social incentives involved in exchange for organizations and individuals. Once established, institutions create constraints for their members, which are not always founded on

an economically efficient basis (Bruton & Ahlstrom, 2003; Roy, 1999). Above all, they are intended to reduce uncertainty and provide a level of meaning (Scott, 2008). This is accomplished by influencing the norms of behaviors. Moreover, institutions determine the border of what is legitimate and what is not. Individuals make decisions based on a pre-determined institutional setting (Lee, Peng, & Barney, 2007). It is argued that institutions also have an impact on differences in firm performance within the institution-based view. Therefore, it is important that companies doing business internationally adapt to institutional differences while acting in various regions (Hitt, Ahlstrom, Dacin, Levitas, & Svobodina, 2004). Institution-based theory deals with these institutions, which are either normative, regulative, or cognitive activities and structures that provide meaning and stability to social behavior (Scott, 1995).

Normative institutions are frameworks of individual and organizational behavior and they rely on social, organizational, and professional interaction. They delineate what an expected and appropriate behavior is in a pre-defined social and commercial situation expressed through values and norms. These norms and values are accepted and complied to due to the social obligation they represent in society. Sanctions are enforced through social exclusion instead of legal enforcement (Baumol, Litan, & Schramm, 2007).

The regulative relies on conformity and sanctions. It assumes an actor behaving rationally. These institutions provide rules and regulations of the “game”, which are monitored and enforced. Their components come from standards, which provide guidelines for individuals and firms alike, industrial agreements, and governmental legislation (Scott, 2008).

The cognitive aspect of institution theory is derived from individual behavior. It relies on subjectively determined senses that set limits for rights actions and beliefs (DiMaggio & Powell, 1994) and can be rather applied to an individual level. This is accomplished with regard to culture and language, and preconscious behavior (Javidan, House, Dorfman, Hanges, & de Luque, 2006; Scott, 1995). Analyzing how society accepts and encourages

entrepreneurship (Bosma, Jones, Autio, & Levie, 2008; Li, 2009), cognition is more and more relevant to the field of entrepreneurship research.

Furthermore, institutions can be grouped by formal and informal institutions. Normative and cognitive aspects belong to the informal part, whereas regulative institutions account for the formal part (North, 1990). When observing the development of new institutionalism, it becomes more and more interesting how institutions matter and what their influence on other objects is (Peng, Wang, & Jiang, 2008). The dimension of institutions can be summarized on the basis of Peng et al. (2009):

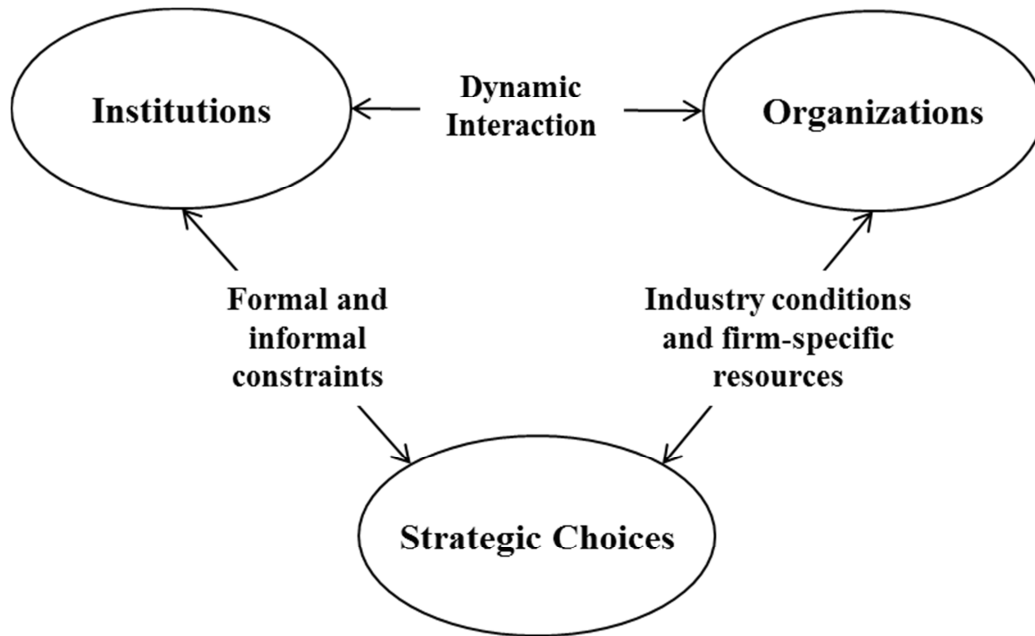
Table: 3 Dimensions of institutions

Degree of Formality (North, 1990)	Examples	Supportive Pillars (Scott, 1995)
Formal institutions	Laws Regulations Rules	Regulative
Informal institutions	Norms Cultures Ethics	Normative Cognitive

Institutions differ widely from region to region, from country to country, and from industry to industry (Fang, 2010). Especially in developed countries, certain structures, mindsets, and processes are taken for granted and are therefore not objects of detailed research. However, when it comes to emerging economies and the difference compared to developed markets, institutions must be analyzed carefully (Peng et al., 2008). Regarding entrepreneurship research, one can better understand the entire matter by finding out what was institutionalized and what was, therefore, taken for granted (Bruton, Ahlstrom, & Li, 2010). The institution theory relies on the dynamic exchange of organizations and institutions. Strategic choices are regarded as the outcome (Peng, 2002). These choices are not solely influenced by firm capabilities and industry conditions. They are also subject to formal and informal constraints of a certain institutional framework, which impacts individuals and their behavior

(Jarzabkowski, 2008). Figure: 1 gives an overview of these insights illustrated by Peng (2002).

Figure: 1 Institutions, organizations, and strategic choices



5.3.2 Institutional Influences on Investment Criteria

Institutional settings can have an impact on the new venture investment industry and its members, and vice versa (Ahlstrom & Bruton, 2006). In particular, research has shown that institutions influence the creation of processes of venture capitalists (Suchman, 1995; Wright, Thompson, & Robbie, 1992). In contrast, they also produce a decisive unity with regard to the behavior of members within the new venture investment industry (Fried & Hisrich, 1995). Institutional theory argues that differences as well as similarities in the behavior of VCs around the world are the consequence of the development of regulatory, normative, and cognitive institutions in every country (Bruton et al., 2005; Busenitz, Gomez, & Spencer, 2000; Wright et al., 2002). Formal as well as informal institutions and their influence on the venture capital industry is summarized by Bruton et al. (2005) as follows in Table: 4.

Table: 4 The institutionalization of venture capital

		Formal Institutions	Informal Institutions	
		Regulatory	Normative	Cognitive
Equity holder		+ Protection of creditors + Law enforcement + Regulation of capital markets + Access to reliable market information	+ Norms of conduct in the venture investment industry + Similarities based on homogeneous task environments	+ Cultural characteristics like collectivism and performance orientation + Reputation of entrepreneurs
Rule-based economies	U.S & U.K	+ Mature + Common law provides high shareholder protection + Strong public equity markets	+ Strong normative values in industry	+ Status of entrepreneurs is high + Reliance on social networks relatively weak
	Continental Europe	+ Mature + Civil law provides lower shareholder protection + Bank-centered financial markets	+ Industry developed from U.S.: Strong normative values from U.S. due to its origin, training and interconnections in the industry	+ Status of entrepreneurs is lower than in the U.S. but higher than in Asia + Reliance on social networks stronger than in U.S. but weaker than in Asia
Emerging economies	Asia	+ Generally poorly developed + Often do not enforce laws/regulations	+ Industry developed from U.S.: Strong normative values from U.S. due to its origin, training and interconnections in the industry	+ Status of entrepreneurs is low + Reliance on social networks stronger than in U.S. or Europe

Based on the institution-based theory, an interpretation of regional differences regarding the impact of new venture risk factors determined by VCs is given in the subsequent paragraphs. The sub-sections are divided according to the main risk factors, namely the entrepreneur, the market, the product, and financial and legal aspects.

The Entrepreneur

In general, according to institution-based theory, it is proposed that interpersonal roles in a new venture investment context are more important in Asia and the U.S. than in Europe (Bruton et al., 2005). Investment managers certainly care about the quality of the entrepreneur they may possibly fund. They assess functional skills, like marketing and finance, as well as cognitive capabilities, like commitment and attention to detail (Khanin et al., 2008). The information they need for the evaluation can be gained from different sources. It has been determined legal systems can be used regarding the source of information used by the VC (Wright et al., 2004). This includes cultural factors in order to determine, which information is actually used (Wright et al., 2005). The decision to use or not to use certain information depends much more on the trustworthiness of the source. Therefore, the entrepreneur as a mutual trustworthy individual is inevitable for new venture investments (McKnight,

Cummings, & Chervany, 1998). In this context, trust plays an important role. Trust relies on past relationships with the entrepreneur. An investor who has already worked together with someone can much better assess his or her skills and capabilities. Moreover, if the investor does not know the entrepreneur in person, references of people the investor trust can be an alternative source of trust (Allen, Song, & Center, 2003; Zacharakis et al., 2007). One can conclude that trust towards the entrepreneur is more important for the investment decision in countries with weak legal systems. Misjudgments regarding the qualities of the entrepreneur cannot be corrected by contractual agreements, as legal enforcement is not guaranteed in these countries with weak law enforcement. Emerging economies represent rather weak legal systems compared to rule-based, developed markets (Ahlstrom & Bruton, 2006). This involves agency risks. Therefore, the entrepreneur as investment criterion might be more important in these markets.

Apart from formal legal institutions, it is important to consider cognitive institutions. They are formed by the culture of the society. The cognitive level in the form of beliefs and values plays a relevant role. The image of the entrepreneur as a cultural characteristic in a society can cause trust or mistrust. The higher the reputation, the more VCs want to be associated with him or her (Bruton et al., 2005). In regions where the status of the entrepreneur is high, the status based on success is high and the social penalty for failure is rather low. By contrast, in countries in which the entrepreneur is thought to be of low reputation, new venture success is not inevitably followed by a high social status (Bruton et al., 2005; Reynolds et al., 2005). Thus, in cultures where the entrepreneur has a low status, entrepreneurial activity poses a cognitive threat and increases perceived risk of a potential investor. In general, the reputation is very high in the U.S. and U.K., whereas the reputation deteriorates when European countries are analyzed. An entrepreneur has the lowest societal status in Asian countries (Bruton et al., 2005; Reynolds, Carter, Gartner, & Greene, 2004). If an investor greatly mistrusts an entrepreneur due to general cultural and cognitive circumstances, analyzing that

entrepreneur's human capital can create trust. Trust is established by the beliefs regarding the entrepreneur's competence (McKnight et al., 1998). Thus, the VC will pay more attention to factors of human capital such as skills, industry experience, and a successful track record in order to increase trust (Lockett et al., 2002; Manigart et al., 2000). Moreover, decision makers in emerging economies regard information about human capital important. Thus, a positive relationship between success and experience is more important to VCs in emerging markets than those in mature and developed economies (Zacharakis et al., 2007).

Closely related to the previous arguments, is the networking effect. It is proposed that interpersonal roles are more important in Asia than in other regions; networking is also thought to be also more important in Asia compared to U.S. and Europe (Bruton et al., 2005). Weak legal institutions pose an investment risk to VCs. If explicit contractual agreements cannot be enforced through regulative institutions, social networks offer an opportunity of execution (Bruton et al., 2009). Thus, a network can serve as an informal substitute for formal institutions. Especially in situations where formal institutions are weak, the relative importance of norms, culture and cognitive aspects increases (Peng & Heath, 1996). An even stronger connection and relevance of social, in particular family networks are found in Asia (Claessens, Djankov, & Lang, 2000). As the venture capital industry is less established and regulated in Asia, the relationship to business partners, potential investment candidates, and social networks might be even more relevant as a substitute for insufficient law enforcement (Bruton & Ahlstrom, 2003). It would seem that, especially in emerging countries, the entrepreneur with a better social network will be more successful. Therefore, investors will focus on this criterion.

The Market

The product market is rated as a very important risk factor in new venture investments (MacMillan et al., 1987). Investors pay close attention to market factors as these risks cannot be regulated or reduced through contractual agreements in a principal-agent problem context

(Fiet, 1995b). Investment risk regarding the post-investment opportunistic behavior of the entrepreneur can be contractually regulated and minimized in countries with strong legislative system (Farag, Hommel, Witt, & Wright, 2004; Zacharakis et al., 2007). Regulative institutions differ from region to region with legal enforcement stronger in rule-based countries, like the U.S. and U.K. (Schertler & Tykvová, 2010). In these countries, investors can count on market data and information as well as their accuracy to a larger extent than information received in non-rule-based economies (Lockett et al., 2002). This represents a significant risk for investors who want to invest in emerging countries (Fiet, 1995a; La Porta et al., 1998; Wright et al., 2005). Thus, reliability plays an important role when considering potential risk factors. Efficient and reliable information transfer and regulated capital markets lead to greater transparency, which increases the risk of imitations; new companies might attract imitators and competitors before they can establish a strong and competitive market position (Colombo & Grilli, 2005; Zacharakis et al., 2007). This increases the necessity to investigate and base investment decision on market factors in countries with strong formal institutions.

Therefore, studies show that especially investments in young companies are accompanied by profound market screenings (Zacharakis & Meyer, 1998). With more and more efficient venture markets, the relative importance of evaluating profit potential, market size, competitive strength, and threat of imitators increases, compared to concerns about the opportunistic behavior of the entrepreneur. Therefore, investors in rule-based countries are assumed to care more about on market factors than investors in less rule-based regions (Zacharakis et al., 2007). It can be deduced that due to the reliability and availability of market information, VCs in rule-based countries will build their investment decision to a larger extent on market data than will investors from countries with less efficient capital and information markets. Additionally, the European venture market is less mature than the Anglo-American market. Therefore, it is expected that European investors concentrate on

market factors to a smaller extent than their Anglo-American counterparts. With a rather immature new venture economy, the Asian investors are said to use the least amount of effort on these highly uncertain and unreliable market criteria.

The following conclusions can be made when analyzing entrepreneur and market criteria. Market-oriented information is more important in mature market economies. By contrast, emerging or transitional economies will rather focus on human capital information. This implies that trust in the entrepreneur as an investment criterion will be of great relevance (Zacharakis et al., 2007). Moreover, the insignificant enforcement of property rights in emerging markets increases the importance of transaction costs. Therefore, the criteria of human capital can be used to determine the level of access to networks of the entrepreneur and the underlying influence within a society (Gill, Boies, Finegan, & McNally, 2005; Zacharakis et al., 2007). By contrast, within societies with strong property rights enforcement, there will be a tradeoff between lower transaction costs and higher transformation costs. Therefore, in developed markets, VCs are supposed to pay more attention to market than to human capital insights. Human capital aspects are regarded as necessary but insufficient for the creation of a new successful company (Wright et al., 2005; Zacharakis et al., 2007).

The Product and Services

When it comes to the product as investment decision criteria, the influence of institutions is less easily to analyze. The relevance and therefore risk of intellectual properties in the form of patents is related to the level of rights enforcement, which depends on the local legal institution (Bruton et al., 2009). If granted patents cannot be used as competitive protection against imitations, their relevance for VC is limited. Risk with regard to research and development of the product can also be explained by institution-based theory. If no functioning prototype yet exists, there is a product development risk. If it turns out that the product does not work as expected, the new venture either fails or more time and money must be spent on development. This involves hiring new competent personnel. With low

educational standards and few research institutes, recruiting of talented employees is difficult. Therefore, the relevance of an existing prototype will be greater in less developed markets than in mature markets with better educational systems. Nonetheless, this argument must also consider additional aspects. The typical stage at which the investor invests is one influencing variable. Depending on the corporate governance and investment strategy, the deal flow might be focused on pre-prototype new ventures. In this case, the relevance of this investment decision criterion is certainly limited. Similar arguments can be made with regard to degree of customer acceptance. The criterion rather depends on the investment focus of the single VC than on institutional influences. In contrast, the degree of innovation can be only assessed with reliable and transparent information about competing products. Therefore, investors within markets with trustworthy information about the level of innovation of competitors will rather concentrate on this investment criteria (Wright et al., 2002).

The Financial Aspects

When arguing that the source of information depends on the relevance of the capital markets, the investors' focus depends on it as well. If the level of importance changes due to positive or negative developments of the capital markets in a country, the focus of VCs on certain investment criteria is supposed to shift as well. In other words, if the efficiency of the capital market increases within a country, investors can rely more on the information gained from it. Efficient and reliable capital markets are usually backed by strong formal institutions. The latest studies have investigated these institutional factors and their relevance. A comparison of mature and emerging markets reveals interesting insights. Research has shown that the conditions and circumstances of capital markets are relatively more important in emerging industries than in developed markets because of the enduring change of its development (Wright et al., 2005). Another good example of this is the impact of economic liberalization in India (Rao, 1998). Differences with regard to the relevance of financial investment criteria of VCs are influenced by these insights. With a mature and regulated capital market, exit options

in the form of an IPO are more feasible than in emerging markets with little capital volume traded (Bell, Moore, & Filatotchev, 2012). The maturity of capital markets also implicates the level of maturity of the new venture investment market within the same country or region (Wright et al., 2004). Missing new venture investment firms in the same region poses a risk to the investor. Fundraising for follow-on investment rounds is much more difficult. Finding a partner for syndicating a large investment is also challenging. Moreover, within a less developed capital market, the volume of capital allocated to this high risk investment class is limited, which leads to smaller fund sizes and more competitive fund raising among VCs (Jeng & Wells, 2000). Therefore, it can be argued that the financial aspects of investment criteria are more important in less developed capital markets as their risk for VCs is higher. Nevertheless, VC-specific characteristics, such as corporate governance and fund size, might play influential role, which must be taken into consideration.

The Legal Aspects

Legal institutions can be regarded as the central foundation of formal institutions in a country. Although, there are vital differences between legal systems based on common law or civil law, the focus should be on legal protection and law enforcement with regard to institutional theory. In principle, a legal system can guarantee protection, but be very non-protective in practice (Bruton et al., 2005). It is shown that cross-country differences regarding legal institutions significantly influence governance structure of investments in the new venture investment industry. In particular, enhanced law enforcement facilitates due diligence activities of the investors. Risk of contract repudiation and slow bureaucracy causes the opposite effect. Therefore, it is argued that the influence of legal institutions on governance structures are one reason for the international differences in VC markets (Cumming et al., 2010). In an analysis of emerging economies, inadequate regulatory and enforcement regimes prevail. Fulfillment of contracts, like new venture investment contracts, is not guaranteed.

Therefore, companies look for alternative measures and less formal mechanisms, which compensate for legal failures (Bruton et al., 2009).

5.4 Empirical Analysis

5.4.1 Relevance and Research Contribution

Apart from its importance for this dissertation, this pure empirical analysis is relevant from an international point of view and contributes to current research and practices. With continuing globalization, it is argued that understanding the relationship between cultures and entrepreneurship is of great theoretical and practical value (Grichnik, 2006; Hayton, George, & Zahra, 2002).¹³ It is also shown that VCs play an important role in this entrepreneurial nexus (Hartmann-Wendels, 2005). However, the analysis of their financial activity in an international context and their motives for and distinct differences within the internationalization process are still underdeveloped (Bruton & Ahlstrom, 2003; George & Prabhu, 2000, 2003; Goslin & Barge, 1986; Hsu, 2007; Li & Zahra, 2011). In this context, it is shown that VCs emphasize different investment criteria during their investment decision-making process independently of their geographic location (Zacharakis et al., 2007). There are several aspects why cross-border differences should be analyzed. There are good reasons why investors in private young companies should continue to invest close to their headquarters. Firstly, private investors must take on an active role in their portfolio companies, which requires local proximity. With increasing distance, it is challenging to mitigate, information asymmetry between entrepreneur and investor in the investment process (Stuart & Sorenson, 2003). Therefore, private investors have been often regarded as purely local investors (Bengtsson & Ravid, 2009; Cumming & Dai, 2010). Secondly, when entering a new market,

¹³ Scholars have undertaken several studies to analyze the impact of national culture on measures of entrepreneurship (Davidsson, 1995; Davidsson & Wiklund, 1997; Shane, 1992; Shane, 1993), the association between national cultures and the characteristics of individual entrepreneurs (Baum et al., 1993; McGrath & MacMillan, 1992; Mueller & Thomas, 2001), and the dimension of national culture and corporate entrepreneurship (Makino & Neupert, 2000; Morris, Davis, & Allen, 1994; Steensma, Marino, & Weaver, 2000).

investors are confronted with local national firms regionally dominating the investment scene. They must gain access to local knowledge in order to comprehend local circumstances, and the cultural and legal environment (Bruton et al., 2005). Nevertheless, the globalization of the institution of private investors, like venture capitalists, has been formed by increasing cross-border entries into new markets (Aylward, 1998). With larger funds and new technologies emerging in previously underdeveloped countries, geographic expansion became inevitable (Schertler & Tykvová, 2010; Wright et al., 2002). Strategic components are very often subordinated in this case (Groh & Von Liechtenstein, 2009). Moreover, new competitors emerged in national markets. With more money available, the valuation of local companies increases and makes it even harder for established firms to find lucrative deals. Increasing national pressure forces the private investors to search for investments abroad in order to broaden their scope of financial opportunities (Gompers & Eckbo, 2005; Hall & Tu, 2003). This is accompanied by the need to learn from foreign partners or competitors (Etemad, 2004; Manigart et al., 2007). Despite advanced globalization, the differences with regard to size and success among venture capital as well as business angel markets around the world remain. It is claimed that the reason is based on the influence of legal institutions on governance structures (Cumming et al., 2010), which is advocated by Peng, applying the institution-based theory (Peng et al., 2009; Peng et al., 2008).

With a rather homogeneous industry regarding business processes and having its roots in the USA, it is consciously tried to copy practices within the industry of VCs, especially venture capitalists. Studies show that there are the same cross-border basic roles of parties involved. Early studies also revealed that venture capitalists use similar investment decision criteria (Knight, 1994; Rah, Jung, & Lee, 1994). However, in terms of analyzing differences in the form of the relevance of investment criteria, little can be found in the entrepreneurial finance literature, with only few studies comparing findings between countries. Knight (1994) collected data from different countries including the USA, Canada, the Asia-Pacific and

Europe, but his cultural analysis is rather basic. General statements refer to similar rankings among countries with regard to high-level criteria like market growth and qualities of the entrepreneur (Brettel, 2002). Concerning theory development and the interpretation of detailed findings, little in the way of theoretical frameworks or statistical methods has been employed in order to reveal regional differences (Zacharakis et al., 2007). Scholars argue that various factors – socio-cultural, economic, cognitive, legal and regulatory environment – might impact the decisions of VCs and explain regional distinctions regarding risk (Schilit & Chandran, 1993; Zutshi, Tan, Allampalli, & Gibbons, 1999). In particular, it is claimed that VCs are influenced by their national legislation and corporate cultures, as well as corporate governance practices (Börner & Grichnik, 2005; Charkham, 1994; Manigart et al., 1997). Further considerations show that similar processes, such as decision factors, do not necessarily imply that the information used is of equal importance. The relative importance of certain issues can vary significantly from region to region (Bruton et al., 2005). It soon becomes obvious that countries and regions are subject to certain forces, which have an impact on investors and their investment practices (Zacharakis et al., 2007).

The contributions of this empirical analysis are diverse. It represents an extension of research activity analyzing international differences with regard to investment criteria and decision-making processes (Bruton et al., 2009; Dai et al., 2011; Guler & Guillén, 2009; Knight, 1994; Manigart et al., 2002; Sapienza et al., 1996; Zacharakis et al., 2007). The topic of internationalization in an entrepreneurial context is still underdeveloped (Keupp & Gassmann, 2009). This aspect also accounts for VCs that are rather comparable to small and medium-sized enterprises with fragmented market and often limited resource base (Manigart et al., 2007). Moreover, this study extends the empirical work of investment criteria used by VCs. An evidence-based approach to entrepreneurial finance (Rauch & Frese, 2006) is accomplished by an empirical meta-analytic review, endorsing the line of theoretical argumentation and providing insights for future empirical research.

There is a need to understand VCs' decision making (Wright et al., 2005), important aspects of which might reveal heterogeneity in certain new venture investment decision policies (Zacharakis & Shepherd, 2009). Additionally, examining this issue has contributed to the ongoing debate if market or management characteristics are more important (Khanin et al., 2008). The controversial discussion started when MacMillan et al. (1985) claimed that the entrepreneur's characteristics impact investors' investment decisions to a larger extent than the quality of the product. By contrast, MacMillan et al. (1987) proved the opposite. Moreover, Zacharakis et al. (2007) showed that market aspects are more important in rule-based countries than in emerging economies. However, this hypothesis, based on institution-based theory, was empirically denied by Levie and Gimmon (2008). Interestingly, literature reveals that many early U.S. studies show that the entrepreneur outweighs market aspects as important investment criterion (MacMillan et al., 1985; Poindexter, 1975; Tyebjee & Bruno, 1984; Wells, 1974). Later studies of the U.S. venture industry rather rely on market aspects (Hall & Hofer, 1993; Zacharakis et al., 2007; Zacharakis & Meyer, 1998), although studies on business angels do not show the same change (May & O'Halloran, 2003; Sudek, 2006). It is necessary to unravel this contradiction (Levie & Gimmon, 2008). Additionally, it extends the scope to Asian markets, which have not been the focus of research for some time (Bruton & Ahlstrom, 2003).

Lastly, these findings contribute to practical matters. Knowledge of investors' investment criteria aids entrepreneurs looking for funding to avoid major mistakes in their investment business plans and to evaluate their projects. They gain insights into VC decision policies and how they distinguish between countries (Franke et al., 2008). Moreover, investors entering different countries may experience challenges with regard to generating target returns. They often fail to adjust to the differing circumstances of individual markets and are disadvantaged in information collection and monitoring because of cultural and geographic distances (Dai et al., 2011). This might be influenced by wider institutional characteristics underlying

regulatory, normative or cognitive aspects (Bruton et al., 2005; Wright et al., 2004). Additionally, the VC community is provided with an extensive overview of investment decision criteria in use and an empirical comparison on an international level with this study. This can encourage rethinking their own investment process and elements of valuation.

5.4.2 Selection of Studies and Empirical Methodology

In a first step, the identification of all relevant studies started with an extensive and comprehensive literature search in well-known and substantial databases. These databases included Wilson Select Plus, Emerald Management Xtra, ABI/INFORM Database, EBSCO, ProQuest Database, EconLit, Social Sciences Citation Index, and JSTOR. In order to reduce publication bias, Google Scholar, Google search, and the Dissertations and Theses Proquest database were used to find as yet unpublished studies useful for the purpose of this study. A keyword search was conducted with 17 words, such as “entrepreneurial investment”, “financing criteria”, “investment decision”, “venture capital”, and “business angel”, and combinations of those terms. The search was limited to the extent that the keywords had either to appear in the title or in the abstract of the study. After this first step, the titles and abstracts of the papers found were analyzed, and non-relevant papers were excluded. Additionally, ten top tier journals in the fields of entrepreneurship and finance research were manually searched starting with the year 1974, as Wells (1974) is thought to be the first scholar to analyze the investment criteria of VCs. In a next step, back- and forward-tracking was applied, that is, references of relevant articles were cross-checked and studies, which cited these articles, were analyzed. The Then results were then scanned for relevance. Not all studies categorized as potentially germane were available in full text digital form. These were copied in libraries, or authors were contacted in cases of unpublished working papers. The literature search concluded with 116 study candidates.

Secondly, more detailed criteria were necessary for the appropriate accomplishment of meta-analysis and to fulfill the academic purpose of this analysis. Studies that did not specifically

research investors of young companies were excluded from the sample. Missing data was a frequent problem when screening the empirical findings; this was particularly true of older studies that did not report all necessary statistics such as standard deviations and country classifications. Authors were contacted to obtain this information. As the purpose of the empirical section is to be robust with critics of synthesizing primary data, studies using the latest empirical methods, like conjoint-analysis, which cannot easily be aggregated, were not considered for further steps. Thus, the use of Likert scale measurements was set as a prerequisite. Finally, articles were searched according to their theoretical and empirical focus. As the entrepreneurs of young ventures and their valuation by venture investors are emphasized, studies not concentrating on this topic were excluded from the set of data. The search process and selection activity were concluded in August 2011, with a total of 44 samples from 16 countries on four continents. These comprise a total sample size of 2370 venture investors analyzed. Table: 5 provides an overview of these studies.

Table: 5 Studies of empirical analysis

Studies	Year	Sample Size	Research Object	Country	Number of Criteria
Anglo-America					
Bachher J , Guild P (1996)	1996	20	BA	Canada	21
Bachher J , Guild P (1996)	1996	20	VC	Canada	21
Bachher J , Guild P (1996)	1996	20	SBDC	Canada	21
Bruno A , Tyebjee T (1986)	1986	121	VC	USA	12
Carter R , Van Auken H (1994)	1994	69	VC	USA	21
Dixon R (1991)	1991	30	VC	UK	6
Goslin L , Barge B (1986)	1986	30	VC	USA	7
Haar N, Starr J , MacMillan I (1988)	1988	130	BA	USA	15
Kaplan S , Stromberg P (2000)	2000	10	VC	USA	12
Knight R (1994)	1994	81	VC	Canada	24
Macmillan I, Siegel R , Narashima P (1985)	1985	100	VC	USA	24
MacMillan I, Zemann L , Narasimha P (1987)	1987	67	VC	USA	64
Manigart S, Wright M, Robbie K, Desbrieres P , Waele K (1997)	1997	66	VC	UK	18
Osnabrugge M (2000)	2000	143	BA	UK	13
Osnabrugge M (2000)	2000	119	VC	UK	13
Rea R (1989)	1989	47	VC	USA	12
Robinson R , Pearce J (1984)	1984	38	VC	USA	15
Ruhnka J , Young J (1987)	1991	65	VC	USA	8

Sudek R (2006)	2006	72	BA	USA	32
Tyebjee T , Bruno A (1981)	1981	46	VC	USA	12
Wells W (1974)	1974	8	VC	USA	12
Wright M, Robbie K, (1997)	1997	66	VC	UK	7
Asia					
Chotigeat T, Pandey I , Kim D (1997)	1997	20	VC	Taiwan	30
Chotigeat T, Pandey I , Kim D (1997)	1997	7	VC	Sri Lanka	30
Chotigeat T, Pandey I , Kim D (1997)	1997	8	VC	Thailand	30
Kakati M (2003)	2003	27	VC	India	45
Knight R (1994)	1994	53	VC	Asia	24
Kumar A , Kaura M (2003)	2003	11	VC	India	16
Rah J, Jung K , Lee J (1994)	1994	74	VC	Korea	31
Ray D (1991)	1991	5	VC	Singapore	6
Ray D , Turpin D (1993)	1993	18	VC	Japan	5
Mishra (2005)	2005	40	VC	India	42
Pandey (1995)	1995	8	VC	India	42
Zutshi R, Tan W, Allampalli D, Gibbons P (1999)	1999	31	VC	Singapore	12
Europe					
Brettel M (2002)	2002	55	VC	Germany	24
Eisele F, Habermann M , Oesterle R (2002)	2002	90	VC	Germany	37
Karsai J, Wright M , Filatotchev I (1997)	1997	9	VC	Hungary	17
Knight R (1994)	1994	195	VC	Europe	24
Manigart S, Wright M, Robbie K, Desbrieres P , Waele K (1997)	1997	32	VC	France	18
Manigart S, Wright M, Robbie K, Desbrieres P , Waele K (1997)	1997	38	VC	Benelux	18
Stedler H , Peters H (2003)	2003	230	BA	Germany	13
Pintado et al. (2007)	2007	51	VC	Spain	14
Total sample		2370			

In order to aggregate and analyze all relevant potential risk factors, a meta-analysis is undertaken. Meta-analysis in a narrower sense is a statistical analysis, which collectively examines the results of different studies on an identical subject (Glass, 1976). This methodology offers an excellent opportunity to bundle knowledge and empirical findings in order to generate further insights. Moreover, the results are robust and reduce sampling error, which makes them applicable for practical guidelines (Lipsey & Wilson, 2001). Following an evidence-based approach (Rauch & Frese, 2006), this meta-analysis is used as a quantitative and systematic empirical method in order to synthesize the findings from previous studies

(Glass, 1976). It is often applied in social science (Glass, 1976) as it reduces the subjectivity bias by analyzing collectively the results of different studies on one identical subject (Fitzgerald, 2003); it represents a hybrid form of primary and secondary research methods, with a work process similar to primary statistical methods (Kornmeier, 2007). Moreover, it can provide vital evidence, especially in fields of research if there are limited sample sizes or conflicting findings (Geyskens, Krishnan, Steenkamp, & Cunha, 2009).

An in-depth meta-analysis comprises a comprehensive literature search, a consistent coding of data, an appropriate analysis, and an accurate interpretation of results (Borenstein, Hedges, Higgins, & Rothstein, 2009; Lipsey & Wilson, 2001). In order to code the data, a coding scheme was developed. The first section records information about general study characteristics while the second section encodes the relevance of decision criteria, relying on the investment criteria found in the article by MacMillan et al. (1985). The analysis is completed by examining further important criteria of latest studies analyzed. 33 criteria resulted from this operation. For reasons of practicability, these criteria were grouped into 6 main classes – namely entrepreneur’s personality, entrepreneur’s experience, financial aspects, market, product and service, and team. Importance was attached to using close-ended items as recommended by Lipsey and Wilson (2001). In case of a non-exact match between one of the 33 criteria in the coding protocol and a criterion in the sample, a classification procedure took place in a second step by analyzing the study affected in detail. The coded criteria are presented in the following table:

Table: 6 Overview of grouped and detailed investment criteria

1. Entrepreneur Personality	
1.1	Ability to evaluate and react to risk/courage
1.2	Appropriate personality for business
1.3	Articulation capability/motivation
1.4	Attention to detail
1.5	Capability of intense effort
1.6	Educational level
1.7	Financial and analytical skills
1.8	Managerial skills
1.9	Marketing skills
1.10	Technical skills
1.11	Social skills
2. Entrepreneur Experience	
2.1	Demonstrated leadership
2.2	Industry/market experience
2.3	Investor's familiarity with entrepreneur
2.4	References of entrepreneur/team
2.5	Success track record
3. Financial Aspects	
3.1	Easy liquidation possible
3.2	High expected return (within 5 years)
3.3	Investment as first round investment
3.4	No follow-on investments expected
3.5	Size of investment
4. Market	
4.1	Existing distribution channel
4.2	High market growth rate
4.3	Investor's familiarity with market
4.4	Little competition
4.5	Market stimulated by the product/service
4.6	Market size
4.7	Creation of a new market by product/service
5. Product/Service	
5.1	Existing market (acceptance) for product
5.2	Existing prototype
5.3	High degree of innovation
5.4	Protected product
6. Team	
6.1	Perfect team match

The arithmetic means as effect size was used for the entire sample to synthesize findings. The majority of studies reported means as well as standard deviations, which are based on five-point-Likert scale measurements. Findings documented in a different scale were transformed into a five-point-Likert scale (Colman, Norris, & Preston, 1997; Wu, 2007). This so-called one-variable relationship (Lipsey & Wilson, 2001) as effect size is less often used in meta-analyses than two-variable relationships, such as mean difference and correlation coefficient. However, it is a straightforward way of synthesizing empirical results if the variables used are operationalized the same way and standard errors can be calculated. Most widely reported studies of this kind analyze central tendency descriptions. Formulas for calculating mean effect sizes, inverse variance as weights, Q values for tests of homogeneity (Lipsey & Wilson, 2001), and others were implemented and analyzed using SPSS 17 and comprehensive MS Excel models. Overall mean effect sizes and mean standard error were calculated by using two different weights – samples sizes and inverse variance (Hedges & Olkin, 1985). The purpose was to test if findings differed by method. Ninety-five percent of confidence intervals were calculated around the weighted effect size as a measure of accuracy (Whitener, 1990).

As standard errors and standard deviations of small samples show a tendency to underestimate the population standard errors and deviations (Gurland & Tripathi, 1971), a correction factor was implemented for effect sizes with a sample size of less than 20 (Sokal & Rohlf, 1995). The data distribution for outliers was analyzed (Geyskens et al., 2009; Hunter & Schmidt, 2004). Following suggested methods, the results were tested, excluding extreme effect sizes – the lowest, the highest and a combination of both outliers – per investment criteria examined. The analysis showed that outliers did not impact the findings and were therefore not excluded from the sample (Huffcutt & Arthur, 1995). Sampling or publication bias is a common problem with meta-analysis findings (Hedges & Olkin, 1985; Hunter & Schmidt, 2004). This problem describes an upward bias of the mean effect size. This is caused due to exclusion of unpublished data. It is argued that insignificant results are less likely to be

published, which might result in subjective and incorrect effect sizes. As the one-variable relationship in the form of arithmetic means as effect sizes is examined, significance does not influence the results (Lipsey & Wilson, 2001). Nonetheless, unpublished working papers and dissertations were included in the sample in order to prevent any bias of this kind. Calculations revealed that at least 11.454 null-effect studies are required, depending on the investment criteria analyzed to question the significance of results according to the file drawer technique. Therefore, this impact is limited (Rosenthal, 1979, 1991). Hunter and Schmidt (1994, 2004) propose adjustments for artifacts in meta-analyses. Due to the transformations, method of analysis and the data used, effects of artifacts have not influenced the results. As no variables testing the scaling behavior of cultures and regions could be coded, all ratings per regional cluster were analyzed with regard to statistically significant differences using two non-parametric tests – the Kruskal-Wallis and Mann-Whitney-U test. Both tests confirmed that the regions do not differ with regard to scaling behavior at the $\alpha = 0,1$ level of significance (Kruskal & Wallis, 1952; Mann & Whitney, 1947). These empirical tests regarding the differences between groups were elaborated based on the normalized scores (Wright et al., 2002). After empirical operations were undertaken, results were transformed back to a 5-point Likert scale measurement as presented in the tables of findings.

Different approaches for grouping countries into clusters, or delimiting institutions from each other, were already applied in the past (Haire, Ghiselli, & Porter, 1967; Hofstede, 1976; Sirota & Greenwood, 1971). The approach of the regional clustering of societal cultures used by House et al. (2004) was chosen. They followed the holistic approach already used by Ronen and Shenkar (Ronen & Shenkar, 1985). Countries that are expected to have high cultural similarity identified by previous research were grouped within one cluster (Inglehart, 1997; Schwartz, 1994). The countries were placed into three regional clusters – Anglo-America, Europe, and Asia. This step is legitimate as the merged clusters reflect limited cultural differences according to House (2004).

In order to test the clusters for moderating effects of regions, three different methods were employed to analyze the relationships between effect sizes and contingency variables as well as to determine whether these variables were related to the heterogeneity of effect sizes. An independent t-test with weighted standard deviation was applied when comparing regional clusters. Results showed that the mean effect sizes differed significantly and gave the first indications of moderating effects. Sample size and inverse variance (Lipsey & Wilson, 2001) were used as weights to perform this statistical procedure. Both results showed only little significant deviations (Field, 2009).

5.4.3 Descriptive Statistics

After selecting and coding all usable studies, the empirical data was analyzed according to descriptive statistics. Out of the total study sample population of 44, there is data generated from 2370 venture investors. Publication date ranges from 1974 until the latest study, which was published in 2007. During this time span of over 30 years, research generated 588 independent variables, which could be coded. Table: 7 gives an overview of the main results.

Table: 7 Descriptive statistics

Number of Sample Population	44
thereof A plus rating	10
thereof A rating	1
thereof B rating	3
thereof C rating	11
thereof D rating	7
thereof no rating	12
Total Sample Size	2370
1974-1985	202
1986-1997	1289
1998-2008	879
Regional Distribution	44
Anglo-America	22
1974-1985	4
1986-1997	14
1998-2008	4
Asia	12

1986-1997	8
1998-2008	4
Europe	10
1986-1997	4
1998-2008	6
Number of independent variables coded	588
Entrepreneur Personality	179
Entrepreneurs Experience	94
Financial Aspects	87
Market	123
Product/Service	93
Team	12

Interestingly, the journal ratings of the studies used¹⁴ showed no normal distribution around B or C journals as might be expected. The majority of the articles were 12 unpublished dissertations or working papers followed by A plus and C journals with 10 and 11 articles. The period in which most venture investors were analyzed reflected the assumptions of this study. The venture industry was first established in the U.S. in the early 70s and gradually expanded around the world; thus the number of investors investigated increased significantly from the period 1974-1985 to 1986-1997. Regarding the regional distributions of the sample size populations, the U.S. represents the largest sample population used with 22. This again reflects the historical development of the new venture finance industry originating in Anglo-American countries. Comparing the regional distribution with its periodic background leads to interesting insights. Very early studies were only conducted in Anglo-American countries as the new venture investment industry started in the U.S. However, it is remarkable that more Asian studies were published in the late 80s and early 90s than in continental Europe. This finding could be interpreted as due to the fact that European scholars might have adopted the latest empirical methods earlier than their Asian counterparts. As described, this led to several exclusions for this meta-analysis, which actually contradicts the current trend of increasing

¹⁴ For coding the quality of journals used the ranking list of the VHB German Academic Association for Business Research available at <http://vhbonline.org/service/jourqual/vhb-jourqual-21-2011/jq21/> was used.

research activity, particularly in Asia (Bonini & Alkan, 2011; Bruton et al., 2010; Cumming et al., 2010; Dai et al., 2011; Li & Zahra, 2011; Schertler & Tykvová, 2010).

When looking at the statistics representing the independent variables coded, the numbers show what was often predicted. The entrepreneur and entrepreneur-related criteria are by far the most dominant factor analyzed when assessing a new venture investment. Market aspects are ranked second, demonstrating their great importance for venture investors and researchers alike. Product and service criteria and financial aspects both rank third, with equal relevance within this high-level statistical analysis.

Table: 8 represents an overview of all 33 investment criteria coded in the meta-analysis and the related findings. At this point, it is not intended to describe every aspect of each region and decision criterion but rather to highlight some of the most interesting results. In general, the past academic assumptions about the primary importance of the entrepreneur are confirmed. 8 out of 10 of the most important investment criteria refer to the entrepreneur; including perfect team match. Surprisingly, social skills ranks first, followed by the capability of intense efforts. Industry and market experience ranks third overall, and first within the experienced-based criteria. Market size and growth stand out as important investment criteria and rank higher than any product factors. However, it is interesting that other market-related criteria rank relatively low. The most interesting finding is that, according to this analysis, it cannot be generalized that all investment criteria regarding the entrepreneur are more important than market or product criteria. For this kind of analysis, a detailed differentiation is needed, which is out of the scope of this dissertation.¹⁵ Important and specific international differences with regard to the different regional clusters are presented in the subsequent section and the appendix.

¹⁵ Detailed results in the form of effect sizes, inverse variance, and t-statistics of each single investment criterion can be found in the appendix.

5.4.4 Comparison of Regional Results

As a detailed interpretation and reasoning of the results is subject to further research, the subsequent paragraphs only highlight some of the most significant findings of the empirical analysis. The significant differences according to the t-statistics are presented in the following table.

Table: 9 t-statistics

		Anglo-Asia		Europe-Asia		Anglo-Europe	
		SZ	IV	SZ	IV	SZ	IV
1. Entrepreneur Personality							
1.1	Ability to evaluate and react to risk/courage			*	*	*	*
1.2	Appropriate personality for business		*		*		
1.3	Articulation capability/motivation						
1.4	Attention to detail						
1.5	Capability of intense effort						
1.6	Educational level			*	*	*	*
1.7	Financial and analytical skills	*	*				
1.8	Managerial skills						*
1.9	Marketing skills	*	*				
1.10	Technical skills						
1.11	Social skills	*	*				
2. Entrepreneur Experience							
2.1	Demonstrated leadership						
2.2	Industry/market experience						
2.3	Investor's familiarity with entrepreneur		*				
2.4	References of entrepreneur/team	*	*				
2.5	Success track record		*				
3. Financial Aspects							
3.1	Easy liquidation possible				*		
3.2	High expected return (within 5 years)						
3.3	Investment as first round investment						
3.4	No follow-on investments expected						
3.5	Size of investment						
4. Market							
4.1	Existing distribution channel				*		
4.2	High market growth rate	*	*	*	*		
4.3	Investor's familiarity with market						
4.4	Little competition		*		*		
4.5	Market stimulated by the product/service						
4.6	Market size						
4.7	Creation of a new market by product/service						
5. Product/Service							
5.1	Existing market (acceptance) for product						
5.2	Existing prototype						
5.3	High degree of innovation						
5.4	Protected product						
6. Team							
6.1	Perfect team match						*

The meta-analysis reveals that investors in Asia rely much more on references than do Anglo-American investors. The t-test is only significant at a 97,5% significant level of difference

when the relationship between Asia and Anglo-America is verified. Moreover, the empirical results demonstrate that Asian investors rely on trust in the form of familiarity with the entrepreneur to a greater extent than venture investors in developed markets. Their absolute relevance is much higher compared to Anglo-American investors. Furthermore, the Asian venture investors are absolutely more concerned about the success track record of the entrepreneur than their Anglo-American counterparts. According to the results of the t-test, the findings are significantly different from each other.

The relevance of market data was tested based on the competitive situation to which the potential investment opportunity is exposed and the expected potential growth of the market into which the product can be placed. Interestingly, observing the level of competition and market growth rate as investment criteria reveals that the venture investors from Asian countries emphasize market criteria higher than their European and Anglo-American counterparts. However, there is no significant difference between Anglo-American and European, as investors proven by the t-test. When comparing these two types of investors to the European investors, a t-test shows a significant distinction with regard to assessing the ability to react to risk. This criterion is most relevant for European investors. Moreover, there is no difference between Asian and Anglo-American investors. When analyzing the appropriate personality for business, the results are varied. There is no significant difference between Anglo-American and European investors. However, the Asian investors emphasize this criterion, leading to a significant difference compared to their European and Anglo-American counterparts. The t-test is positive for both comparisons. There are significant differences with regard to analytical, social, and marketing skill between Anglo-American and Asian investors. On the one hand, American investors rely more on marketing and social skill than the Asian investors. On the other hand, analytical skill is more emphasized by Asian investors. Lastly, the criterion of the educational level is worth mentioning. There are significant differences between European and Anglo-American as well as European and Asian

investors. Interestingly, the relevance is least in terms of the European investors. There is no significant distinction between the Asian and Anglo-American investors.

5.4.5 Limitations

There are some limitations to this empirical analysis and its explanatory power. From a methodological standpoint, it might be argued that the latest research shows that the importance of investment decision criteria changes between different stages of the new venture assessment process and there are might be some important criteria still not identified. Moreover, the data is generated through post-hoc research methods, which can be subject to rationalization bias (Petty & Gruber, 2011). These drawbacks cannot be denied, but having used studies with the same empirical framework, general assumptions can be made despite certain biases. Moreover, the studies used did not focus on a particular stage during the investment process. As such, the evaluation of venture investors might be concentrated on a general assessment of investment criteria independent of stage. It is believed that this analysis of 44 sample populations represent an adequate international overview of the relevance of the investment decision criteria of venture investors. It is the first analysis to compare these criteria across 16 countries, whereas other studies concentrate on a single country and region. Criticisms of meta-analysis certainly exist. It is argued that meta-analysis ignores qualitative differences between studies and study quality. However, qualitative differences and the impact of quality are normally coded as a moderator. Moreover, the criticism of opponents centers on the idea that meta-analysis are not able to derive solid conclusions as significant empirical results are published only, making it a “garbage-in, garbage-out” procedure. These arguments can be mitigated as meta-analyses are less influenced by the bias of including only published data, as unpublished studies are supposed to be included. Furthermore, a properly conducted meta-analysis offers insight in its methodology and selected studies, which make it easier to detect poor meta-analysis compared to poor narrative reviews (Borenstein et al., 2009; Lipsey & Wilson, 2001). Addressing methodological limitations of this study, grouping

countries in regions because of relatively small sample size in some countries can be criticized. However, other studies showed that this can be an appropriate approach if applied correctly (Wright et al., 2004) to overcome the problem of small sample size and obtain an general overview of institution-based differences.

A potential bias of these findings might be that newer studies could not be included in the sample due to an emerging use of conjoint analysis as an empirical method. As it was controlled for publication year in the meta-regression, this bias is limited. Moreover, low numbers of studies analyzing certain investment criteria could pose a bias to the empirical results. Meta-analysis synthesizes the current state of empirical research; therefore, derived findings need to be interpreted in light of studies available and used (Borenstein et al., 2009). Due to the data reported, there are two possible reasons for false interpretation of the results: biases and heuristics and signaling (Levie & Gimmon, 2008). Similar arguments might arise because the findings of VCs and BAs are synthesized. Research has shown that there are differences between these two types of venture investors. However, when it comes to the entrepreneur's characteristics and market criteria, both are in close agreement (Haar et al., 1988). The results were controlled. Firstly, the limited number of studies investigating business angels was excluded. Secondly, the type of investor as control variable was used in the regression model. The results revealed similar empirical insights.

6 New Venture Risk Assessment and Reduction

6.1 *Relevance for Venture Capitalists*¹⁶

As described in the section of the risk return profile of new ventures, investments in new ventures are very risky (Cochrane, 2005). As new ventures are highly intangible, and tangible assets are highly specified, each investment is typically sunk for the VC (Tykvova, 2007). In order to control investment risk, there are several risk factors that must be assessed and considered by the VCs before investing in a new venture. Therefore, risk management of external and internal risk factors is crucial for the VCs (Kut, Pramborg, & Smolarski, 2006). The ex-ante determination of risk always involves uncertainty in itself, since a perfect quantification of the probabilities of outcomes is difficult and often based on past events, which are not available in the case of a new venture (Mishra & O'Brien, 2005). Moreover, risk factors of new ventures in particular change during an investment period (Van Gelderen, Thurik, & Bosma, 2005). With these insights, many quantitative and qualitative risk factors prevailing and no experience in terms of historical data, the new venture risk assessment is a very complex, but important, decision process (Mantell, 2009) with each investment step requiring new multiple decisions (Payne, Davis, Moore, & Bell, 2009). This highlights the need of an appropriate risk assessment model for new ventures.

Due to the high risk of new ventures and the underlying complex and difficult risk assessment process, VCs attempt to reduce the risk. Research has identified a variety of risk reduction strategies available to the VC when structuring a deal. The main risk-reducing instruments are analyzed in the last part of this section. They involve transaction costs, which must be also considered during the investment decision and compared with alternative approaches (Hopp & Lukas, 2012). Therefore, analyzing the development of different types of risk, the risk-

¹⁶ This section contains elements of the unpublished working papers: Buchberger, A., & Grichnik, D. (2013): New Venture Risk Optimization: A Multi-Stage Approach for Venture Capital Firms, Unpublished Working Paper. / Buchberger, A., Grichnik, D., & Koropp, C. (2013): New Venture Risk Assessment for Venture Capitalists: An Analytic Hierarchy Process Model, Unpublished Working Paper.

influencing mechanisms, and the related costs in order to find an optimized risk allocation for the VC is important and must be accomplished simultaneously. This even increases the complexity of the risk assessment process of the VC and emphasizes the relevance of decision models for general new venture risk assessment.

As described, Cochrane (2005) finds a highly skewed return distribution with high volatility. As the distribution of returns of these firms is asymmetric, it decreases the reliability of conventional risk models assuming normality by understating downside risk and kurtosis (Korteweg & Sorensen, 2010). Therefore, frequently used risk measures such as the variance of returns still neglect the magnitude and frequency of large, negative returns of VC investments (Cochrane, 2005). Moreover, determining in advance these risk parameters of new ventures with no or limited financial data available is very challenging (Kerins et al., 2004; Korteweg & Sorensen, 2010) as forecasting returns of young firms with no historical track record involves high uncertainty (Messica, 2008). Moreover, the performance of new ventures depends to a large degree on intangible and qualitative factors as described in the previous section. Therefore, the assessment of new venture risk is forced to shift from a pure quantitative analysis towards a more qualitative assessment.

However, the majority of financial risk models do not consider subjective factors during the evaluation of risk (Szego, 2002). A decisive reason for that is the complexity of incorporating qualitative aspects requiring a decision model into a quantitative risk model (Jia & Dyer, 2009). Indeed, there are few studies developing or analyzing alternative risk assessment models for new ventures, e.g., Boudreaux, Rao, Underwood, and Rumore (2011), Ewens (2009), and Vos (1992). However, these models are mainly based on financial data, approach risk assessment ex-post, and disregard important venture-specific qualitative factors as described above. Based on these insights, financial risk theory, including modeling risk and risk measures, risk perception, and aggregation of risk, must be further analyzed. This is accomplished in the subsequent sections.

6.2 *Financial Risk Theory*

6.2.1 *Risk Preference and Perceived Risk*

Studies have shown that perceived riskiness and preference are two distinct concepts (Brachinger & Weber, 1997; Weber, Anderson, & Birnbaum, 1992). The meaning of risk depends on the people and the situations (Finucane, Alhakami, Slovic, & Johnson, 2000; Ganzach, 2000; Ganzach, Ellis, Pazy, & Ricci-Siag, 2008; Slovic et al., 2007). Risk averse investors only invest in risk-free assets or if the risky asset's return compensates for the risk taken, i.e., the asset has a positive RP. However, a risk neutral investor will only analyze the expected return as the level of risk is not decisive. Risk lovers gamble. They invest in fair games and enjoy being exposed to the risk taken (Bodie et al., 2005, pp.168-170).

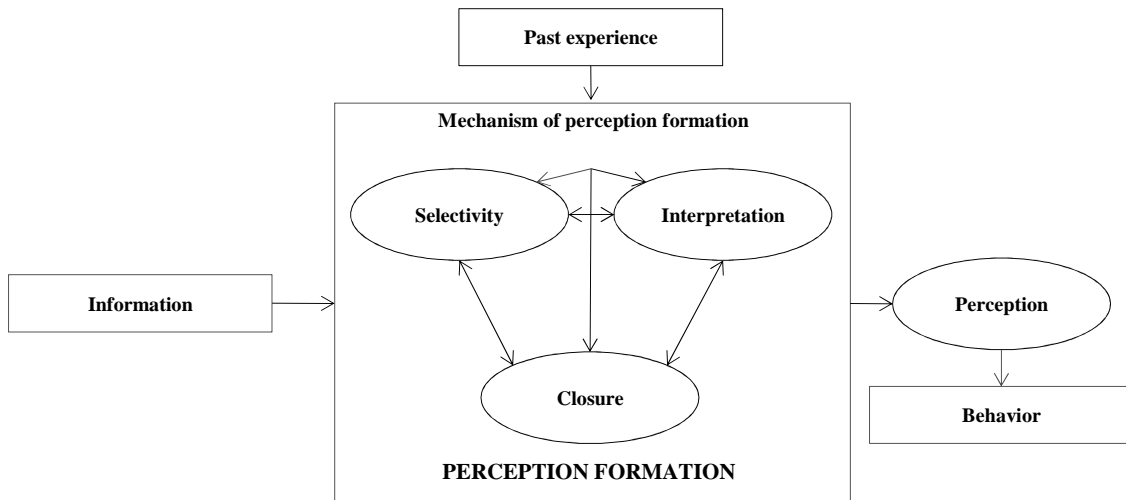
There is a difference between measuring risk and risk preference. Preferences can be ordered by comparing individual preferences A and B with financial consequences, i.e., risk, XA and XB . This is accomplished by applying a preference function Φ on XA and XB . If $\Phi(XA) > \Phi(XB)$, then A is preferred over B ($A \succ B$) (Weber & Johnson, 2009). The utility function (Von Neumann, Morgenstern, Rubinstein, & Kuhn, 2007) and (cumulative) prospect theory (Kahneman & Tversky, 1979; Tversky & Kahneman, 1992) are established preference models. In comparison, a risk order $A \succ_R B$ implies that A is riskier than B . This link is illustrated by an objective risk measurement function R (Albrecht, 2003). Thus, risk preference is the preferability of an alternative under conditions of risk and depends on preference. Risk is only one, but a significant aspect in this context. The preference of a decision maker depends on additional positive or negative features. Thus, risk ordering that is subject to many risk theories needn't simply be related to the preference ordering (Brachinger & Weber, 1997). Empirical studies of preference under risk show that loss affects preference more than gain (Fishburn & Kochenberger, 1979; Kahneman & Tversky, 1979). Findings in risk judgment coincides with this (Weber, 1988; Weber & Johnson, 2009). Moreover, recent

research has shown that preference differs; changing the fourfold pattern of prospect theory (Kahneman & Tversky, 1979); if the options are explained or experienced through feedback and observation (Barron & Leider, 2009; Hau, Pleskac, & Hertwig, 2009; Rakow & Newell, 2010).

When discussing objective risk measures, there are several issues to consider. In principle, objective measures are quantitative as they can be based on past occurrences. Finance scholars often prefer this notion of risk as an effective investment method. However, this kind of risk is only objective if the probabilities of occurrence are objective and can be observed in nature. Different forms of investments, which are not exactly similar, like investments in different new ventures, are always exposed to some level of inevitable subjectivity (Moore, 1968). When talking about objective risk, people consider risk as precise and including all obtainable knowledge and data, whereas perceived risk is influenced by factors of subjectivity (Garland, 2003).

Perceived risk is the amount of risk attached to a given alternative dependent on the perception of an individual decision maker, and is determined by the subjective amount of potential losses and its subjective probability. Models of perceived risk are very often normative and include expected utility theory or non-expected utility functions (Jia & Dyer, 1996; Jia, Dyer, & Butler, 1999). The figure below (Kast & Rosenzweig, 1974; Ricciardi, 2004) gives an overview of how risk perception can be formatted.

Figure: 2 Model of risk perception



The attractiveness of an investment is determined by its perceived risk and its perceived return. Perceived risk reflects actual risk and perceived return is supposed to reflect actual return. This risk perception is a bottom-up model (Jia & Dyer, 1996, 2009; Sarin & Weber, 1993). By contrast, a top-down model is proposed by research indicating that basic affective reaction underlies complex evaluations and that specific perception and decisions are often gained from a comprehensive evaluation of a prospect. It relies on a preference and comprehensive attitude regarding the prospect. Risky prospects are considered unidimensional. They range from “good” to “bad”. If evaluated as “good”, the prospect is considered to have low risk and high return (Kahneman, 2003; LeDoux, 2001).

Individuals’ choices can differ either due to differences in risk perception or in risk attitude (preference) (Knight, 1921 reprint 1964). However, there are concepts, which combine both differences. It is demonstrated that risk perception changes due to choices, and a perceived risk attitude is remarkably constant for individuals (Weber & Milliman, 1997). For some time, risk was primarily analyzed from a utility perspective in operational research and management science (Pedersen & Satchell, 1998). It was shown that this approach is compatible with some type of mean-risk models (Bell, 1995) or risk-value models (Sarin & Weber, 1993). Risk-value models refer to decision making under uncertainty, assuming that the preference for an alternative is exclusively determined by its riskiness and its value. The

decision problem is to choose among possible risk-value combinations wherein riskiness of each alternative is numerically represented by a risk measure (Jia & Dyer, 2009). Further aspects of risk preference and perception, which are important for the risk model developed, are described in detail in the appropriate subsequent sections.

The fact that entrepreneurs, managers, and VCs differ with regard to risk perception is generally accepted (Busenitz & Barney, 1997). Therefore, it is argued that entrepreneurs might use information differently, rely more on intuition, follow instincts, or apply different heuristics and rules in order to make decisions (Cooper, Folta, & Woo, 1995; Forlani & Mullins, 2000; Schwenk, 1988; Schwenk, 1986). This results in differing constitution of risks compared to the non-entrepreneurial individuals (Janney & Dess, 2006). The outcome of risk assessment depends on the choice of measurements and methods used. Therefore, the risk, which is supposed to be captured or measured, must be determined precisely (Baucus, Golec, & Cooper, 1993; Bromiley, Miller, & Rau, 2001; McNamara & Bromiley, 1999).

6.2.2 Modeling and Measuring Financial Risk

Risk is normally modeled as a random variable. It is measured through a function RI , mapping a space X of random variables, e.g., the returns of a given set of investments, to a non-negative real number $RI(X)$, i.e., $RI: X \rightarrow \mathbb{R}^+$. If, for example, X defines the loss of a financial portfolio, then $RI(X)$, can be interpreted as the amount needed to compensate that loss. Scalar measures of risk allow a comparison of different investments according to their level of risk (Embrechts et al., 2009). According to Artzner et al. (1999), any acceptable risk measure $RI: X \rightarrow \mathbb{R}$, the so-called “coherent risk measure”, must satisfy the following features:

- Translation invariance: $RI(X + r\alpha) = R(X) - \alpha$, for each risk X . Adding the sure initial amount α to the initial position and investing it in the reference instrument simply decreases the risk measure by α .

- Positive homogeneity: $RI(cX) = cRI(X)$, for all risks X and constants $c > 0$.
- Monotonicity: if $X \leq Y$ a.s., then $RI(X) < RI(Y)$, for all random variables X and Y ,
- Subadditivity: $RI(X + Y) \leq RI(X) + RI(Y)$, it can be shown that any positively homogeneous functional RI , is convex if it is subadditive. This reflects the idea that risk can be reduced through diversification.

These axioms also apply to situations of uncertainty when no measurement of probability is available in advance. For the model used in this study, the axiom of non-negativity $RI(X) \geq 0$ is added (Pedersen & Satchell, 1998). Thus, risk functions are mappings, which assign real risk values to a probability measure. Risk modeling includes finding the appropriate probability distributions of the underlying uncertainty factors are available. Three sources of information are available in order to elaborate a risk factor probability model¹⁷ – historical data, i.e., empirical distribution, not considering any trends or long-term changes, theoretical considerations, e.g., GARCH models, ARMA models, vector autoregressive models, stochastic differential/difference equations, and expert opinion (Pflug & Römisch, 2007).

In general, financial risk measures can be grouped into two categories – risk as a magnitude of deviations from a target, i.e., risk of the first kind, and risk as necessary capital respectively necessary premium, i.e., risk of the second kind (Albrecht, 2003). Two-sided risk measurements apply the distance magnitude, i.e., from the realizations of X to $E(X)$ in both directions. This measure is also used in the pioneering work of Markowitz (1952). In this case, the standard deviation is mainly used to measure risk of portfolio or asset returns. However, there are situations in which the standard deviation alone is no adequate measurement of risk and further mean-variance analysis must be completed. To do so, the entire set of possible outcomes during a certain period of time should be analyzed. As described, the probability distribution function comprises all important key data. One

¹⁷ Standard statistical parameters consist of location parameters, such as mean or median, dispersion parameters, such as variance or lower semi variance, and correlation parameters, such as covariance, correlation (Pflug & Römisch, 2007). Additionally, behavioral studies contribute to subjectivity and risk modeling. It is argued that irrationality and the caused errors are predictable (Kahneman & Tversky, 1979).

important data are the expected value of outcomes or the mean, the median and the mode. The gain for bearing a certain risk is normally evaluated by the expected value across all possible scenarios and can be described by (Bodie et al., 2005):

$$E(r_i) = \sum_{s=1}^n \text{Pr}(s) r(s) \quad (21)$$

where s are the possible outcomes, $r(s)$ is the return for outcome s , and $\text{Pr}(s)$ is the probability. The median can be described by “the outcome value that exceeds the outcome values for half the population and is exceeded by the other half” (Bodie et al., 2005, p. 184). As the median considers the rank order, it can differ from the mean significantly. This is especially the case, if there are extreme values. By contrast, the mode describes the outcome with the highest probability (Bodie et al., 2005, pp. 184-190). Additionally, the deviation is an important key data. Deviations can be measured in two ways. First, expected absolute value of deviation known as mean absolute deviation can be used given by:

$$\sum_{s=1}^n \text{Pr}(s) * \text{Absolute value}[r(s) - E(r)] \quad (22)$$

The second possibility is the expected squared deviation:

$$\sigma^2 = \sum_{s=1}^n \text{Pr}(s) [r(s) - E(r)]^2 \quad (23)$$

The variance σ^2 does not represent the entire distribution function of risk. When analyzing risk, the negative uncertainty is important. For example, there are two probability distributions A and B with the same expected returns and variances and that the probability distribution B is the same as of A with one difference: it is mirrored. Therefore, the downside risk for one distribution is higher compared to the other one. This difference of asymmetric distributions is named skewness and can be measured by the third central moment (Bodie et al., 2005):

$$M_3 = \sum_{s=1}^n \Pr(s) [r(s) - E(r)]^3 \quad (24)$$

The skewness is positive for right-skewed distributions, i.e., long tail on the right side and more upside potential, and negative for left-skewed distributions (Bodie et al., 2005; Ebert, 2005). Portfolio theory assumes that the returns are normally distributed. The argument that only the first two moments are important was analyzed by Samuelson in 1970. It is shown that higher moments are important but neglected by investors (Samuelson, 1970). However, when analyzing new ventures, this might pose a problem as their distributions are highly skewed (Cochrane, 2005). Therefore, the measure of downside risk is important for new ventures, which is analyzed in the next section.

6.2.3 Measurement of Downside Risk

With highly skewed return distributions and the fact that VCs should care about risk as losses (Korteweg & Sorensen, 2010), emphasis should be on downside risk rather than return variability (Miller & Leiblein, 1996). Due to its relevance for new ventures and this study, it is analyzed in more detail. In the pre-Markowitz era, an ad-hoc correcting factor of expected returns was used to account for financial risk. First, Markowitz (1952) suggested measuring risk by means of the deviation from the mean of the return distribution, i.e., the variance. If several assets are combined, the risk level is calculated through the covariance between all investments and leads to the main pricing models CAPM and APT. However, this type of measure can only be applied if the relevant distribution of return is symmetric (Szego, 2002). Unfortunately, the Markowitz model is often incorrectly applied to many cases in real life situations, like risk of new ventures, where risk cannot be described by pure variance and dependence cannot be determined by linear correlation coefficient. Variance neglects fat tails of the underlying distribution, as new ventures have. This leads to the integration of skewness and kurtosis into risk models (Albrecht, 2003). Additionally, the two-sided risk measures

described above are contrary to the intuitive understanding of risk being only dangerous if negative deviations are existent. In certain cases, it is only interesting that the risk of outcomes does not meet a target value (Unser, 2002). Investors often argue that it is better to miss a positive outcome if, for that to occur, a negative outcome with relatively greater possibility must be first accepted (Janney & Dess, 2006).

This concept of downside risk was already introduced by Markowitz (1952) and Roy (1952) in the early 50s. Markowitz (1959) argued that investors want to minimize downside risk for two reasons: 1. the financial securities might be not normally distributed, 2. an investor only cares about downside risk. However, it took some decades until the 90s for downside risk measures to begin to emerge in the practitioner literature. Brian Rom (Rom & Ferguson, 1994) and Frank Sortino (1991; Sortino & Satchell, 2001) are one of the strongest supporters of the downside risk measure for practical purposes. Regarding downside risk as a one-sided risk measures, it is determined relative to a target figure. This target is in general a deterministic target z . This can be a target gain, a minimal accepted return or a stochastic benchmark, i.e., mean or median (Balzer, 1994). The class of lower partial moments is a general class of this kind of risk measure and can be expressed by (Unser, 2002):

$$LPM_k(z; X) := E[\max(z - X, 0)^k] \quad (25)$$

There are special cases of downside risk. They can be described by the type of loss consideration.

With shortfall probability:

$$SP_z(X) = P(X \leq z) = F(z) \quad (26)$$

With shortfall expectation:

$$SE_z(X) = E[\max(z - X, 0)^1] \quad (27)$$

With shortfall variance:

$$SV_z(X) = E[\max(z - X, 0)^2] \quad (28)$$

The semi variance is obtained by replacing z with $E(X)$:

$$SV_\mu(X) = E[\max(E(X) - X, 0)^2] \quad (29)$$

The most commonly known technique is the semi-variance (special case) and the lower partial moment (general case). Balzer (1994) and Merriken (1994) also analyze skewness in asset returns and the relevance of the semi-variance and its applications. Thus, the beta factor used in the CAPM is regarded as questionable. Hence, the downside beta based on semi-variance, proves to be a more appropriate measure of risk especially for diversified investors of small and private companies (Bali, Demirtas, & Levy, 2009; Estrada, 2004, 2007b, 2008). An additional advantage of using semi deviations as risk measures is that it follows the assumption of second degree stochastic dominance (Ogryczak & Ruszczycki, 1999).

6.2.4 Aggregation of Risk

As total risk of new ventures consists of several internal and external risk factors, aggregation of risk is relevant for the development of a theoretical risk and cost of equity model. Risk aggregation can be defined by the task of incorporating several types of risk into a single metric. The metric defined is often the overall capital at risk or value at risk for a financial institution. However, other metrics can be more appropriate depending on the purpose-specific context applied. The three main issues with which one must cope are (a) the identification of the components, which must be aggregated, (b) the appropriate technique or algorithm for the risk aggregation, and (c) the calibration of the parameters such as correlation coefficients in order to derive the single risk metrics (Saita, 2004). This section concentrates on the second topic – risk aggregation – after presenting some important notes on correlation.

The difference between dependence and correlation can be described as follows: If there is no statistical condition of independence, two variables are considered dependent. In contrast, correlation merely indicates that two variables move together; a causal relationship is not

mandatory (McClave, Benson, & Sincich, 2008). When using the Pearson's correlation coefficient, there is a significant challenge. The Pearson's coefficient is zero if the variables are independent. However, the reverse is not right. The correlation formula identifies solely linear dependencies. Therefore, two variables can be perfectly dependent and the correlation is zero. Uncorrelatedness can be regarded as counterpart to independence if two variables are normal (Dowdy, Wearden, & Chilko, 2004). Non-linear relationships can be illustrated by rank correlation coefficients. These include Kendall's rank correlation coefficient (τ) and the Spearman's rank correlation coefficient (Hoeffding, 1957; Kendall, 1948).

The idea of correlation as a dependence measure between financial instruments is derived from the CAPM and APT. However, in terms of general risk management, this assumption is often challenged when the distributions of risk deviate. For instance, a multivariate t-distribution with uncorrelated risk factors is not a distribution with independent risk factors. This is an example wherein zero correlation does not necessarily imply independence of risk. Only with multivariate normal distribution, uncorrelatedness can always be interpreted as independence. Therefore, risk management systems built on purely "CAPM thinking" can have shaky foundations. Hence, not only must each of the risks have a normal distribution, but they must also jointly have a multivariate normal, also known as multivariate Gaussian, distribution (Embrechts, McNeil, & Straumann, 1999).

As to aggregation of risk, a very general approach of two correlated risk types can be expressed through:

$$F_{RI1 \cup RI2} = (F_{RI1} + F_{RI2}) - (F_{RI1} \cap F_{RI2}) \quad (30)$$

with $RI1$ and $RI2$ representing two risk factors. But the question is how the intersection of F_{RI1} and F_{RI2} ($F_{RI1} \cap F_{RI2}$) can be determined. Risk types differ extensively. While some types are easily characterized and measured, like market risk, much less is known about other risks with varying distributional shapes (Rosenberg & Schuermann, 2006). A major problem is how to obtain the simultaneous distribution of all risk factors and the parameters involved.

When analyzing risk aggregation models, there is normally a distinction between the classic square root formula (SRF), the multi-factor approach, and an aggregation through copulas. The prevailing field of research in which risk aggregation is most often analyzed is the banking industry (Brockmann & Kalkbrener, 2010; Saita, 2004).

The first approach, the square root formula, represents a simple and, in practice, popular way of aggregating risk. It is based on the covariance structure of different risks and designed for elliptic distributions only (Kuritzkes, Schuermann, & Weiner, 2003; Rosenberg & Schuermann, 2006). The SRF can be expressed with an example from the Solvency II Directive for insurance companies (Christiansen, Denuit, & Lazar, 2010) through:

$$SCR_T = \sqrt{\sum_i \sum_j SCR_i SCR_j Corr_{ij}} \quad (31)$$

with SCR_T representing the solvency capital requirement, SCR_i and SCR_j are the sub-module components of total risk, and $\rho = Corr$ is the correlation coefficient of the two components. This formula¹⁸ is similar to the portfolio variance formula in asset management, which is:

$$\sigma_p^2 = \sum_{i=1}^n w_i^2 \sigma_i^2 + \sum_{i=1}^n \sum_{j \neq i}^n w_i w_j \sigma_i \sigma_j \rho_{ij} = \sum_i \sum_j w_i w_j \sigma_i \sigma_j \rho_{ij} \quad (32)$$

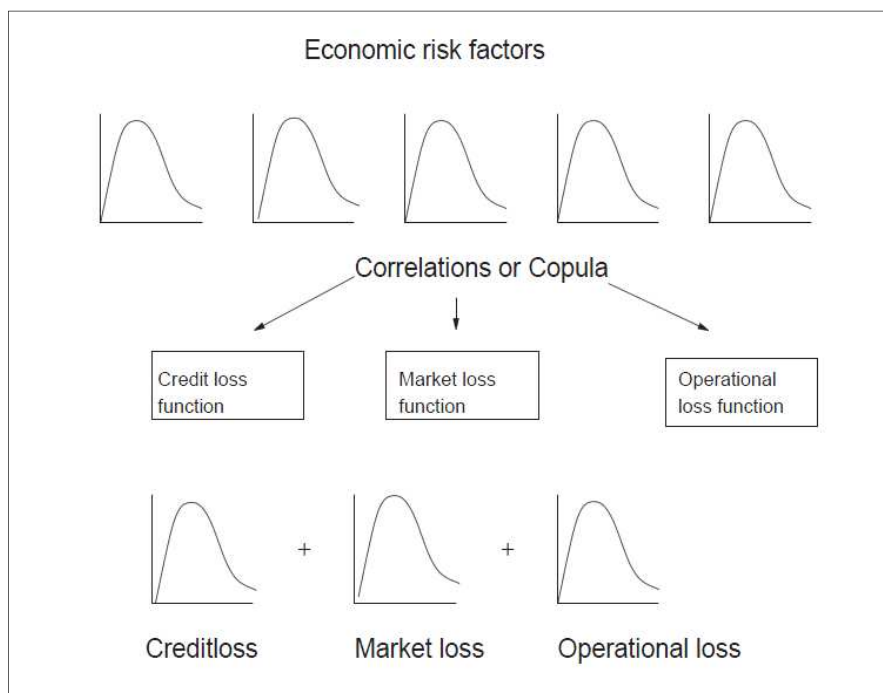
where ρ_{ij} is the correlation coefficient between the risk factors i and j . This is only applicable when there are no problems for elliptic distributions; a particular case is a multivariate normal distribution or multivariate student distribution (Saita, 2004).

A multi-factor approach is another alternative of risk aggregation. It identifies economic risk factors that are influential on the different risk types. Then, a joint model is developed that integrates the different risk factors and their dependence structure based, for example, on a correlation matrix (Alexander & Pérez, 2003). The underlying losses are calculated by non-

¹⁸ Compare with Saita (2004) p. 26.

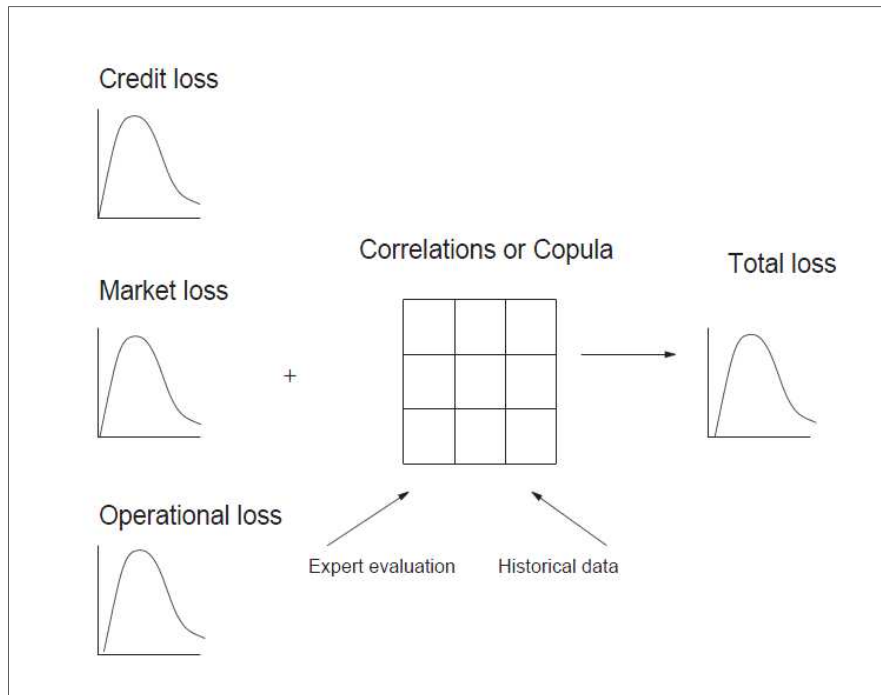
linear functions of the fluctuations in the risk factors. The following figure illustrates this approach using 5 risk factors and three risk types. Marginal models are related by integrating a common correlation matrix or copula. The movements in the risk factors are converted into losses by using a non-linear loss function for every risk type. The generated marginal loss distributions include the correlations indirectly through the correlation matrix or copula of the risk factors (Aas, Dimakos, & Øksendal, 2007). This is illustrated by Aas et al. (2007) in Figure: 3

Figure: 3 Risk aggregation I



The copula function approach starts with the independently determined loss distributions for the individual risk types. The marginal distributions are consolidated to a joint distribution. A correlation structure or copula function defines their dependence structure. This approach is supported by several researchers (Aas et al., 2007; Dimakos & Aas, 2004; Rosenberg & Schuermann, 2006; Tang & Valdez, 2005; Ward & Lee, 2002). A major advantage of the Copula function is that complex estimation methods can be used for the dependence structure as well as the marginal distributions (Hlawatsch & Reichling, 2010). This method is shown in the figure below by Aas et al. (2007).

Figure: 4 Risk aggregation II



The conceptual differences between the last two approaches are as follows: The copula model aggregates given loss variables for different risk types. The multi-factor model starts with the dependent systematic risk factors and determines the loss functions for different risk types on top (Brockmann & Kalkbrener, 2010).

6.3 Risk Reduction Strategies^{19 20}

6.3.1 Venture Capital Contracts

Agency problems represent the internal risk factors for VCs. Therefore, they are important in terms of contract design, staging, and monitoring (Kaplan & Stromberg, 2004).²¹ The VC can

¹⁹ This section contains elements of the unpublished working paper: Buchberger, A., & Grichnik, D. (2013): New Venture Risk Optimization: A Multi-Stage Approach for Venture Capital Firms, Unpublished Working Paper.

²⁰ In this section, it is concentrated on the particular risk-reducing strategies applied in the theoretical model developed. Additional risk reduction instrument, such as syndication (Ferrary, 2009), specialization (Gompers et al., 2009), and portfolio diversification (Cressy et al., 2012), are not analyzed.

²¹ The existence of asymmetric information is the fundamental assumption of signaling theory (Spence, 1974). The entrepreneurs are supposed to know more about the new venture than the VC (Keasey & Short, 1997). In this context, it is argued that entrepreneurs communicate to VCs a commitment and value signal based on their level of own investment (Morris, 1987). However, empirical analysis shows that these signals during the early stage do not have any significant impact on long-term venture risk and outcomes (Busenitz, Fiet, & Moesel, 2005). Therefore, aspects of signaling are not included in the model developed.

mitigate these principal-agent problems through contracting (Elitzur & Gaviols, 2003a), which is costly (Tian, 2011). Contracting theory analyzes how information and agency problems are mitigated by the allocation of contractual rights between an entrepreneur and a VC (Bengtsson & Sensoy, 2011b). It is customary for VCs to demand protection of their investment in the form of preference rights classified into cash flow and control rights (Kaplan & Stromberg, 2003). They can be regarded as control mechanisms (Sahlman, 1990) and have an influence on the exit channel (Cumming, 2008). There are several contractual control mechanisms that are generally accepted within the VC industry.²² The VC uses these clauses in order to reduce the internal risk of the investment. It is argued that the risk of the VC is minimized when there is an optimal level of goal alignment. This is difficult to be determined as the expected future development of the new venture is unknown. Moreover, the VC is often not familiar with the entrepreneur, which deteriorates this situation. However, during the early investment stage, the VC must assess the optimal level of control that is prevalent at that time (Payne et al., 2009). In general it is argued if internal risk is expected to be high, performance-sensitive compensation should be emphasized and the VC should retain more control (Kaplan & Stromberg, 2004).

As described, the topic on control in a VC-entrepreneur context is complex. It depends on benefits and costs of control, bargaining power, information asymmetry, participation constraints, skills, opportunistic behavior, efforts, and additional external variables (Tykvova, 2007). There are many studies that investigate the actual optimal determination of control rights between a VC and an entrepreneur. One interesting finding is that control and cash flow rights in a subsequent financing round contract are recycled from the previous financing round clauses, although changes might be necessary (Bengtsson & Sensoy, 2011a). There are only a few studies analyzing the agency risk and contractual terms from a theoretical model

²² Among the most common are: dilution of the entrepreneur's shares, the capability of making managerial changes, altering the compensation structure, cash flow rights, staged financing, and management stock ownership requirements or limits (Payne et al., 2009).

perspective. Elitzur and Gaviious (2003b) develop a multi-period game theoretic model that includes moral hazard consideration and shows that an optimal incentive scheme should shift as much incentive payment as possible to the entrepreneur. External influences, like bad financing conditions, are external risk factors and also influence the control rights (Lerner, Shane, & Tsai, 2003). However, most of these studies only analyze contractual terms while contract theory in combination with new venture risk assessment, monitoring or staging is neglected.

6.3.2 Staging and Monitoring

One important attribute of the VC is its ability to decrease the information asymmetries and consequently, agency risk. Therefore, VCs use financial staging (Elitzur & Gaviious, 2003b); i.e., the entrepreneur does not obtain the total necessary investment funds, but receives them in stages according to the new venture development. In general, staging has several major mechanisms. Staging represents a stopping option for the VC, which reduces the cost of financing (Dai et al., 2011). It gives the VC the option to continue or liquidate the firm (Hellmann, 1994). Through staging, VC can abandon new ventures with low returns and, therefore, distinguish between good and bad investments. If the output is low at an early stage, the VC should quit the investment. Moreover, staging skews resources to future financing rounds; i.e., it is efficient to invest greater amounts later (Dahiya & Ray, 2012; Krohmer, Lauterbach, & Calanog, 2009). In this context, the latest empirical research shows that staged financing is efficient (Dahiya & Ray, 2012). Without staging, many new venture investments might not become profitable if upfront financing was rejected (Wang & Zhou, 2004). It can be argued that the higher the actual risk of the new venture, the higher the value of the staging option for the VC. These insights are confirmed in several VC contexts (Gompers, 1995; Hege, Palomino, & Schwienbacher, 2003; Krohmer et al., 2009; Tian, 2011).

Staging can also be used as a signaling mechanism. Entrepreneurs with private information of the quality of the new venture can apply staging as a method to signal this quality (Dessein, 2005). It also represents a tool for the entrepreneur to show his commitment, i.e., not renegotiating the contract. Therefore, the problem of hold-up risk is decreased. VCs also use staging to reduce the bargaining power of the entrepreneur, which creates inefficiencies (Neher, 1999). By contrast, Hellmann (1994) claims that staged financing triggers the entrepreneur's short-term behavior. This implies a window dressing problem. The entrepreneur wants to continue funding and therefore manipulates short-term signals and prevents long-term goals (Cornelli & Yosha, 2003). However, this is relativized by Wang and Zhou (2004) who argue that short-termism caused by staging is of minor consequence.

Transaction costs are relevant to the staging decision. On the one hand, longer contracts are less flexible and high transaction costs emerge if the VC plans to terminate the contract in advance. On the other hand, longer contracts have the advantage that the VC does not have to frequently replace and negotiate them (Fehle & Tsyplakov, 2005). Thus, the longer individual stages are, the larger the risk that a significant amount of cash will be lost. Shorter stages, however, involve higher transaction costs due to the recurring assessment of information. Moreover, the delay through new negotiations causes costs and deteriorates the competitive advantage of the new venture. Thus, the staging decision is a trade-off between high transaction costs of new financing rounds versus less capital spent within one stage. The goal should be to determine in advance the optimal structure and timing of stages based on this trade-off. It is empirically shown (Bergemann & Hege, 2005) that initially, investment flow starts low because the failure risk is high at that early stage. Then, it accelerates when the new venture grows. Second, the investment flow reacts positively to information disclosed. Third, the higher the anticipated failure rate, the more financing rounds are used by the VC (Bergemann et al., 2009). Thus, it is shown that the duration of funding in later rounds and the investment amount increase over time (Bergemann et al., 2009). Later-stage new ventures

need less active monitoring and support from the VC; thus, there will be fewer stages for financing a new venture (Payne et al., 2009).²³

Hence, staging offers the VC the opportunity to learn about the new venture and the entrepreneur during a financing round (Bergemann & Hege, 1998). Gathering information at the beginning increases the efficiency of future choices. An important question is how to create an optimal investment policy that will reflect the trade-off between waiting for more information and the transaction costs incurred by doing so (Bouvard, 2010). Moreover, it would be interesting how other factors, like contracting and monitoring might impact the use of staging by VCs.

When analyzing new venture risk and staging, real options are used as a theoretical foundation (Hsu, 2010; Li & Mahoney, 2011; Sahaym, Steensma, & Barden, 2010) that consider the option to terminate the investment (Bigus, 2006; Copeland & Tufano, 2004; Pendharkar, 2010; Shockley, Curtis, & Jafari, 2003). Moreover, rainbow options for valuing biotechnology ventures including systematic risk and idiosyncratic risk are analyzed (Brous, 2011). However, there is no multi-stage approach focusing on VC risk assessment, staging, additional risk-reduction strategies, and the underlying transaction costs in a VC investment process.

Apart from staging, VCs can also solve incentive problems and reduce internal risk with direct monitoring. Active involvement of the VC through monitoring leads to different terms in the investment contract and less downside protection that has an impact on performance (Hopp & Lukas, 2012). Therefore, VCs with more experience, greater financial capacity to monitor, and more value-added services, demand weaker downside protection in the form of

²³ Similar results are derived when staging is analyzed with regard to return. It has a positive effect at the beginning of the investment, but is negatively associated in terms of return prior to the exit (Krohmer et al., 2009). Interestingly, some studies show a positive effect of staging on returns (Gompers, 1995; Hsu, 2010), while other claim a negative impact (Bergemann & Hege, 1998; Cornelli & Yosha, 2003; Hege et al., 2003). In contrast, it is also shown that staged investments can increase, decrease, or rise and fall over time (Giat, Hackman, & Subramanian, 2009).

contractual cash flow rights, but use their abilities instead to achieve non-financial rights, such as board representation (Bengtsson, 2011; Bengtsson & Sensoy, 2011a).

When comparing staging and monitoring, it is argued that monitoring and staging are substitutes in order to reduce agency problems (Tian, 2011). Both are costly. On the one hand, VCs have to spend significant time in order to accomplish effective monitoring of the entrepreneur. This is expensive but aims to decrease the new venture risk (Bottazzi et al., 2008). On the other hand, staging incurs negotiation and contracting costs for the VC and entrepreneur (Kaplan & Stromberg, 2003). Additionally, through staging, the entrepreneur focuses on short-term success and “window dressing” rather than on long-term creation of value in order to achieve the goals agreed on or increase the probability of the next financing round (Baker, 2000; Sahlman, 1988). Staging causes financing lags, which can be costly for the new venture due to longer development cycles among other things (Wang & Zhou, 2004). Therefore, the VC will balance the staging and monitoring initiatives in order to reduce risk and find the best combination of risk-reducing impact and higher transaction costs.

7 Financial Decision Theory

7.1 General Decision Theory

It was shown in the previous sections that risk factors of new ventures are often intangible and not easy to quantify. However, to evaluate these risk factors, qualitative factors must be quantified. To do so, decisions must be made by the VC. Moreover, the risk assessment process of the VC involves several decisions with regard to different risk factors, risk-reducing strategies, and the investment phase. It is at this point that decision theory, which deals with decision models and the process of deriving an optimal decision, becomes important. It plays an important role in accomplishing this task properly (Johnson & Busemeyer, 2010). Decision making is analyzed through different theoretical approaches. Normative theories focus on how to make the best decision by maximizing the expected utility among probabilities distributions of different outcomes; one example is the expected utility theory (Von Neumann et al., 2007). Descriptive models adopt findings of normative theories and incorporate known limitations of human behavior; they attempt to describe the way in which humans actually make decisions, rather than insisting what an ideal decision for any given situation is. The well-known (cumulative) prospect theory of (Kahneman & Tversky, 1979; Tversky & Kahneman, 1992) belongs to the descriptive models of decision making. In addition, computational methods focus on emotional, motivational and cognitive processes that lead to the selection of one choice over another. Contrary to both previous approaches, this method is built from cognitive and emotional processing assumptions and attempts to analyze the dynamic processes that influence the final decision. The most intuitive computational method specifying simple procedures are heuristics like certain rules, which describe discrete steps of decision making (Johnson & Busemeyer, 2010; Shah & Oppenheimer, 2008). In a risk context, scholars sometimes combine normative and

descriptive models and derive a prescriptive model of risk preferences. These models rely on both rational and realistic risk preferences (Sewell, 2009).

It is necessary to differentiate between decision-making under uncertainty and decision-making under risk. Hence, if the VC does not know which payoff will result from a particular decision, but if he knows all of the possible payoffs and the respect probabilities, then decisions are made under risk. By contrast, decision making under uncertainty prevails if the decision maker knows the payoff possible, but he does not know the underlying probabilities of the payoff. VCs try to analyze the potential payoffs of a new venture and to determine probabilities for each payoff (Johnson & Busemeyer, 2010; Ruhnka & Young, 1991). Therefore, these decisions can be made under risk.

Decision making is closely related to judgment policy studies. Judgment as a process can be described as forming an opinion, estimate or conclusion. Good judgment as a personal capacity is the capability to make a decision objectively. Overall judgment consists of several factors: the identification of salient variables, estimation of the simple bivariate relationships, and their impact, and estimates of the effects of multivariate contingencies of these variables. Overall judgment policy is an individual's specific though uncertain view of certain circumstances in a special domain. By contrast, judgment as an outcome is only the choice made and refers to decision making (Priem, Walters, & Li, 2010).

7.2 Biases and Heuristics of VCs

When intending to develop a new venture risk and cost of equity model based on subjective decisions, the decision maker must be considered and analyzed. The VCs are the most likely decision makers when it comes to new venture risk assessment. VCs have been subject to several studies on investment decision making and processes (Zacharakis & Shepherd, 2009). Optimal decision models require that the decision makers are rational (Power & Sharda, 2007). In reality, however, biases usually account for deviations from a only rational decision

process (Busenitz & Barney, 1997; Zacharakis & Meyer, 1998). There are several factors accounting for no rational decision processes (Busenitz & Barney, 1997; Zacharakis & Meyer, 1998), which are known as biases. It involves high costs revealing an optimal decision process (Simon, 1979) and uncovering limits of individuals regarding information processing (Abelson & Levi, 1985). The rationality required in managerial judgment and decision making rarely exists (Simon, 1959). Moreover, the type and amount of information available influences the decision process of the VC. If certain information becomes available, the VC's attention is shifted (Zacharakis & Meyer, 1998). Thus, biases, consisting of overconfidence, similarity effects, availability, values, and experience among other things, cause decision makers to process information incorrectly leading to judgments and decisions that are probably erroneous (Kahneman et al., 1982; Schwenk, 1988).

There are two types of overconfidence that influence decision making. First, optimistic overconfidence is the overestimation of the probability that a preferred outcome will occur. Secondly, overestimation of one's own know-how regards the validity of the judgment itself, even with no preferred outcome or hypothesis existent (Griffin & Varey, 1996). In a venture capital environment, the level of overconfidence depends on the type of information available, the amount of information used, and the level of belief of the venture capitalist that the new venture will succeed or fail (Zacharakis & Shepherd, 2001). Although, overconfidence does not necessarily results in a poor decision, the bias can decelerate or hinder the learning process. Zacharakis and Shepherd (2001) observe that overestimation can be reduced through counterfactual thinking, formally recording of steps and cues used in past decision making, and the use of actuarial decision aids that decompose decisions into basic elements. Closely linked to overconfidence, there exists an availability bias. If VCs are overconfident that a new venture is going to succeed or fail, they might limit information search (Zacharakis & Shepherd, 2001), which influences decision making. A similarity effect involves that an individual assesses other people, which are believed to be more likewise, much better (Byrne,

1971). An affective reaction is caused by perceived similarity, which influences the decision (Franke et al., 2006; Lefkowitz, 2000; Murnieks, Haynie, Wiltbank, & Harting, 2007). This fact is very relevant to the assessment of the management team of the new venture and its particular characteristics. The experience of the investors can also influence the decision-making process and the underlying risk perception as well as risk preference (Parhankangas & Hellström, 2007). Individuals making ad-hoc decisions often search their experience for a similar situation that occurred in the past and make little adjustments. This might work in predictable situations, but not in uncertain environments like the new venture market. Empirical evidence shows that it is already sufficient to provide an individual with a simple linear model and a “database” of previous situations in order to increase decision performance significantly (Hoch & Schkade, 1996). Research shows that inexperienced VCs enhance decision accuracy by gaining experience. However, beyond a specific point, gaining experience is considered as reduction of reliability of VCs’ decisions. An experienced VC might focus on features, which match past successes and failures, and therefore have increased susceptibility to an availability bias (Shepherd, Zacharakis, & Baron, 2003), with diverse degrees of importance attached to certain criteria depending on the experience of the investor (Franke et al., 2008). Values are similar to experience as an investment decision bias. Decision makers may resolve uncertainty by judging investment criteria or risk factors in accordance with their values (Matusik, George, & Heeley, 2008). Apart from the biases, decision makers try to handle complex situations by applying heuristics. Heuristics simplify decisions and lessen complexity through a decrease of the number of cues as well as choices. The decision-making context determines the level of heuristics applied by the decision-maker. If there are many choices available, heuristics are used more often (Payne, Bettman, & Johnson, 1993).

Entrepreneurs face similar problems when investing in and founding a new company. They invest in new ventures despite a high failure rate and a risk-return level higher than that of a

private equity index and even greater than that of a public equity index (Moskowitz & Vissing-Jørgensen, 2002). Subjective rationality and a strong conviction of success can explain this behavior. This entrepreneurial puzzle emerges from entrepreneurial risk, return, and the risk-return trade-off. Although risk is higher, the expected returns are equal to investments in less risky assets (Deligonul, Hult, & Cavusgil, 2008). Entrepreneurs are overconfident (Simon, Houghton, & Aquino, 2000). They have great optimistic confidence in their ability to perform tasks relevant to entrepreneurship. Interestingly, outcome expectancies do not play an important role. This might be an explanation for undertaking an entrepreneurial endeavor despite the high base rates of failure and low average returns (Koellinger, Minniti, & Schade, 2007; Townsend, Busenitz, & Arthurs, 2010). In conclusion, a novel risk model should reduce the biases of the decision maker. Although, there will be still some errors in the assessment of single risk factors, the overall valuation will mitigate the influence and reduce the error terms of irrationality.

7.3 Financial Decision Models

When it comes to decision making and theory, the lack of coherent processes makes a decision very subjective, particularly when intuition alone does not determine which option is the most desirable (Saaty, 1994). Therefore, today, decision making has turned into a mathematical science (Figueira, Greco, & Ehrgott, 2005), which makes all its aspects of decision processes more transparent and formalizes them. Decision making itself consists of many criteria and subcriteria used to rank the alternatives (Saaty, 2008a). It is claimed that a mathematical model and a theory are indistinguishable, that is, the development of an appropriate model makes a theoretical contribution (Dubin, 1978; Whetten, 1989). The mathematical model adds structure to an academic analysis of a certain topic. Underlying assumptions and relationships among variables can be integrated and consolidated by mathematics. Moreover, mathematics can be used to perform sensitivity analysis on different factors (Lévesque, 2004). This mathematical approach to theory development is attended with

multiple strengths. It structures the analysis of a research question and forces assumptions to be made precisely. The model relies on existing theories, can consist of several variables, parameters, and functional forms, and can be tested against counterintuitive findings (Lévesque, 2004). The design objectives are manifold. The model is supposed to integrate information from both quantitative and qualitative variables. Measures are developed for qualitative or subjective factors, which provide users the ability to conduct sensitivity analysis. These aspects of mathematical models support a good framework for a profound and interesting theory development (Sutton & Staw, 1995; Whetten, 1989).

Financial decision models are developed by decision theorists and finance scholars with the goal of reducing problems caused by biases or misleading heuristics. An investment in a new venture is characterized by an opportunity with a prospect of potential gain and loss. In this context, risk is regarded as a function of the amount of loss and its probability, which combined refer to the prospect of loss (Ruhnka & Young, 1991). In conventional finance theory, it is assumed that investors always tend towards risk aversion (Chou, Huang, & Hsu, 2010). Thus, the risk profile of a financial investment is decisive for an investor. If the level of risk can be determined objectively, the investment decision can be made based on the investor's individual risk preference. In a VC decision-making context, research began not long ago to analyze the process of decisions and success of decision making models. Venture capitalist investment decisions are analyzed by several decision scholars (Shepherd, 1999b; Shepherd & Zacharakis, 2002). Empirical evidence shows that it is already sufficient to provide an individual with a simple model and a database of previous situations in order to increase decision performance significantly (Hoch & Schkade, 1996). Additional studies applying decision aids to VCs and analyzing their decision performance also prove that decision models significantly improve the decision reliability of VCs (Maxwell, Jeffrey, & Lévesque, 2009; Shepherd & Zacharakis, 2002) and increase their return on investments (Zacharakis & Shepherd, 2005). Accordingly, the opportunity to select successful rather than

unsuccessful companies is enhanced (Astebro & Elhedhli, 2006; Astebro & Koehler, 2007). Researchers of decision making and cognitive science claim that decision models enhance the accuracy of financing decisions (Zacharakis & Meyer, 2000) and VCs can benefit significantly from the application of decision-making models. Therefore, models improving decision making are requested in the field of entrepreneurial research (Lussier & Halabi, 2010) and a more profound analysis of the decision models applied and tested must be accomplished for the purpose of our study.

There are different types of models developed in a financial decision-making context. Actuarial models were predominantly used to capture the task system and to show that they outperform the decision maker (Brunswik, 1955, 1956; Khan, 1987). Actuarial models are linear models and use those cues that past outcomes have proven to be correct predictors of success or failure; these are also referred to environment-based models. They weight those factors high that have shown to be the best predictors of new venture performance and risk in the past. These models are implemented in a variety of domains, such as banking, and have been found to be a robust approach to increasing financial decision accuracy (Mukherji, Rajagopalan, & Tanniru, 2006). The success of the models might rely on their consistency across applications. However, they often rely on data and information that might be difficult to obtain and use. Especially in the new venture investment environment, information concerning investment decision and the ultimate outcome of performance take several years to reveal any coherence. Additionally, models need adjustments over time, which might make the environment-based model obsolete before it can be completed with all information needed and available (Zacharakis & Meyer, 2000). Bootstrap models use the relative weights actually utilized by investors in the past in trying to catch the investor's cognitive system (Fischhoff, 1988; Zacharakis & Meyer, 2000). It is shown that these models enhance investment decision accuracy because of their consistency and low bias of a non-random sample. Moreover, information factors are optimally weighted and the cognitive load of the decision maker is

reduced (Zacharakis & Shepherd, 2005). Equal weighting models can be described as basic bootstrap models. They assume that each factor used by the investor is weighted equally. This represents a simplification of the bootstrap model (Shepherd & Zacharakis, 2002).

Among these models, a subclass is called non-compensatory models, i.e., a high value of one factor cannot be used to compensate for a low value of another factor. The two forms are called conjunctive and disjunctive models. If someone places strong emphasis on one or two factors during an investment decision, it is called a disjunctive decision process. If each factor must be satisfied to a certain minimum level, it is called a conjunctive decision process (Khan, 1987).

Moreover, decision models can be used to foster learning by providing cognitive feedback (Sapienza & Korsgaard, 1995). However, research in the application of decision aids in the new venture investment and cognitive feedback context is sparse. Therefore, academics have called for a scientific basis because decision aids enable a faster acquisition of know-how compared to current training and educational techniques (Shepherd & Zacharakis, 2002). Outcome and cognitive feedback are the two types of feedback that can enhance learning. The first is based on experiences regarding the output of a decision. However, the time that the decision is made and the output in the form of return of investment fall apart. This distracts from effective learning. By contrast, cognitive feedback is the feedback provided to an individual about the process used to derive the decision (Shepherd & Zacharakis, 2002).

As to the evaluation of financial decision making of VCs, the results are puzzling. Derived from the resource-based view, analysis has shown that private investors of young ventures use non-additive decision models in order to derive the decisions. It is analyzed that decision model incorporating non-additive interaction terms and one based on main-effects-only outperform the investors' own decision (Zacharakis & Shepherd, 2005). When testing non-compensatory models, environment-based conjunctive models, i.e., those in which the dependent variable represents the actual outcome, and an acceptable new venture surpasses a

certain minimum level of each salient attribute, are superior predictors to disjunctive models and to the venture capitalists' own judgments (Khan, 1987). Zacharakis & Meyer (2000) compared VC decisions to a bootstrap model with regard to forecasting accuracy. The bootstrapping model outperformed (60% accuracy) the intuitive VC decisions (17.1% - 39,5%). This shows that investors can benefit significantly from the application of decision-making models (Astebro & Elhedhli, 2006; Zacharakis & Meyer, 2000). Moreover, models developed are limited to subjective measurements and self-reported data; that being the case models that strengthen decision making are needed. This has already been confirmed by early studies on new ventures (Keeley & Turki, 1992; Peng, 2001; Sarin, Das, & Jagannathan, 2002), which also determined that it is, in practice, primarily a subjective assessment on an ad hoc basis for the investment decision (Ruhnka & Young, 1991). However, a junction of a measurement of risk and a decision-making tool has not yet been developed.

Moreover, it has been long argued that most people use heuristics to ease decision making as complexity is reduced and the number of choices or cues are limited (Kahneman et al., 1982), which, however, lead to a significant deviation from optimal decisions (Kahneman & Tversky, 1979). By contrast, other research showed that simple decision heuristics, which combine data based on several cues and use different characteristics, can be a fast and accurate method to arrive at a precise forecast in context of complex decision-making (Astebro & Elhedhli, 2006; Gigerenzer & Goldstein, 1996). Linear additive statistical models in the form $\beta_1 X_1 + \dots + \beta_n X_n$ can better predict outcomes than can the intuitive decision of individuals or experts. However, this is not always true (Astebro, 2004). A linear additive bootstrap model for evaluating the commercial success for early stage new ventures is inferior to the expert's intuitive decision, beaten by the conjunctive decision heuristic, which counts "good" and "bad" rated cues separately, correctly predicting 86% of the outcomes (Astebro & Elhedhli, 2006). The procedural method of the conjunctive decision heuristic can be explained as follows: "If the number of positives is greater than or equal to p and the number of

negatives is less than or equal to n , the projects are classified as having future commercial success. Suppose that the possible values for n and p are $[0,1,2,3,4]$ and $[5, 6,7,8,9,10]$, respectively” (Astebro & Elhedhli, 2006, p. 401). Despite the fact, that many (qualitative) cues suggest severe challenges with regard to deriving precise predictions (Goldberg, 1968), empirical evidence showed that good decision making can be promoted (Fischhoff, 1982). An explanation for good forecasting performance is the standardized and decomposed heuristic including advanced training of the decision maker. There are measurement errors of each cue itself as each cue is a forecast. However, if there are several redundant cues, these errors might not be critical (Armstrong, Brodie, & McIntyre, 1987; Astebro & Koehler, 2007; York, Doherty, & Kamouri, 1987). Interestingly, business angels use similar decision heuristics. Rather than applying the fully compensatory decisions model, which the literature recommends, they use a so-called elimination-by-aspects heuristic, rejecting investment opportunities diagnosed with a fatal flaw. This decreases complexity for the business angel (Maxwell et al., 2009). This evidence reveals ambiguity regarding decision heuristics and their reliability in making accurate decisions. As heuristics can be transferred to standardized decision models, these insights must be considered for the development of a new venture risk model.

7.4 The Analytic Hierarchy Process

Following these research findings, VCs’ decision-making problems can be overcome by a mathematical decision model (Lévesque, 2004). These models integrate information from both quantitative as well as qualitative variables and conduct sensitivity analysis, which is especially important with regard to risk measurement of new ventures (Sutton & Staw, 1995; Whetten, 1989). However, an important disadvantage of many existing mathematical decision-making models is that the user, in this case, the VC, requires specialized knowledge. Therefore, feasible models are intended to be simple to apply and natural to the intuition and general thinking of VCs (Saaty, 2006). They should simplify the complex process of

assessing the risk of a new venture (Power & Sharda, 2007). The AHP is one of the decision models incorporating the important characteristics relevant to a new venture risk model.

A significant drawback of many models used in order to improve decision making is that specialized know-how is required in order to create the structures and implement the decision procedure. Therefore, these models are supposed to be easy to set up and related to the patterns of general intuition (Saaty, 1994; Saaty, 2006). One important requirement of model-driven decision paradigms is that the user can change parameters in order to analyze the sensitivity of outputs. The general types of models used should provide a simplification of a complex decision situation for a decision maker (Power & Sharda, 2007). The Analytic Hierarchy Process is one of the models incorporating the important aspects described above. Its frame and process is very appropriate for the risk model described in this study. The main advantages of using the AHP compared to other approaches to model qualitative variables are as follows: (1) the AHP helps to develop measures for things that are difficult to measure such as qualitative or subjective factors, (2) it provides a structured decision process to develop the scores, and (3) the resulting scores have ratio scale validity, unlike their ordinal counterparts (Jain & Nag, 1996). Unfortunately, when looking at the banking and investment sector, there is a dearth of literature available on the application or utility of the AHP (Bhattarai, 2005; Bolster, Janjigian, & Trahan, 1995; Jiang & Ruan, 2010; Saaty & Vargas, 2001; Su, Jiang, & Ma, 2009). In this section, relevant aspects of the Analytic Hierarchy Process for the proposed new venture risk model are briefly described. The reader is referred to specific literature (Saaty, 2006; Saaty, 2008a) if interested in more detailed explanations.

The Analytic Hierarchy Process was developed to provide solutions for estimation and decision challenges in multivariate environments. It belongs to the model-driven decision systems of decision analysis. It is based on organizing objectives, criteria, and subcriteria in a hierarchic structure in order to establish priority weights (Bernasconi, Choirat, & Seri, 2010; Saaty, 2008a; Saaty & Vargas, 2001). The AHP finds proponents in managers and decision

makers at all levels of decision making, who appreciate it because it enables the inclusion of strength of feelings needed to express judgment and the logic and understanding relating to the issues involved in the decision (Saaty, 2006). Its foundations are in the theory of measurement (Forman & Gass, 2001). The AHP can be a useful tool, especially if intangible factors are involved, which do not possess measurement scales. This situation prevails in many multi-criteria decision making contexts. The obtained measurements are aggregated in order to determine a cardinal scale of absolute numbers. This is supposed to be stronger compared to a ratio scale. When comparing two objects, the dominance of one over the other can take three forms: importance, likelihood, and preferences as in decision-making (Saaty, 2008b). Moreover, the AHP is based on four axioms: (1) hierarchic or feedback dependent structure, (2) rank order expectations, (3) homogeneous elements, and (4) reciprocal judgments (Bernasconi et al., 2010; Saaty, 2008a).

A central element of the AHP is the procedure in order to measure. A set $A_1 \dots A_n$ of items of a complex decision problem with n alternatives can be matched regarding one certain criterion or attribute c_1 out of a set of criteria $C = (c_1 \dots c_k)$. A basic scale for c_1 is the illustration of P_{c_1} . It allocates to each item pair $(A_i; A_j)$ a non-negative number $P_{c_1}(A_i; A_j) = a_{ij}$ with $a_{ij} > 1$ iff A_i is strictly preferred to A_j , and $a_{ij} = 1$ iff A_i is regarded as indifferent or equivalent to A_j for criterion c_1 . The AHP constructs a response matrix $A = [a_{ij}]$. It includes the decision maker's assessment of the comparisons of the alternatives. The matrix can be expressed as (Bernasconi et al., 2010; Saaty, 2008b):

$$\begin{array}{c}
 A_1 \quad \dots \quad A_n \\
 A_1 \begin{bmatrix} \frac{w_1}{w_1} & \dots & \frac{w_1}{w_n} \\ \vdots & \ddots & \vdots \\ \frac{w_n}{w_1} & \dots & \frac{w_n}{w_n} \end{bmatrix} \\
 A_n
 \end{array} \quad (33)$$

The scale w can be obtained briefly by $Aw = nw$ or by:

$$\begin{bmatrix} w_1 & \dots & w_1 \\ w_1 & & w_n \\ \vdots & \ddots & \vdots \\ w_n & \dots & w_n \\ w_1 & & w_n \end{bmatrix} * \begin{bmatrix} w_1 \\ \vdots \\ w_n \end{bmatrix} = n * \begin{bmatrix} w_1 \\ \vdots \\ w_n \end{bmatrix} \quad (34)$$

To solve this equation, the eigenvalue must be determined $(A - n * I) * w = 0$, which is a system of homogeneous linear equations with n as the eigenvalue (Saaty, 2008b).

Thus, a_{ij} is used to determine the dominance of an item i over j on a subjective ratio scale.

The AHP assigns a single number from the fundamental scale 1-9, instead of using two numbers w_i and w_j from a scale. For all pairs compared, it is defined that:

$$a_{ij} = \frac{w_i}{w_j} * e_{ij} \quad (35)$$

with w_i and w_j representing the underlying subjective priority weights, which belong to a scale of priorities. This is presented by a n -dimensional vector $w(A) = (w_1 \dots w_n)'$, with $w_1 > 0$, and $0 < w_i \leq 1$, or $w_1 > 0, \dots, w_n > 0$, and $\sum w_j = 1$, whereas the i -th element of $w(A)$ illustrates the relative dominance of an alternative A_i among the n alternatives. Moreover, e_{ij} is a multiplicative term for errors. It also includes inconsistencies and is supposed to be close to one. Furthermore, it is reciprocally symmetric, i.e., $e_{ij} = e_{ji}^{-1}$, $e_{ii} = 1$ for all i . However, this assumption implies that the AHP might violate cardinal, i.e., $a_{ij} = a_{ik} * a_{kj}$, and ordinal consistency, i.e., $a_{ij} > 1, a_{ik} > 1$ then $a_{kj} > 1$. Moreover, the possible lack of inconsistency might harm the estimation of the priority weights $w(A) = (w_1 \dots w_n)'$ (Bernasconi et al., 2010). Therefore, Saaty (1982) proposes the maximum eigenvalue (ME) method:

$$Aw = \lambda_{max} w, \quad \sum_{i=1}^n w_i = 1, \quad (36)$$

with $A = [a_{ij}]$ and $\lambda_{max} > 0$ is the eigenvalue, which is largest, i.e., the Perron eigenvalue of A . Additionally, $e_{ij} = 1$ for all pairs (i, j) that A is cardinally consistent. This leads to the fact

that the maximum eigenvalue will be at the minimum value $\lambda_{max} = n$. If it is not consistent, then $\lambda_{max} > n$. The so-called normalized difference $\mu_{AHP} = (\lambda_{max} - n)/(n - 1)$ is regarded as consistency index (*CI*). $\mu_{AHP} \geq 0$ and $\mu_{AHP} = 0$ iff A is consistent. With $\mu_{AHP} \rightarrow 0$, $a_{ij} \rightarrow \frac{w_i}{w_j}$, i.e., no error is existent. The consistency ratio (*CR*) of a pairwise comparison matrix is determined by the its consistency index divided by the random index value (Saaty, 2008b). In practice it should not exceed 10%. If it exceeds that certain level, an adjustment of the subjective judgments is recommended (Saaty, 2003). An alternative method for calculating the priority weights is the logarithmic least squares method (LLSM). For further details on the LLSM calculation procedure, the reader is referred to Genest & Rivest (1994).

For the priorities relative weight, there are two modes used. The weights of the distribution mode or normalized mode add up to 1. The figures of this mode can be directly derived from the values derived from the maximum eigenvalue method. The ideal mode divides each alternative by the largest priority from the distribution mode. Thus, the highest priority or weight always equals one (Saaty & Vargas, 2001). The absolute measurement mode, also called ratings mode or scoring, ranks simultaneously independent alternatives. The ratings mode is a method to derive priorities for alternatives. So-called rating categories for each criterion are set up and then prioritized by pairwise comparison for preference. For example, priorities for ratings on job security can be high, medium and low. To conclude, the alternatives are scored by analyzing their respective ratings under each criterion. The ratings are summed up for all the criteria. This sets up a ratio scale score for the alternative. It is a decent method for risk factor measurement if the weights or impact are not given from empirical evidence (Saaty, 2008a).

Although occurring only 8% of the time, rank preservation, contrary to rank reversal, is an important issue in the AHP. Reversal can happen if objects or alternatives are added or if old ones are deleted (Saaty & Vargas, 1993). The different modes described above play an important role within this context. In the distribution mode, rank reversal can occur, which is

useful when there exists dependence on alternatives present or on dominating new alternatives that might affect preference among old alternatives, which causes rank reversals. The problem of rank reversal can be solved by adding the ideal mode in relative measurement. This mode prevents situations in which an alternative that is added and irrelevant is compared to “old” alternatives to affect ranking of existing higher rated alternatives. Similar effects occur when the absolute measurement mode is used. Thus, rank reversal can be avoided by two methods of measurement – the ideal mode prevents alternatives that are determined as irrelevant; using the absolute mode of the AHP preserve absolutely the ranking of alternatives (Saaty, 2008a, 2008b).

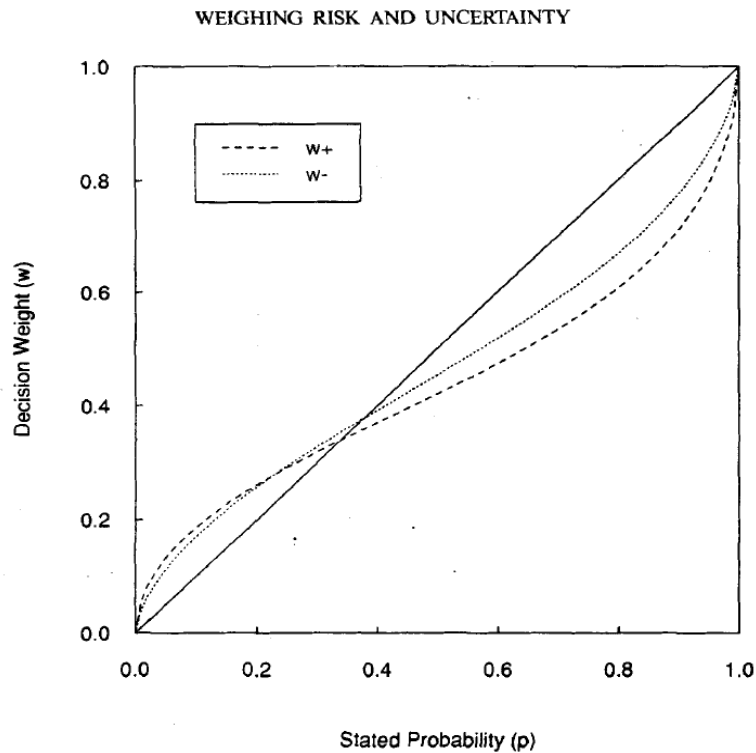
In recent years, an axiomatization of several theories of subjective ratio judgment, which belong to the class of separable representations (SR) (Luce, 2004, 2008; Narens, 2002) has taken place (Bernasconi et al., 2010). SR are relevant as they take into account the ratio judgments of individuals, which can related to cognitive distortion (Bernasconi, Choirat, & Seri, 2008; Bernasconi et al., 2010). Considering SR, the comparisons made by the AHP are adjusted to (Bernasconi et al., 2010):

$$a_{ij} = W^{-1} \left(\frac{w_i}{w_j} \right) * e_{ij} \quad (37)$$

with $W^{-1}(\cdot)$ representing the inverse of a subjective weighting function $W(\cdot)$ (Bernasconi et al., 2010). Risk prospects have proposed a nonlinear transformation of the probability scale overweighting low probabilities and underweighting moderate and high probabilities (Tversky & Fox, 1995).

The subjective weighting function can be illustrated according to Tversky and Fox (1995).

Figure: 5 Subjective weighting function



As the application of the AHP in combination of separable representations and subjective weighting function are subject to the new venture risk model developed in the subsequent section, further detailed analysis is desisted.

Group decision making is also an aspect relevant to the developed risk model. The AHP considers two issues. First it reflects the aggregation of decisions of an individual into a group judgment. Second, the AHP determines group choices based on individual choices. The reciprocal property is relevant in this situation. It has been theorized that individual judgments can be aggregated by the synthesizing function satisfying certain conditions regarding the weighted geometric mean. Therefore, each decision is raised to the power of $1/n$ if each decision maker has equal importance. If the experts can be ranked according to their experience, the individual evaluation is raised to the power of its importance in terms of experience (Saaty, 2008b). If there is inconsistency within the group, it can be used as a measure of the reliability of the risk measure. For more details, the reader is referred to the group decision-making literature (Aczél & Saaty, 1983; Saaty & Peniwati, 2008).

8 Development of a Risk Assessment and Cost of Equity Model²⁴

The valuation of possible investments can be reduced to two main considerations: 1. the probability or uncertainty of possible outcomes, i.e., risk, and 2. the value associated with those possible outcomes, i.e., return. Decision makers try to solve this problem by making a trade-off between the risk and the value associated with a risky firm. With stocks, rational investors might trade off the variance of the stock's return, i.e., risk, against the level of expected return, i.e., value (Butler, Dyer, & Jia, 2005).

However, in a context of new ventures, venture valuation is an under-developed field in research literature (Davila, Foster, & Gupta, 2003; Phan, 2004; Sarasvathy, 2000) and very challenging, since their equity shares are not traded publicly and are, therefore, illiquid (Ruhnka & Young, 1991; Seppa & Laamanen, 2001; Wright & Robbie, 1997). The estimation of the cost of equity, which consists of a time value of capital employed and a compensation for the risk born is very difficult. With missing data, the risk cannot be measured by the volatility of a time series of market prices (Weidig & Mathonet, 2004). Risk is usually taken as the standard deviation around the average returns (Cochrane, 2005; Weidig & Mathonet, 2004), but forecasting returns for young companies with no history is very difficult. As the assets of the new venture are firm specific as well as intangible (Gompers & Lerner, 2001a), the use of cross-sectional information in the form of comparable companies is also difficult as this procedure still leaves a high rate of error and subjectivity (Brigham & Ehrhardt, 2008; Brigham, Shome, & Vinson, 1985; Ruhnka & Young, 1991). Hence, risk measures like regression beta estimates contain substantial errors if applied to ventures for several reasons (Damodaran, 1999a). First of all, most new ventures do not generate earnings at all when the valuation takes place. Secondly, defining the boundary of the reference comparables is not always easy or even possible. Thirdly, if a peer group is set up, the same level of risk is

²⁴ This section contains elements of the unpublished working paper: Buchberger, A., Grichnik, D., & Koropp, C. (2013): New Venture Risk Assessment for Venture Capitalists: An Analytic Hierarchy Process Model, Unpublished Working Paper.

implied although maturity and size of the companies suggest lower risk. Fourthly, it is quite subjective to choose the comparables with no theoretical guidance for this choice (Ge et al., 2005). As shown, the determination of new venture risk is very complex, but essential for venture valuation and the calculation of cost of equity. Therefore, it is first focused on new venture risk assessment.

This is why the goal of this section is (1) to set up a theoretical financial model, which can be used to measure ex-ante risk and (2) the development of a cost of equity model for new ventures. This shall enhance the investment decision process of investors.

8.1 Relevance and Research Contribution

With the insights gained from the previous sections, the development of a theoretical risk and cost of equity model for new ventures is important, however, still lacking in the field of entrepreneurial finance (Keupp & Gassmann, 2009; Short et al., 2010). Although several quantitative risk models have been established over the last decades (Embrechts et al., 2009), a pure focus on entrepreneurial new ventures was neglected. One reason is that it is not completely clear how to incorporate the qualitative aspects a decision model requires into a quantitative risk model. Therefore, these models are often developed separately and are limited in improving decision making of individuals with regard to new venture risk assessment (Jia & Dyer, 2009).

This analysis contributes to the field of new venture risk assessment in several ways. First, it extends existing risk assessment models (Embrechts et al., 2009) to the emerging field of new ventures (Keupp & Gassmann, 2009; Messica, 2008; Short et al., 2010; Woodward, 2009). In doing so, research findings of venture-specific characteristics that impact future performance and risk are included. Insights from the fields of venture capital investment decision making, new venture risk assessment, and analytic hierarchy process decision theory are combined. In this context, this section contributes to the analysis of new venture risk factors (Van Gelderen

et al., 2005) and related theory development (Fama & French, 1996; Nagel et al., 2007). Davis (1971) argues that theorists are considered great not because they are correct in their theoretical assumptions, but because they develop interesting theories. Busenitz et al. (2003) claims that entrepreneurship requires additional theory development. In their evaluation of 15 years of entrepreneurship, they found that only a fraction of all top tier management journal publications are related to entrepreneurship theory development (Lévesque, 2004). It is the goal of this study to fulfill both propositions.

Second, finance research by developing an important component, i.e., the assessment of new venture risk, as a potential alternative to the conventional cost of equity models, which mainly require quantitative financial input data, is addressed (Lawrence et al., 2007; Nagel et al., 2007). The majority of existing studies (Cochrane, 2005; Korteweg & Sorensen, 2010; Mason & Harrison, 2002) as well as VCs (Petersen et al., 2006) base their risk analyses on these models. With this section, a new approach to prospective empirical studies on new venture risk and performance measurement as well as a link to new venture-specific cost of equity models is offered, e.g., Kerins et al. (2004). In this context, this study contributes to the venture valuation techniques in theory and practice. Cost of equity models needed for venture valuation are mainly based on quantitative data. This data is used as a measurement for risk. Many studies use IPO data of “young” ventures to account for the missing data (Müller, 2010). This analysis represents a starting point for new or adjusted cost of capital models of new ventures. The matter of benchmarking risk and return of new ventures impacts this problem as well. For registered and publicly-traded securities, indices are easily constructed and provide measures of overall market measures of value, return, risk, and risk-adjusted return. Non-traded security classes, like investments in private young companies, have no similar benchmarks. Although, there are attempts to establish such indices, the proper application for single companies remains challenging (Woodward, 2009; Woodward & Hall, 2004). Additionally, it is not possible to use proxies of market benchmarks of publicly traded

securities as the correlations between public equity and VC equity is estimated to be very close to zero (Chen, Baierl, & Kaplan, 2002).

Third, this section contributes to decision theory in the field of venture capital investment decision. Applying the latest scientific insights of multi-criteria decision making (Bernasconi et al., 2010) to a new venture context broadens decision theory in this important field of research. Findings of venture capital biases and subjectivity during the decision-making process are included (Zacharakis & Shepherd, 2009). This accounts for improving decisions and highlights the existence of biases. Moreover, it extends the methodologies used in studies on VC's decision-making processes (Shepherd et al., 2003; Zacharakis & Shepherd, 2005). Future studies can include these findings of this analysis in order to test a VC's own decision-making performance in comparison to the structured AHP-based new venture risk model.

Finally, the model developed in this section makes an important practical contribution, since a more systematic risk assessment significantly improves a VC's investment decision and therefore its financial return. VCs often make wrong decisions, as they are not aware of their investment process, criteria applied, and the influence of biases (Zacharakis & Meyer, 1998). The model developed prevents VCs from having irrational expectation about a new venture's future success and current risk (Zacharakis & Shepherd, 2009). Furthermore, research argues that entrepreneurs do not actually calculate the risks of new ventures and determine the cost of capital. This rule-of thumb mentality can be overcome by implementing structured models (Pattitoni et al., 2010). Entrepreneurs expose themselves to high risk by overlooking diversification and investing a high portion of their net wealth (Deligonul et al., 2008). They have irrational expectations of the success of the new venture, which is a cause of the high failure rates of new ventures (Hayward, Shepherd, & Griffin, 2006; Townsend et al., 2010). Therefore, a decision support model based on risk level assessment can enhance new venture quality for outside investors and inside entrepreneurs alike (Hsu, 2007).

These contributions are derived by the development of a risk and cost of equity model for new ventures. This requires an investigation of several aspects. Apart from quantifiable risk factors like market size, qualitative factors must be considered in the risk assessment. A quantification of these qualitative factors is necessary to derive a meaningful consolidation of qualitative and quantitative factors. But this can involve subjectivity of the individual making the decision and challenges how to quantify a qualitative issue. Therefore, decision theory and its findings in the specific context of investors and young ventures regarding biases and human heuristics are considered (Zacharakis et al., 2007; Zacharakis & Shepherd, 2005). As the risk and danger of failure is high among new ventures, a decision model in the form of a mathematical model can add precision and structure to assumptions and can have considerable economic significance (Jain & Nag, 1996).

8.2 Single-Stage Risk Model Development

8.2.1 Assumptions

In social science, there is little agreement on what differentiates a good theory from a bad theory (Sutton & Staw, 1995). However, it is said that a thorough theory must comprise several essential elements, incorporating all factors necessary to describe and justify the underlying cause-and-effect relationship between two or more variables. If all relevant factors are considered, it is expressed by comprehensiveness. Moreover, a certain order to the conceptualization must be constructed by describing pattern and linking factors. Why these factors are connected and their proposed causal relationship must be analyzed and explained by psychological economics and proven aspects (Whetten, 1989). The model development approach of this study follows these arguments. It is based on several assumptions, which specify, but also set limits to its application. The difference between risk and uncertainty depends on the probabilities. Risky prospects where the probabilities associated with outcomes are supposed to be known are risky, and uncertain prospects where the probabilities

of the outcome are not known are uncertain (Knight, 1921 reprint 1964). For identifying the risk of a new venture, the investor tries to identify the various potential outcomes and assigns certain subjective probabilities to the outcomes. This is accomplished in order to alter the uncertainties into reward-to-risk estimates for the new venture (Lipper III, 1988; Ruhnka & Young, 1991). Therefore, the model developed focuses on risk, not uncertainty. Empirical studies showed that the majority of investors believe that risk and return are not necessarily connected or not correlated at all (Shapira, 1995). Behavioral finance argues that the brain codes return and risk separately (Bossaerts, 2009). Thus, the focus is on risk assessment only.²⁵ Theory of risk models and the risky object itself, the young venture, and its characteristics causing risk and the probability of failure are decisive for the risk model specifications. The venture capital and business angel market is regarded as highly imperfect (Manigart et al., 2002; Wright, 1998). This fact implies that idiosyncratic investment risk may be as relevant as market risk in determining required return (Müller, 2008, 2010; Rea, 1989). With the possibility of underdiversification, the consideration of total risk is relevant for VCs (Cotner & Fletcher, 2000; Estrada, 2004). This means that all risk factors of a new venture, both systematic and firm-specific, are incorporated into the developed model. As multiple types of risk factors impact total risk, multiple decisions must be made in order to evaluate the level of risk. This implies that the theoretical number of risk factors influencing new venture risk is infinite. As a result, the model of this analysis is designed as a multi-criteria decision problem. Regarding dynamics and time span, this model concentrates on a static and single period approach, i.e., risk is calculated and decisions are made at a specific point of time with no adjustments undertaken after a certain period. If a new venture matures, the impact of single risk factors should change and the level of risk must be calculated anew. The distributions of returns of new ventures are asymmetric (Cochrane, 2005). Therefore, the model regards risk from a downside loss perspective, i.e., upside potentials are not relevant.

²⁵ Risk-value or risk-return models could be a further step of research but are excluded from this study. For example, compare with Jia and Dyer (2009).

This approach seems to be the most appropriate way regarding analyzing risk of new ventures (Estrada, 2004; Janney & Dess, 2006). Moreover, ventures are regarded as all-equity financed. In the established framework, individuals have a probabilistic mindset, i.e., they rely on a sort of likelihood judgment and incorporate likelihood in their decisions (Rottenstreich & Kivetz, 2006). Research shows that a VC's decision is influenced by biases (Shepherd et al., 2003; Zacharakis & Meyer, 2000). It is attempted to overcome this problem by incorporating a structured decision process. Lastly, demographic factors such as the gender and age of the individual decision maker, which might necessitate adjusted separable representations or weighting functions, are not considered (Fehr-Duda, Epper, Bruhin, & Schubert, 2011).

8.2.2 Input Variables

When it is challenging to value or measure a subject based on output, like historical data, estimations based on inputs can provide a useful complementary method and be more accurate than a pure guess from gut feeling. Therefore, key variables must be determined and reliable coefficients are identified from a greater population (Ge et al., 2005). This section concentrates on the input variables used and their coherence.

Risk has an impact on either the expected cash flows or the cost of equity representing a compensation for risk and time value taken (Bali et al., 2009; Korteweg & Sorensen, 2010). Therefore, a starting point is the identification of all relevant risk factors and a model that quantifies the impact according to common metrics. The downside risk of a new venture comprises several risk factors influencing the probability of failure. These are categorized into quantitative and qualitative factors, like market size and quality of the management team (Lussier & Halabi, 2010). Index i , which determines the type of risk, is defined. As the number of risk factors can be infinite, i is limited to $i \in \mathbb{N}^+$ and $1 < i < \infty$.²⁶ The risk factors belonging to a new venture k are indexed with k . The amount of risk contributing to total

²⁶ Models often integrate cues, i.e., venture-specific decision factors. Although there are measurement errors of each cue itself, these errors might not be critical, especially if there are many redundant cues (Åstebro & Koehler, 2007).

downside risk of a new venture k by a single risk factor i is described by $RF_{ki}(X_{ki})$, called factor risk i of new venture k with $RF_{ki}(X_{ki}) \geq 0$. Each RF_{ki} comprises of a relative impact factor I_i and a venture-specific risk level $RL_{ki}(X_{ki})$. Thus, each risk factor has a specific global impact on total downside risk of a company at a certain age independent of specific characteristics of the new venture k . This relative impact is denoted by I_i . Considering all possible risk factors, it is defined:

$$\sum_{i=1}^n I_i = 1; 0 \leq I_i \leq 1 \quad (38)$$

As the elaborated model is static, I_i is a constant value. Therefore, companies at the same level of maturity are influenced by a risk factor i with the same global impact. Reversely, the relative impact I_i of each risk factor changes when companies mature. Therefore, there are two reasons for a risk factor having zero influence on calculated total risk. First, if the impact of a risk factor 1 has no more influence on the total risk of a new venture due to the fact that a company matures, I_1 , i.e., equals zero. Second, a risk factor is omitted if there is no possibility to estimate a reliable risk level. Then, the corresponding relative impact I_i also changes. However, the ratios of the relative impact factors, e.g., I_2/I_3 , remain constant.²⁷ If data of absolute impact I_{Ai} is only available, the corresponding relative impact can be calculated by $I_i = \frac{I_{Ai}}{\sum I_{Ai}}$. The determination of actual impact figures is difficult. Contrary to other sectors like banking, where the weights of market and credit risk can be identified according to the amount of trading assets and lending assets (Rosenberg & Schuermann, 2006), the weights of (above all qualitative) risk factors affecting total new venture risk are hard to observe. With no parameters for simulation, a decent weighting of risk factors through expert estimation can be used (Saaty, 2008a).

²⁷ If only data of an absolute impact I_{Ai} are available, the corresponding relative impact is calculated by $I_i = \frac{I_{Ai}}{\sum I_{Ai}}$.

In addition to the impact factors, which are supposed to be constant among new ventures at the same stage, the magnitude of a particular risk factor i on total downside risk differs from new venture to new venture. Aggregation of risk is only possible if all factor risks are calculated in the same unit of measurement. $RL_{ki}(X_{ki})$ should be regarded as the “currency of risk” or common standard for measuring the degree of risk. Thus, the risk level $RL_{ki}(X_{ki})$ determines the magnitude of risk type i on a certain new venture. It is specified in risk units, which are positive and divisible in nature. The factor risk RF_{ki} is defined as a non-negative real number, i.e., RL_{ki} must be also positive with the lower bound zero. The upper bound is not limited, i.e., $RL_{ki}(X_{ki}) \geq 0$. X_{ki} stands for a notional function reflecting the real and definitely occurring risk of one factor i with regard to one new venture k . This function cannot be determined, but is approximately calculated by the AHP approach in the subsequent sections. With these assumptions of impact and risk level, factor risk i of a particular new venture k is expressed by:

$$RF_{ki}(X_{ki}) = I_i * RL_{ki}(X_{ki}) \quad (39)$$

8.2.3 Determination of Risk Level

In order to calculate total downside risk, the venture-specific risk level $RL_{ki}(X_{ki})$ of each risk factor i must be determined. This is accomplished by a VC, who evaluates the risk levels. As described previously, forecasting these levels is highly challenging. This is true for both experienced and novice VCs as well as for real and experimental settings (Franke et al., 2008; Hau, Pleskac, Kiefer, & Hertwig, 2008). A recent study of the judgmental process of experts in the evaluation of new product ideas (Astebro & Koehler, 2007) suggests that over-extremity and over-prediction in case-based judgments are mitigated through class-based probability information. The study subjects evaluated new products by assessing single cues, followed by making an overall prediction of future success. With highly structured

standardized and decomposed procedures, the experts outperformed other experts by using the available information to make predictions with a high probability of success. It is suggested that decision makers should incorporate class-based probability information in their evaluations by making a “direct link between rank order assessment and the probability forecast” (Astebro & Koehler, 2007, p. 383).²⁸ Mathematical functions can be used to set up such a decision (risk) system. The risk level can be described by a function $z = (f(x_1, x_2, \dots, x_n) = f(x))$ where x represents a vector of input attribute levels to which a risk level can be assigned. In a first step, x is mapped to a description $y = g(x)$. This qualitative vector y is then transferred into a risk rating vector z , leading to a process: $x \xrightarrow{g} y \xrightarrow{h} z$. Most qualitative risk measurements use direct qualitative ratings of quantitative factors. One important issue is soundness, i.e., that a high quantitative risk should receive high qualitative risk labels and vice versa (Cox, Babayev, & Huber, 2005). Hence, it is difficult to assess $RL_i(X_i)$ as it involves qualitative decisions, which are subject to biases and errors.

The AHP (Saaty, 1987; Saaty, 1980; Saaty, 2008a) presents a profound approach to coping with the challenges and requirements described. First of all, the AHP deals with intangible properties, which have no measurement scales (Saaty, 2008a) similar to those of qualitative risk levels. The AHP is applied by using comparable companies in order to determine the relative risk levels $RL_{ki}(X_{ki})$. When comparing two objects, dominance can be measured through likelihood. This enables the comparison of two new ventures regarding one risk factor i . Thus, the firms function as alternatives. A risk factor i can be scaled by mapping its riskiness to every pair of companies compared $(C_k; C_l)$. Thus, a positive real number $P_i(C_k; C_l) = c_{kl}$ is assigned to each pair $(C_k; C_l)$ with $c_{kl} > 1$ iff C_k being strictly riskier than

²⁸ This suggestion is supported by studies on venture investments, which indicate that theoretical and statistical models are superior to intuitive judgmental methods (Grove, Meehl, & Campus, 1996), especially within the venture investment process (Shepherd & Zacharakis, 2002; Zacharakis & Shepherd, 2005).

C_l and $c_{kl} = 1$ if both companies are equally risky regarding risk factor i . Thus, a decision maker's reciprocal response matrix $C = [c_{kl}]$ can be defined by:

$$C = \begin{matrix} & C_1 & \dots & C_m \\ \begin{matrix} C_1 \\ \vdots \\ C_m \end{matrix} & \begin{bmatrix} \frac{w_1}{w_1} & \dots & \frac{w_1}{w_m} \\ \vdots & \ddots & \vdots \\ \frac{w_m}{w_1} & \dots & \frac{w_m}{w_m} \end{bmatrix} & & \end{matrix} \quad (40)$$

w_k represents the level of riskiness of a firm concerning a risk factor i and with $c_{kl} = \frac{w_k}{w_l} * e_{kl}$. Subjective ratio judgment and separable representations have an important connection (Luce, 2004, 2008; Narens, 2002). SRs address the fact that certain ratio estimations cannot be known directly. They are relevant as they consider that individual ratio judgments are subject to cognitive distortion (Bernasconi et al., 2008, 2010). This leads to the following adjustment of the equation and the response matrix above:

$$c_{kl} = W^{-1} \left(\frac{w_k}{w_l} \right) * e_{kl} \quad (41)$$

whereas $W^{-1}(\cdot)$ represents the inverse of a subjective weighting function $W(\cdot)$. The error term e_{kl} is still necessary as states of minds, lapses of reason or concentration, and trembling prove that no model of human behavior can be held deterministically. Prospect theory (Kahneman & Tversky, 1979) first introduced the necessity of decision weights and analyzed how those weights were psychologically determined. This led to the implementation of the probability weighting function (Kahneman & Tversky, 1979). In this context, support theory (Fox, 1999; Fox & Tversky, 1998) describes the process of individuals estimating probabilities. This can be used to derive decision weights. It is shown that the subjective probability weighting function converges towards linearity when experience is integrated in the experiments, i.e., if respondents make repeated decisions and direct feedback is given after each decision (Van de Kuilen, 2009). Regarding the problem here, i.e., the determination of risk of a particular

venture, direct feedback is given after each investment decision; however, the experience is gained from different new ventures. Therefore, the weighting functions will not converge towards linearity with increasing experience of the VC. A separable representation holds in ratio estimation if there exists a psychophysical function ψ and a subjective weighting function W , following:

$$W(p) = \frac{\psi(z)}{\psi(x)} \quad (42)$$

whereas z and x represent two stimuli, and p is the value that an individual states to the subjective ratio of z to x (Luce, 2004, 2008). This represents the ratio $\frac{w_k}{w_l}$ in this model. Distortions can occur when assessing subjective intensities or subjective ratios (Luce, 2002). Correcting decisions in order to make individual judgments more consistent with prescriptive principles and to imply psychological biases is important. It is shown that these distortions must also be taken into account in the AHP. The subjective weighting function²⁹ is used to improve the accuracy of consistency of the decision makers' assessments (Bernasconi et al., 2010). Research analyzed that decision makers overestimate low probabilities and underestimate moderate to high probabilities during risk assessment (Bernasconi et al., 2010; Tversky & Fox, 1995). In a previous study, it was observed that VCs' decision making is in accordance with prospect theory (Valliere & Peterson, 2005). Therefore, it is stated that a subjective weighting function must be applicable to VCs as well, although there might be different classes depending on the VC. These considered aspects lead to proposition 1.1:

Proposition 1.1: *Venture capitalists represent a fourfold pattern of risk attitudes.*

It is assumed that the weighting function follows the distinctive fourfold pattern of risk attitudes, i.e., risk seeking for losses of high probability and risk aversion for losses of low

²⁹ Due to the property of cardinal consistency in the AHP, i.e., $c_{kl} = c_{kq} * c_{ql}$, and due to $c_{kk} = 1$, the weighting function must satisfy $W(1) = 1$ and must rely on monotonicity, which follows from the mathematical derivation of separable representation. If $W(\cdot)$ is monotonic, it is also invertible (Luce, 2002). Moreover, reciprocal symmetry is required, i.e., $c_{kl} = 1/c_{lk}$ leading to $W(1/\cdot) = 1/W(\cdot)$.

probability (Tversky & Kahneman, 1992). It is empirically analyzed that the most common patterns of probability transformation have an inverse S-shape (Abdellaoui, 2000; Abdellaoui, Bleichrodt, & Paraschiv, 2007; Bleichrodt & Pinto, 2000; Tversky & Fox, 1995). These conditions are used as a first proxy to the elaborated new venture risk model leading to the following general weighting function for negative outcomes (Luce, 2001, 2002; Prelec, 1998):

$$W^-(p) = \gamma * e^{(-\beta)*(-\ln p)^\alpha}; p \in]0; 1] \quad (43)$$

α, β and γ are parameters with $\alpha; \gamma \in]0; 1]$ and $\beta > 0$. As this model is concerned with downside risk and therefore negative outcomes or losses, W^- represents a weighting function for losses only. It favors risk aversion for small probabilities of losses and risk-seeking behavior for larger probabilities. In the subsequent sections, $W(\cdot)$ matches W^- . The inverse $W^{-1}(\cdot)$ transforming the weighted elicited numerals into the “real” numerical ratios can be written as:

$$W^{-1}(y) = e^{-\left(-\frac{1}{\beta} * \ln\left(\frac{y}{\gamma}\right)\right)^{\frac{1}{\alpha}}} = \frac{c_{kl}}{e_{kl}} \quad (44)$$

whereas y represents the weighted elicited numerals. The m -dimensional vector $\vec{w}(C) = (w_1; \dots; w_m)'$ is the priorities vector with $w_1 > 0; \dots; w_m > 0$ and $\sum w_l = 1$. In order to derive \vec{w} , the AHP compares the riskiness of companies relative to each other in the first step. In accordance with Fiet (Fiet, 1995a; Fiet, 1995b), and Moesel and Fiet (2001), the risk levels are modeled in terms of risk classes rather than point estimates of risk probabilities. Simple classifications of risk are often more useful, albeit imperfect, substitutes for statistical approximations (Fiet, 1995a; Fiet, 1995b). VCs are able to rate investment opportunities by risk classes. Instead of taking two numbers w_k and w_l from a scale, a single number from a fundamental scale 1-9 of absolute numbers is assigned to each comparison for one risk factor. Thus, qualitative risk factors are quantified and quantitative data are used by converting the

ratios into the fundamental scales. If the ratio exceeds 9, clustering is a suitable solution.³⁰ The definitions of the numerical values of the scale are presented in table 2:

Table 10: Risk classes

Numerical value	Definition of risk class
1	Equal risk level
3	Marginal higher risk level
5	Essential/obvious higher risk level
7	Strong higher risk level
9	Extreme higher risk level
2, 4, 6, 8	Intermediate risk level between two adjacent judgments
Reciprocals of above	$c_{kl} = c_{lk}^{-1}$

Based on these definitions, the verbal scale as an ordinal measure can be used for judgments.

The subjective assessments are then transformed into an objective response matrix $C = [c_{kl}]$.

Proposition 1.2: *The inverse weighting function can be transferred using a fundamental scale 1-9 of absolute numbers.*

As the numerical values range between 1 and 9, the following adjustment of the inverse weighting function above is accomplished through:

$$W^{-1}\left(\frac{w_k}{w_l}\right) = \begin{cases} e^{-\left(-\frac{1}{\beta} \ln\left(\frac{1}{8} \left(\frac{w_k}{w_l} - 1\right)\right)\right)^{\frac{1}{\alpha}}}; & \text{if } w_k > w_l \\ e^{-\left(-\frac{1}{\beta} \ln\left(\frac{1}{8} \left(\left(\frac{w_k}{w_l}\right)^{-1} - 1\right)\right)\right)^{\frac{1}{\alpha}}}; & \text{if } w_k < w_l \end{cases} \quad (45)$$

As it is assumed, that the results of the subjective responses and the adjusted relative dominance are identical when it comes to the outer boundaries of comparison, i.e., 1 and 9, γ is set to one. This equation leads to the adjusted relative dominance of the alternatives:

$$c_{kl} = \left(8 * W^{-1}\left(\frac{w_k}{w_l}\right) + 1\right) * e_{kl} = \left(8 * e^{-\left(-\frac{1}{\beta} \ln\left(\frac{1}{8} \left(\frac{w_k}{w_l} - 1\right)\right)\right)^{\frac{1}{\alpha}}} + 1\right) * e_{kl} \quad (46)$$

³⁰ If this scale proves to be inadequate for allowing precise assessments during the risk evaluation process, a method of clustering with a pivot from one cluster to another cluster extends the scale as far out as desired. Compare with Saaty (2008b).

with the adjusted relative dominance of one firm over another firm regarding a certain risk factor, the scale w is obtained by determining the eigenvalue n through:

$$(C - n * U) * w = 0 \quad (47)$$

whereas U represents the unity or identity matrix and w is the principal eigenvector. Saaty (2006) suggests using the maximum eigenvalue method to solve this problem. At its minimum value, the maximum eigenvalue is n , if full consistency prevails:

$$Cw = \lambda_{max}w, \quad \sum_{k=1}^m w_k = 1, \quad (48)$$

with the equation above, the relative weights of a risk factor i is determined. They are expressed through $\vec{w}(C_i) = (w_1; \dots; w_m)'$. If the consistency index $\mu = (\lambda_{max} - n)/(n - 1)$ and the related consistency ratio exceeds 10% for one risk factor, the decision maker can revise his subjective judgments. If possible, this form of interactive sessions in which the decision maker can reconsider inconsistent choices and correct for biases is recommended. For the priorities weights, the ideal mode is used as rank preservation is provided (Saaty, 2008a). That means that the vector $\vec{w}(C_i) = (w_1; \dots; w_m)'$ is taken and all weights are divided by the highest weight. Moreover, it is recommended that the number of alternatives, in that case, the firms, should not exceed 7 due to increasing inconsistency (Saaty, 2008b). As it is difficult to find many appropriate comparable firms in practice, this restriction should not harm the application of this model. Thus, the risk level $RL_{ki}(X_{ki})$ is gained from $\vec{w}(C_i)$.

8.2.4 Correlation of Risk Factors

Correlation of risk factors is an important aspect of determining total downside risk. New ventures are permanently exposed to a variety of risk factors. If a VC identifies an additional risk factor, which he or she can quantify, the question arises if correlation of this new risk factor should have an impact on total risk already determined. Therefore, it is proposed:

Proposition 1.3: *Any additional perfectly correlated and equally distinct risk factor does not increase total downside risk.*

This model is based on a “constant risk level” approach, i.e., no matter how many risk factors are applied in a meaningful way, the level of total downside risk should remain constant. The issue of dependence (correlation) is incorporated by considering the interference of correlated risk factors for each impact weight I_i by using an adjusted impact factor $I_{corr i}$. As $I_{corr i}$ depends on the correlation of risk factors, the correlation coefficient matrix λ_{CCMij} for new ventures must be set up. This is defined as:

$$\lambda_{CCMij} = \begin{pmatrix} 1 & \cdots & \rho_{I_1, I_j} \\ \vdots & \ddots & \vdots \\ \rho_{I_i, I_1} & \cdots & 1 \end{pmatrix} \quad (49)$$

with $i = \{1; \dots; n\}$; $j = \{1; \dots; n\}$; $i, j \in \mathbb{N}^+$

In a new venture context wherein the levels of risk cannot be observed from market data, it is expected that the distributional shapes vary considerably (Rosenberg & Schuermann, 2006). Only a few correlation coefficients of risk factors can be determined by quantitative market data. Given this limitation, it is also questionable if a reliable selection of a copula function or correlations coefficient matrix can be accomplished by purely statistical techniques. The majority of information relies on a qualitative analysis (Brockmann & Kalkbrener, 2010).³¹ Given a correlation coefficient matrix λ_{CCM} for new ventures, δ_i as the adjustment value for the relative impact of risk factor I_i is calculated through:

³¹ The determination is subject to errors with difficulties in forecasting the realistic covariance of risk factors involved. Therefore, the correlation factor is believed to often be neglected during practical business applications. Yet, in order to solve the problem of missing correlation data, a qualitative approach suggests that for each risk factor a weight of 25%, 50%, or 75% is assigned for low, medium, or high dependence to another risk factor. 0% are assigned if it is considered to be uncorrelated, and 100% states, only in exceptional cases, that the value of a risk factor is determined entirely by another risk factor (Brockmann & Kalkbrener, 2010). Subjective expert opinions enhance the evaluation of risk factor correlations based on internal historical experience (Aas et al., 2007).

$$\delta_i = \sum_{j=1}^n \vartheta_{ij} \quad (50)$$

Theta ϑ_{ij} represents the partial adjustment due to the correlation between the i -th and j -th risk factor. The sum of ϑ_{ij} results into δ_i while holding i constant. ϑ_{ij} is expressed by:

$$\vartheta_{ij} = \begin{cases} \rho_{I_i, I_j} * I_i \div \sum_{j=1}^n \rho_{I_i, I_j}; \text{ if } i \neq j \\ 0; \text{ if } i = j \end{cases} \quad (51)$$

When the adjusted impact weights $I_{corr\ i}$ are used, total downside risk accounts for any dependence between the risk factors and an overestimation is prevented. Accounting for the correlation of the risk factors leads to the new impact weights $I_{corr\ i}$ expressed through:

$$I_{corr\ i} = \left(\frac{I_i - \sum_{j=1}^n \vartheta_{ij}}{\sum_{i=1}^n (I_i - \sum_{j=1}^n \vartheta_{ij})} \right) = \left(\frac{I_i - \sum_{j=1}^n (\rho_{I_i, I_j} * I_i \div \sum_{j=1}^n \rho_{I_i, I_j})}{\sum_{i=1}^n (I_i - \sum_{j=1}^n (\rho_{I_i, I_j} * I_i \div \sum_{j=1}^n \rho_{I_i, I_j}))} \right) \quad (52)$$

In general, it increases with the number of factors, decreases with greater weights, and decreases with greater correlation. If total downside risk is dominated by a single risk factor, the “correlation benefits” become smaller (Kuritzkes et al., 2003).

8.2.5 Risk Aggregation and Determination of Total Risk

In terms of risk aggregation, there must be a differentiation regarding new additional risk factors and unobservable non-assessable risk factors that are known to the VC. On the one hand, there are aggregation techniques, which account for additional risk factors emerging immediately because of internal or external changes. On the other hand, there are methods, which account for non-assessable risk factors that leave total downside risk unchanged (Aas et al., 2007; Kuritzkes et al., 2003; Rosenberg & Schuermann, 2006).

The first situation, new single factor risks, can be aggregated to total risk through a multi-factor aggregation model in a single period setting. To do so, the risk factors, the relative weights of each distribution and the marginal distributions should be known. A risk i has marginal distribution $F_i(x) = P\{RL_{ki} \leq x\}$. Then, an inter-risk correlation matrix is assigned and a copula function specified (Rosenberg & Schuermann, 2006). When doing so, it is assumed that each risk level $RL_{ki}(X_i)$ is multi-dimensionally normally distributed, strictly increasing function, and has a planning horizon of one year. The functions underlying the risk level is not specified here, because the determination of the risk level of single risk factors is described below.

In banking, the first described problem is overcome with a risk management copula function to aggregate different kinds of risks. The approaches of Rosenberg & Schuermann (2006) and Aas et al. (2007) are often. Rosenberg & Schuermann (2006) showed that an additive composition of credit risk, market risk, and operational risk in a banking environment leads to an overvalued total risk. Instead, they use different types of copula functions to aggregate correctly the single risk factors. Additionally, Aas et al. (2007) designed a base-level aggregation method with some top-level aggregation steps included in order to include credit, market, operational, and business risk. In order to account for the necessary inputs, the variance covariance matrix of the risk factors is needed in general. Given the different distribution functions, the correlation of risk factors can be estimated with a multivariate GARCH model. The variance covariance matrix λ_{VCM} can be transformed into the correlations coefficient matrix λ_{CCM} with $\rho = \sigma_{12}/(\sigma_1 * \sigma_2)$:

$$\lambda_{VCM} = \begin{pmatrix} \sigma_{I_1}^2 & \cdots & \sigma_{I_1, I_n} \\ \vdots & \ddots & \vdots \\ \sigma_{I_n, I_1} & \cdots & \sigma_{I_n}^2 \end{pmatrix} \rightarrow \lambda_{CCM} = \begin{pmatrix} 1 & \cdots & \rho_{I_1, I_n} \\ \vdots & \ddots & \vdots \\ \rho_{I_n, I_1} & \cdots & 1 \end{pmatrix} \quad (53)$$

with λ_{VCM} representing the variance covariance matrix of a random vector $[I_1; \dots; I_n]$, which is symmetric and positive semi definite. Consider that two marginal, one period risk factors x

and y with the distribution functions F_1 and F_2 are given with a correlation between x and y . The bivariate distribution function of the random vector (x, y) is described with the correlation. The copula function $C(u, v)$ describes these risk dependencies. It contains only information about the dependency structure of the risk factors, but no information about the marginal distributions. The covariance and correlation are statistical factors that do not determine completely the relationship or dependence of two risk factors (Pflug & Römisch, 2007). For the purpose of the risk model, the following simplified assumption is supposed to be sufficient. New emerging single risk factors can be considered by a simple method in dependence on (Kuritzkes et al., 2003) through a Gaussian approach:

$$RI_{Tk \text{ correlated}}(X) = \begin{pmatrix} I_1 * RL_{k1}(X) \\ \vdots \\ I_n * RL_{kn}(X) \end{pmatrix}' \begin{pmatrix} 1 & \cdots & \rho_{I_1, I_n} \\ \vdots & \ddots & \vdots \\ \rho_{I_n, I_1} & \cdots & 1 \end{pmatrix} \begin{pmatrix} I_1 * RL_{k1}(X) \\ \vdots \\ I_n * RL_{kn}(X) \end{pmatrix} \quad (54)$$

with the correlation coefficient matrix described by λ_{CCM} and the factor risk summarized to

the vector $\overrightarrow{RF}_k = \begin{pmatrix} RF_1 \\ \vdots \\ RF_n \end{pmatrix}$, $RI_{Tk \text{ correlated}}(X)$ can be reduced to:

$$RI_{Tk \text{ correlated}}(X) = \overrightarrow{RF}'_k * \lambda_{CCM} * \overrightarrow{RF}_k \quad (55)$$

The assumption of all risks are jointly normally distributed represents a major problem with this kind of risk aggregation. Moreover, it should not be mistaken with the axiom of subadditivity of Artzner et al. (1999) coherent risk measures. It applies to two separate risk systems, e.g., two different new ventures, but not within one system.

As it is assumed that, in practice, the first case is irrelevant to a venture capital context, it is concentrated on the second method. The model relies on an additive type of risk model, which can be compared to a bootstrap model. Bootstrap models are useful if the decision maker includes subjective ratings in order to determine the level of risk. The success of bootstrap models in a new venture evaluation context has been demonstrated by previous studies (Zacharakis & Meyer, 2000; Zacharakis & Shepherd, 2005) leading to proposition 1.4:

Proposition 1.4: *Total downside risk can be expressed as the sum of all factor risks adjusted for correlation.*

It is anticipated that young companies are exposed to certain permanent risk factors. However, a closer analysis must be accomplished if no reliable data on a certain risk factor are determinable or new data are suddenly available while the factors are significantly dependent. There are trade-offs between one risk factor and the other, i.e., one might be high, which softens the influence of the other lower one (Franke et al., 2008). In the unlikely event that the identified risk factors are independent, total downside risk can be expressed through an additive model of factor risks available:

$$RT_{k \text{ uncorrelated}}(X_{ki}) = \sum_{i=1}^n RF_{ki}(X_{ki}) = \sum_{i=1}^n I_i * RL_{ki}(X_{ki}) \quad (56)$$

Independence of two random variables implies their non-correlation. The riskiness of young ventures is a relative matter. Risk must be analyzed with regard to a target or reference level. If an investment in a new venture is presented as a one-shot game, the expected value or outcome of the new venture can serve as a reference point for relative gains and losses (Jia & Dyer, 1996). Any possible outcome below the target z is interpreted as risk. This concludes that a decrease of risk of one factor does not necessarily decrease total risk of the new venture. The model is based on a “constant risk level” approach, i.e., no matter how many risk factors can be applied in a meaningful way, the level of total downside risk should remain constant. Using a simple additive approach implies that “calculated” total downside risk increases with the number of risk factors, although “actual” total risk does not increase. With these insights and equation 13, the total downside risk function accounting for the correlation between risk factors can be expressed through:

$$\begin{aligned}
RT_{k \text{ correlated}}(X_{ki}) &= \sum_{i=1}^n (I_{corr i} * RL_{ki}(X_{ki})) \\
&= \sum_{i=1}^n \left(\left(\frac{I_i - \delta_i}{\sum_{i=1}^n (I_i - \delta_i)} \right) * RL_{ki}(X_{ki}) \right)
\end{aligned} \tag{57}$$

with delta δ_i defined as the adjustment value for the relative impact of risk factor i due to the correlation of other risk factors.³² The value of δ_i is driven by the number of risk factors, the concentration of these factors, i.e., the relative weights, and the correlation between the risk factors. All correlation adjusted impacts $I_{corr i}$ are pooled in an impact vector $\overrightarrow{I_{corr}} = (I_{corr 1}; \dots; I_{corr n})'$. Once the relative weights regarding one risk factor of the firms are compared and $I_{corr i}$ are determined, the aggregation of the factor risks is conducted. The weight vectors $\vec{w}(C_i) = (w_{C_i1}; \dots; w_{C_im})'$ of each risk factor i are summarized into a matrix $\varphi = [w_{C_ik}]$ with each column representing a firm's relative weights interpreted as the risk level $RL_{ki}(X_{ki})$:

$$\varphi = \begin{pmatrix} w_{C_11} & \cdots & w_{C_1m} \\ \vdots & w_{C_ik} & \vdots \\ w_{C_n1} & \cdots & w_{C_nm} \end{pmatrix} \tag{58}$$

with the adjusted impact vector $\overrightarrow{I_{corr}}$ and φ , the total downside risk vector \overrightarrow{RT} of all companies is determined through.

$$\overrightarrow{RT} = \begin{pmatrix} RT_{1 \text{ corr}} \\ \vdots \\ RT_{V \text{ corr}} \\ \vdots \\ RT_{m \text{ corr}} \end{pmatrix} = \varphi^T * \overrightarrow{I_{corr}} \tag{59}$$

³² An example: Total risk of a notional venture consists of three risk factors: experience, age, and market growth with equal absolute and relative impact $I_1 = I_2 = I_3$ if uncorrelated, and risk levels of $RL_1 = RL_2 = 2$ and $RL_3 = 1$. If there is a high causal correlation between the age of a manager and his experience, i.e., $\rho_{I_1, I_2} = 1$, adjustments must be made due to the high dependency; otherwise, total risk is overestimated. If $RT_{k \text{ uncorrelated}}$ is used, total risk would add up to 1,67. As age and experience are highly correlated, the two single factor risks overestimate total risk due to unchanged impacts used. Therefore, the impact of each correlated risk factor must be altered, leading to an adjustment of $RT_{k \text{ uncorrelated}}(X)$.

\overline{RT} illustrates total downside risk of the companies used in the risk model with a relative measure of risk scale. The risk of a company k is defined by RT_k with $k = 1; \dots; m$. RT_V is the risk of the new venture investigated. For a practical illustration of the new venture risk model, refer to the appendix.

Finally, group decision making can play a decisive role for the risk model. It is argued that risk assessments of multiple individuals might increase reliability as well as accuracy of future risk predictions. Moreover, it can solve the problem of inconsistency. According to the AHP, individual choices can be aggregated by a function of geometric mean, i.e., raising every decision to the power of $1/n$ if equal importance of each decision maker is provided or to the power of its importance in term of experience (Saaty & Peniwati, 2008).

8.3 Cost of Equity Model Development

8.3.1 The Downside Cost of Equity Model

There has been little research undertaken in the field of developing venture-specific cost of equity models, primarily for two reasons. First, financial data of a young firm are rarely available and a true market value cannot be observed with infrequently traded assets and small numbers of investors (Lerner & Schoar, 2004). Second, research focuses on comparable public markets that deliver all data necessary to apply conventional methods. However, the new venture investment industry and the new ventures themselves operate in a highly imperfect market (Fiet, 1995b; Poindexter, 1975; Wetzel Jr, 2000). Therefore, there has been an attempt to develop a cost of equity model, which has proven reliable with regard to listed companies similar to new ventures.

VCS invest in illiquid equity shares of young firms, which contain high risk and have volatile cash flows. Therefore, when analyzing comparable public markets, illiquidity, age of the companies traded, and risk play important roles. This kind of market can be compared to public companies operating in emerging markets (Lesmond, 2005). Research shows that

investors substantially increase the required rate of return on equity when assessing investment opportunities in emerging markets. It is argued that these markets are riskier compared to developed markets, which leads to higher required returns. Moreover, assets are infrequently traded (Bekaert & Harvey, 2003; Bekaert, Harvey, & Lundblad, 2007).

Additionally, it is relevant to analyze public markets where young firms are traded. Young listed companies are characterized by attributes similar to those of new ventures. It has been argued that public internet stocks in developed markets can be regarded as a comparable for non-listed ventures. Although traded on stock exchanges, they are often mainly financed by equity, are still young, and have major shareholders with little free float (Bekaert et al., 2007). Thus, they represent similarities to new ventures with regard to financial structure and shareholders' group. Similar to stocks in emerging markets, internet stocks are very volatile assets, have often a short history of returns, exhibit a low correlation to the market, and, above all, have return distributions, which are relatively skewed (Estrada, 2000, 2004). Analyses of the risk profile of private new ventures show similar characteristics with regard to return distribution and skewness (Cochrane, 2005; Ewens, 2009; Korteweg & Sorensen, 2010; Weidig & Mathonet, 2004).

There have been several studies that analyze and attempt to explain the risk-return characteristics of the stocks in both markets described above, e.g., Mishra and O'Brien (2005), Harvey (2001), Barry et al. (1998), Bekaert et al. (2003). In this study, the concentration is on the downside model of Estrada as a cost of equity model, which was empirically verified for emerging market stocks (Estrada, 2000, 2001, 2002) and internet stocks in developed markets (Estrada, 2004). The model outperformed the conventional CAPM in both markets. For these reasons, it is assumed that a cost of equity and risk measure that successfully explains expected rate of return of internet stocks and stocks in emerging markets is likely to provide a good starting point to develop a model for new ventures.

Estrada examines stocks in emerging markets with regard to their semi-deviation, which is used to account for (1) the skewed right-tailed distribution, and (2) the idiosyncratic risk, which is also important for investors. In general, the semi-deviation defines risk as volatility below a benchmark. The semi-standard deviation of returns can be described by the risk below the mean. Estrada tests the stock returns of internet companies and emerging market with a standard semi-deviation downside measure instead of the conventional beta. The downside measure can be expressed through:

$$\text{total downside risk} = \frac{\sigma_{SVi}}{\sigma_{SVM}} \quad (60)$$

σ_{SVi} represents the downside semi-standard deviation of the asset i and σ_{SVM} denotes the downside semi-standard deviation of the market, which leads to the following cost of equity model:

$$E(r_i) - r_f = \frac{\sigma_{SVi}}{\sigma_{SVM}} [E(r_M) - r_f] \quad (61)$$

This proxy explains to a large extent the cross-section of returns within developing markets as well as internet stock markets. Its relevance is also linked to the existence of skewed distributions of returns. Emerging market stocks and, internet stocks, as well as return simulations of new ventures, all follow highly non-normal distributions (Chen, Jorgensen, & Yoo, 2004; Cochrane, 2005; Estrada, 2004; Rosenberg & Schuermann, 2006). Thus, this evidence suggests that the semi-deviation as a risk variable is likely better than the beta factor to assess the risk of the assets described above (Estrada, 2006).

Moreover, it is shown that the level of total risk is significantly similar to the share returns in emerging markets, whereas systematic risk has low explanatory power. It is argued that the ex-ante expected returns proxies of single firms in emerging markets, which are listed, are linked to the variance of returns of the shares, i.e., total risk (Mishra & O'Brien, 2005). This is also confirmed by other studies, e.g., Harvey (2000). There is a correlation between

unsystematic risk and semi-deviation. This leads to the conclusion that unsystematic risk is priced in emerging markets (Estrada, 2000, 2007a), which emphasizes the relevance of idiosyncratic risk. Across emerging markets, total risk describes the cross-section of returns of shares (Estrada, 2000). The problem with total risk is that it contributes to downside risk as well as upside potential. However, as the distribution of returns of emerging market stocks are skewed to the right, total risk in the form of the standard deviation overestimates risk and cost of equity. In addition, if total risk is analyzed on a cross-section of industries in emerging markets, its influence on mean returns diminishes (Estrada, 2001). In comparison, empirical findings reveal that the downside risk approach, relying on the downside semi-variance, best describes the cost of equity of internet stocks and stocks in emerging markets (Estrada, 2000, 2001). This measure considers systematic as well as unsystematic risk and skewness of returns.

There are diverse reasons that academics and practitioners include the unsystematic risk factor (Mishra & O'Brien, 2005). It is argued that an investor must account for a firm-specific adjustment factor due to political risk in emerging markets, which consists of overall political and the share's exposure to political risk. The market might close due to political incidences (Bansal & Dahlquist, 2002; Damodaran, 2003). Other scholars argue that additional risk prevails because of illiquidity (Bekaert et al., 2003). Further, local emerging market investors do not hold a diversified portfolio (Sabal, 2004).

As total downside risk measures systematic and unsystematic risk, Estrada (2000) proposed the D-CAPM as an alternative cost of equity measurement of systematic risk for emerging markets. The semi-covariance cost of equity model of Estrada can be described as follows. The CAPM formula is used and the covariance of the beta factor as a measure of systematic market risk is replaced by the semi-covariance. The downside CAPM can be expressed through:

$$E(r_i) - r_f = \frac{Cov_D(r_i, r_M)}{\sigma_{SVM}^2} [E(r_M) - r_f] = \beta_{Di} [E(r_M) - r_f] \quad (62)$$

with $Cov_D(r_i, r_M)$ representing the downside covariance or cosemivariance, i.e., only the covariance between an asset i and the market below a certain target value is considered. β_{Di} is the downside beta factor. This approach is not new; it has been already pointed out by Markowitz (1959) that “the semi-deviation produces efficient portfolios somewhat preferable to those of the standard deviation”. Empirical analysis confirms the advantage of the downside beta over the standard beta (Estrada, 2002) for explaining systematic risk in emerging markets for diversified investors (Estrada, 2007b).

In conclusion, it can be argued that the most appropriate cost of equity model explaining the risk-return relation in markets, which are comparable to the venture capital industry, i.e., stock markets in emerging industries with low liquidity and internet stocks, relies on downside risk as a relevant method. Moreover, listed firms, which are comparable to new ventures, such as internet stock companies, show a skewed distribution of returns. Compared to other models, applying a downside risk cost of equity model to those companies results in higher performance. Depending on the diversification of a VC, either the downside beta or the total downside risk can be an appropriate measure for new venture risk.

8.3.2 Model Development

On the one hand, the return distributions of new ventures are highly skewed and therefore comparable to listed companies in the internet industry or in emerging markets. Moreover, the investors and entrepreneurs are often not fully diversified, which increases the relevance of a total risk approach, which considers firm-specific risk factors. On the other hand, it is shown that cost of equity models, which rely on the skewed distribution profile of returns generate the best results; specifically, they outperform the conventional model when the returns of listed companies that are similar to new ventures are analyzed. Regarding the risk measure, these models are based on semi-variance for total risk or semi-covariance for systematic risk.

The next step is to model how the determined total risk level of a new venture, namely $RT_{k\text{ correlated}}(X) = \sum_{i=1}^{\infty} I_{i\text{ corr}} * RL_{ki}(X)$, can be incorporated into an appropriate risk measure and a required risk-return profile.

A decision maker is confronted with uncertainty and risk almost everywhere. It is often argued that given a probability distribution over an outcome, the decision maker chooses an alternative depending on her or his preference as described by a Neumann-Morgenstern utility function. In doing so, the expected utility of an individual is maximized (Von Neumann et al., 2007). An alternative is to assess risk more objectively and directly by comparing the result with a given level of return or index (Grootveld & Hallerbach, 1999). Therefore, market data of the comparable companies used in the AHP can be applied as a benchmark. As it is focused on total and downside risk, the semi-variance of weekly or monthly market returns of publicly listed companies operating in the same market as the new venture analyzed can be used. If the comparables are private companies, accounting data in the form of semi-variance of quarterly or yearly cash flows, earnings or net income represent an alternative first approach (Damodaran, 2000). However, the reliability of private data as a proxy for risk is controversial due to its nature. Accounting figures are influenced by non-operating factors and tend to be downplayed relative to the value of the firm. Moreover, access to the necessary information of privately held companies is often restricted (Damodaran, 2002; Petersen et al., 2006).

Let's assume that there are $m-1$ companies found, which can be used as comparables for new venture V . Data in the form of semi-variance or semi-covariance of market returns of the comparables are available for a similar period of time. In that case, a benchmark vector \overline{BM} can be expressed through:

$$\overrightarrow{BM} = \begin{pmatrix} bm_1 \\ \vdots \\ bm_V \\ \vdots \\ bm_m \end{pmatrix} \quad (63)$$

with bm_i representing the benchmark risk value of firm i , e.g., the semi-variance of returns. The benchmark value of the new venture bm_V is an unknown parameter. Thus, the vector is incomplete with one coordinate still to be determined. The relative total risk weight derived from the risk model can be used to calculate the missing parameter. The equation is defined by:

$$\overrightarrow{RT} = a * \overrightarrow{BM} \quad (64)$$

The variable a is an absolute term. In a hypothetical environment with perfect information distribution, rational and objective decision makers, the parameter a is constant for all sub equations and can be determined by using all but one (the equation with the unknown parameter bm_V) of the linear equations. After the calculation of variable a , the equation can be solved leading to one unique solution for bm_V .

In reality, the valuation of new ventures with negative earnings, high growth and limited information is always challenging (Damodaran, 1999a, 2005a). Moreover, not all biases can be predicted and necessary correction factors determined in advance. Therefore, subjective decisions are never entirely accurate. This leads to the fact that there is only a small probability for a unique variable a , which solves all linear equations. In order to account for this real world condition, a noise vector $\vec{\zeta}$ is included in the model. This reflects the level of reliability of the risk estimates for each relative total risk weight. Thus, the real world benchmark for the new venture can be determined by:

$$\vec{\zeta} * \overrightarrow{RT} = a * \overrightarrow{BM} \quad (65)$$

In general, $\vec{\zeta}$ is a reflection of the underlying real risk about the future prospects of the firm and of information inconsistency because of real world conditions. Alternatively, the m -dimensional vectors \overline{RT} and \overline{BM} can be reduced to 2-dimensional vectors by averaging all but the missing factors of new venture V by an arithmetic mean operation.

With a benchmark risk value bm_V calculated through one of the equations above, a risk-return model can be established. If the benchmarks rely on semi-deviation and if total downside risk is relevant for a non-diversified investor or entrepreneur, the downside cost of equity model introduced by Estrada (Estrada, 2004, 2007a) can be used leading to the following equation:

$$E(r_V) = r_f + \frac{bm_V}{\sigma_{SVM}} [E(r_M) - r_f] \quad (66)$$

σ_{SVM} is the semi-standard deviation of the market portfolio. There are several reasons that this model is appropriate for this purpose. Firstly, it relies on the CAPM. However, it is important to stress that it is considered to be an empirical rather than a theoretical model. Secondly, it fulfills requirements of usability and practicability. Thirdly, its application is possible on a market as well as on a company level. Fourthly, it is not entirely based on a subjective measure of risk. Fifthly, it can be determined with a flexible target return, if the mean is not the desired benchmark. Last but not least, it deals with downside risk; the type of risk that actually concerns VCs. This is in accordance with behavioral finance and utility theory (Estrada, 2000; Statman et al., 2008; Tversky & Kahneman, 1992).

VCs often have internal benchmark rate of returns. These benchmarks can be also integrated into a cost of equity model for new ventures by using a benchmark B as the target return in the shortfall variance formula:

$$SV_\mu(X) = E[\max(B - X, 0)^2] \quad (67)$$

This leads to the following cost of equity formula:

$$E(r_V) = r_f + \frac{bm_V}{\sqrt{SV_\mu}} [E(r_M) - r_f] \quad (68)$$

In this case, bm_V is derived from a benchmark vector \overline{BM} , which is based on shortfall variance with regard to one particular target below or above the mean. This target can be determined beforehand by the VC.

If the VC is fully diversified and interested in the systematic risk-return relationship, the D-CAPM (Estrada, 2002) is an appropriate model, which relies on the semi-covariance. Its equation can be transformed to a systematic risk cost of equity model for new ventures:

$$\begin{aligned} E(r_V) &= r_f + \frac{Cov_D(r_V, r_M)}{\sigma_{SVM}^2} [E(r_M) - r_f] = r_f + \rho_{VM} \frac{bm_V}{\sigma_{SVM}} \\ &= r_f + \beta_{SVV} [E(r_M) - r_f] \end{aligned} \quad (69)$$

The beta factor β_{SVV} is comprised of the market variance and the expected covariance of the market and the new venture. ρ_{VM} is the correlation coefficient between the total downside risk of the new venture and the market semi-variance. In order to determine the correlation coefficient, the coordinates of the benchmark vector \overline{BM} can be used as a proxy. In this case, it is important to understand that only market risk factors should be considered when using the relative risk measure model developed. It is important to determine the cost of equity based on total downside risk and systematic downside risk.

8.3.3 Adjustment for Diversification

In a financial context, there are two types of risk prevailing, i.e., systematic as well as non-systematic risk. Together, they comprise total risk (Embrechts et al., 2009). For a comparison of the riskiness of a new venture and the required rates of return, the model developed considers all important aspects in order to derive reliable results. As the model is based on total downside risk, diversification of the VC is not considered in the first place. However, VCs are not exposed to total risk, but still not fully-diversified. As described, compensation

for idiosyncratic risk can be required. For instance, this can be caused by the costs of illiquidity of these financial assets. Moreover, venture capital firms or business angels, which focus on one investment type, are less-diversified if they specialize in a specific industry (Norton & Tenenbaum, 1993).

Moreover, there are new ventures, which have high total risk. However, their required returns with regard to systematic risk can be very low. For example, new ventures in the biotechnology industry in which returns for success can be very high and the risk is independent of market risk can have a systematic risk level of almost zero, i.e., beta near zero, resulting in very low theoretical required returns based on systematic risk (Smith, 2009). Hence, it is important for a VC to adjust a cost of equity model according to the personal level of diversification and it is important to know to what extent non-diversified VCs are exposed to non-systematic risk.

In the following section, two approaches how to formulize this question are considered and applied to the cost of equity model developed. First, Müller (2010) measures the idiosyncratic risk exposure in the form of the share of the investor's net worth invested. Second, Kerins et al. (2004) analyze underdiversification of entrepreneurs and VCs by total risk in combination of the allocation of assets to a new venture and a well-diversified portfolio.

The approach of Müller (2010) is applied. Müller (2010) used two calculations for the share of net worth invested (SNWI) to measure exposure to idiosyncratic risk:

$$SNWI A = \frac{\text{ownership share} * \text{market [book] value of equity}}{\text{net worth}} \quad (70)$$

SNWI B

$$= \frac{(\text{ownership share} * \text{market [book] value of equity}) + \text{guarantees} + \text{collaterals} + \text{net loans}}{\text{net worth}}$$

It was shown that this measure was sufficient to explain the increased cost of equity capital due to the lack of diversification of owners of private companies (Müller, 2010). Accordingly,

the idiosyncratic risk exposure can be determined by the share of invested net worth. Risk increases with SNWI. Nevertheless, the risk can also impact the amount VCs are willing to invest. VCs might only invest large amounts if they think that they can manage the risk taken. Apart from owner managers, this measure can be also applied to VCs. If bm_V is determined through the relative risk model and represents the total downside risk of the new venture, the semi-variance can be split to determine the fraction of idiosyncratic risk provided that the correlation coefficient is known. Depending on the idiosyncratic risk exposure of the VC, expressed by the share of net worth invested, a VC-specific downside risk can be calculated.

$$\sigma_{DV}^2 = \beta_{DV}^2 \sigma_m^2 + SNWI * \sigma_{DV}^2 (1 - \rho_{Vm}^2) \quad (71)$$

This value can be inserted in the cost of equity formula. It is important to mention, that the amount of money invested is not the amount that influences idiosyncratic risk exposure. *SNWI* depends on the individual circumstances of the VC, i.e., carry interest, investment in other portfolio companies, and salary waivers among other things. This leads to the following required return for the underdiversified VC:

$$E(r_V) = r_f + \frac{\sigma_{DV}}{\sigma_{SVM}} [E(r_M) - r_f] \quad (72)$$

Apart from this approach, which is based on relative exposure with regards to the share of net worth invested and semi-deviation, a portfolio approach also used by Kerins et al. (2004) is applied.³³ Hypothetically, if a VC invests all of his wealth in one new venture, idiosyncratic risk cannot be diversified away. Therefore, the VC bears total risk. This is described by a factor that uses the standard deviation of new venture returns divided by the standard deviation of market returns (Smith, 2009). A non-diversified individual is exposed to 2 until 4 times more cost of equity compared to a diversified external investor. As a high amount of total human and financial capital is committed to a single new venture, total risk affects cost

³³ The authors also apply the certainty equivalent in order to determine minimum equilibrium required return of a partly diversified individual. It is concentrated on this standard portfolio approach as it is assumed that equilibrium holding period returns can be estimated.

of equity (Kerins et al., 2004). It is proposed that a VC can determine the required return of a new venture by a value-weighted average portfolio in the new venture and in the market.

$$\sigma_P = \sqrt{x_V^2 \sigma_V^2 + x_M^2 \sigma_M^2 + 2x_V x_M \sigma_V \sigma_M \rho_{V,M}} \quad (73)$$

$$r_P = x_V r_V + x_M r_M \quad (74)$$

Based on the standard deviation of the portfolio, the portfolio return r_P can be determined.

The required return of the new venture is found according to:

$$r_V = \frac{r_P - x_M r_M}{x_V} \quad (75)$$

As described, adjustments of cost of equity models are made due to local influences. Integrated or segmented markets play an important role. It can be argued, comparing new venture markets with emerging markets, that new ventures in integrated markets do not need an adjustment, i.e., the global market risk is applied, whereas the local market risk is used in order to determine the cost of new ventures operating in segmented markets (Keck et al., 1998; Sabal, 2004). Therefore, the theoretical approach of cost of equity models described above needs only an adjustment with regard to the semi-variance of market returns, in the case of total downside risk, and the semi-covariance between the market factors and the new venture, in the case of the downside beta.

8.4 Limitations

It is concentrated on the AHP in order to gain a relative risk measurement for new ventures. A disadvantage is that it restricts numerical values of a comparison to less than 9. However, in situations where the relative measurement of riskiness of a factor exceeds the risk level of 9, a hierarchical decomposition of the criteria into clusters can be performed (Saaty, 2008a). Moreover, it is argued that the AHP allows for misjudgments by an irrational decision maker with limited information (Forman & Gass, 2001). However, if the level of inconsistency is too

high, the decision maker can reconsider the information and make adjustments (Golden & Wang, 1989; Saaty, 2008b). It is also argued that the use of a fundamental verbal scale as an alternative to numeric valuations might deteriorate accuracy (Forman & Gass, 2001). However, Saaty (1980) empirically showed that the eigenvector of a pairwise ordinal verbal judgment matrix often approximates the true weights from ratio scales, as the eigenvalue calculation has an averaging effect. Moreover, it is argued that intangible factors do not have a metric scale at all and the fundamental scale used is a reasonable approximation.

With hypothetically unlimited numbers of risk factors influencing the risk of a new venture, the values of the impact $I_{corr\ i}$ might be noisy. Most experiments are constructed by using factors, which are not intercorrelated because multicollinearity deteriorates statistical analyses. However, factors in circumstances of real decisions are expected to be highly redundant (Shepherd & Zacharakis, 2002).

Furthermore, there was an effort to avoid or mitigate major biases of the decision maker based on the model structure and theoretical adjustments. As the weighting function used in the model derived from the cumulative prospect theory (Tversky & Kahneman, 1992) does not consider all biases, aspects like prior experience and demographic factors are not considered by an additional error term. Investors often purchase financial products based on prior experience (Harrison, 2003). This personal experience affects risk assessment and awareness. Thus, the risk that people are willing to bear depends on their attention, interpretation and memory process. It influences their decision making regarding risky outcomes (Sitkin & Pablo, 1992; Sitkin & Weingart, 1995). The more experienced investors are, the higher their risk propensity relatively is and the lower their risk perception is (Chou et al., 2010). As the weighting function used in the model (derived from the cumulative prospect theory (Tversky & Kahneman, 1992)) does not consider this fact, the level of prior experience was not considered by an additional error term. Moreover, the relative risk model does not account for demographic differences of the decision makers, which might necessitate an adjustment of the

error term or the subjective weighting function. Studies showed that there are disparities. Female investors tend to be more conservative regarding investment behavior and are more risk averse than their male counterparts (Fellner & Maciejovsky, 2007). By contrast, a recent study showed that risk attitude of men and women does not differ, but between female and male groups. Men showed a higher risk tolerance acting within groups than females (Ronay & Kim, 2006). Moreover, it is analyzed based on laboratory experiments with monetary incentives that the shape of the probability weighting curve is influenced by the mood of the investor. Pre-existing good mood significantly influences the probability weights of female investors. Women in a mood better than average tend to overweight optimistically probabilities. However, men seem to ignore aspects of mood and rather apply mechanical decision criterion like maximization of expected value (Fehr-Duda et al., 2011). In general, attitudes towards risk is very similar for both genders (Chou et al., 2010). Interestingly, educational level, personal income level, occupation, and financial knowledge play a role in the prediction of risk tolerance (Grable & Lytton, 1999).

There might be arguments, which criticize the use of (listed) comparable companies. Public firms are almost exceptionally older than new ventures. There is a high probability that they generate high revenues and most likely profits, have strategic partners, and had the chance to establish entry barriers for competitor. Therefore, their risk is reduced, which cannot be compared to a new firm. However, there are several arguments, which invalidate this assumption. Firstly, risk of listed companies is not “just taken”. Each risk factor is analyzed with regard to relative riskiness between the new venture and the comparable company. Therefore, a probable higher risk of the new venture will be determined by using the risk model developed. Moreover, several comparable companies are investigated relative to the new venture. This increases reliability and reduces selection biases and errors. Secondly, one of the most serious critiques of cost of equity models and risk measures is that they often rely on data, which is generated in the past, although the models claim to predict the future. Using

data of more mature companies might still involve errors due to economic cycles or extraordinary events, which impact the data and might be not relevant for the new venture analyzed. However, applying past data represents also two advantages. The data was generated in the past when the comparable company was immature and therefore to a greater extend comparable to the new venture. Moreover, trends of the risk development of the comparable company can be analyzed and might describe the future life cycle of the new venture.

There is one practical limitation of this model proposed. Reliance on one model reduces the chances to outperform other VCs (Shepherd & Zacharakis, 2002). General opinion is that VC expertise is based on intuition and cannot be quantified (Khan, 1987). Nevertheless, it is believed that the model introduced still allows the integration of intuition and experience while structuring and improving the decision process of the risk evaluator.

It can be argued that integrating the relative risk measure in the cost of equity model of Estrada (2000) might still not reveal the right costs of equity for VCs. However, prior analysis showed that the model used is an empirically appropriate fit for firms, which have similar characteristics compared to new ventures. Therefore, the model is assumed to deliver profound results.

Last, it might be argued that risk reduction instruments are not considered in the development of cost of equity model. However, risk reduction mechanisms are directly considered in the assessment of each risk factor. Nonetheless, as the model of this analysis is static, a multi-stage approach might be necessary to account for the entire investment period and the expected development of the risk factors.

9 Development of a Multi-Stage Risk Reduction Model³⁴

9.1 *Relevance and Research Contribution*

Apart from the relevance of new venture risk assessment, there is little scientific attention given to VC risk measurement and risk optimization (Ferrary, 2009; Li & Mahoney, 2011). Research of financial and corporate risk management mainly relies on static and single-stage models (Acciaio & Penner, 2011; Szego, 2002). These risk models often have shorter maturities than the actual investment. Therefore, they do not adequately represent the timing and sequence of VCs' risk-management decisions (Fehle & Tsyplakov, 2005). Moreover, the few studies developing models of multi-stage VC investments (Berk, Green, & Naik, 2004) do not focus on pure risk assessment. Prior research has focused on risk-taking behavior (Busenitz, Fiet, & Moesel, 2004) and post-investment risk management strategies (Fiet, 1995b). However, an analysis of the investment decision and risk-reducing instruments in a multi-stage setting is still lacking (Parhankangas & Hellström, 2007). Last, most existing venture valuation methods do not consider the flexibility of VC investments gained by actively managing the ex-ante and ex-post investment process. This includes the risk-reducing instruments available throughout an entire investment period (Messica, 2008).

The ability to stage the new venture investment is often neglected when determining its value and risk (Dahiya & Ray, 2012). Without the staging option, the VC might undervalue the new venture. Although there are models including staging as a real option, e.g., Brous (2011) and Hsu (2010), important additional factors, which can reduce the risk for the VC in addition, are not considered. In this context, most methods neglect agency problems as important risk factors for VCs (Hsu, 2010). When it comes to further risk-reducing mechanisms, contract theory is relevant as it explains how contractual rights should be allocated according to risk. It

³⁴ This section contains elements of the unpublished working paper: Buchberger, A., & Grichnik, D. (2013): New Venture Risk Optimization: A Multi-Stage Approach for Venture Capital Firms, Unpublished Working Paper.

is shown that preference rights are optimal contracting provisions (Hellmann, 2006; Schmidt, 2003) in order to reduce risk. By contrast, scholars point out that there are severe disadvantages, which explains why these provisions are not used as frequently as theory suggests (Cumming & Johan, 2009; Leisen, 2012). Further, monitoring is used in order to reduce risk. Through active monitoring, the VC can prevent negative investment decisions by identifying increasing risks, such as agency risk, at the right time before further financial means are invested (Hopp & Lukas, 2012).

Despite these insights, the proxies of VC risk are not accepted in practice (Obrimah & Prakash, 2010). That is why there is still uncertainty about the decisive factors influencing the VC investment decision with regard to new venture risk (Hall & Hofer, 1993; Payne et al., 2009). With a missing multi-stage risk model for new ventures developed at this time (Mantell, 2009), research in this area is past due. Therefore, it is argued that a comprehensive study of multi-staged financing considering the entire investment period of VCs, including different risk-influencing aspects, is needed (Wang & Zhou, 2004).

This section contributes to entrepreneurial finance research in several ways. First, this analysis is the first exploration of a formal theoretical model concentrating on VC risk assessment including staged financing, monitoring, and contractual terms, as a means to assess and optimize new venture risk. In this context, it is also the first model that comprehends multi-period and multi-criteria settings (Roorda, Schumacher, & Engwerda, 2005) considering the whole investment path until exit. Apart from external and internal risk, the notion of the capital risk function, which addresses the staging option of the VC (Leisen, 2012) and transaction costs caused by risk reduction strategies, is introduced. The established model is used to create a comprehensive link between risk factors and risk-influencing elements.

Second, by examining the subjects described above within a multi-stage approach the analysis contributes by reducing the research gaps regarding risk and risk reduction strategies. Past

research of VC risk control has either concentrated on staging (Hsu, 2010), contracting (Kaplan & Stromberg, 2003), monitoring (Hopp & Lukas, 2012) or a combination of these elements without focusing on risk and their interrelated possible impacts. Hence, the demand for more theoretical models in order to better explain and predict the behavior of VCs in a financial context is addressed (Hsu, 2010). Based on the model developed and proven propositions, mutual impacts of the analyzed risk-reducing factors are revealed. Therefore, a framework for an optimal policy setting for VCs that includes all available options is developed. This mode of analysis is novel and will be of interest to scholars in the field of financial risk management as well as entrepreneurial finance.

Third, and linked to the previous contribution, the VC investment decision literature is enhanced. While VCs are mainly considered to be good decision makers, inaccuracies in their judgment are well-documented and evident (Zacharakis & Shepherd, 2009). VCs should consider the entire investment period and must realize their losses if goals are not achieved as expected. However, this is very often not accomplished (Birmingham, Busenitz, & Arthurs, 2003). Moreover, the relevance of decision criteria can vary extremely during the lifecycle of a new venture (Petty & Gruber, 2011), which increases the complexity of the VC decision and makes a non-static approach necessary. The model provides a theoretically sound basis to guide VCs during their investment decision and presents decision policies in order to reduce this shortcoming.

Fourth, this section contributes to agency theory and analyze its predominant concerns of complex informational asymmetries and control problems from a risk-assessment perspective (Hirsch & Walz, 2013). Options are implemented in many financial contracts, nevertheless, real option analysis has not been common in VC literature (Leisen, 2012), because VC research has focused primarily on how agency problems influence contract design (Gompers, 1995). As initial and subsequent VC investments can be seen as real options, this option approach by introducing capital risk and considering a staging factor for every risk factor is

added. This complements the agency perspective (Li & Mahoney, 2011) and addresses theoretical research in the field of VC financing and contract structure (Kaplan & Stromberg, 2003).

9.2 Model Assumptions

The model developed considers the entire investment phase. Points of time are defined by t_m with T representing a set of positive time instants $t_m \in T = [0, \infty[; m \in \mathbb{N}_0^+; t_m < t_{m+1} \leq t_{\text{exit}}$. m represents certain occasions in subsequent order, like a new financing round or exit, which are relevant to the new venture investment. The timespan between m and $m + 1$ and therefore the discrete point of times are defined by external circumstances or the VC.³⁵ The new venture is founded by one entrepreneur who is the only shareholder. Based on the skills, experience, and motivation, which depends on external and internal factors, the entrepreneur decides on the actual work effort at time t_m . Ex-post, the VC indirectly observes the work effort through the achievements of the entrepreneur. Ex-ante, the VC must forecast the work effort through a subjective function on agency risk involved and the skill level of the entrepreneur. The higher the actual work effort, the lower the entrepreneur-specific risk. As there is only one entrepreneur, one internal risk function is determined by the VC based on their insights and expectations.

Furthermore, it is assumed that there is one independent VC that is not fully diversified and cares about total risk in the first instance. Hence, diversification is neglected and total risk is important. Moreover, there is no financing restriction for the VC and investment syndications, which can be used as a risk reduction strategy, but increase transaction costs, are not available. Last, the investment of the VC is modeled as an investment process in continuous time.

³⁵ Either the absolute point of time, e.g. 3 years, or the abstract point of occasion, e.g. t_1 , as time notation, is used.

9.2.1 Investment and Staging

A VC plans to invest at time $t_0 \in T$. The new venture needs a total anticipated amount of K in order to become profitable and an exit is generated. The total investment K is constant, i.e., the pre-revenue new venture can achieve profitability in time with total K . Although K is fixed, the VC can divide the amounts paid into different stages³⁶ at time t_m with $1 < m < exit$. Moreover, the time of exit t_{exit} can change. If the new venture spends less resources during one period, it achieves profitability later, which postpones t_{exit} . There is no financing break-up of the entrepreneur anticipated. It is assumed that the entrepreneur is eager to continue the relationship with the VC until the new venture has received the total amount of K . Therefore, only the financing decision of the VC matters. The VC provides an initial investment commitment of k_{t_0} at time t_0 with $k_{t_0} \leq K$. If the new venture is abandoned by the VC, the new venture fails and k_{t_0} and all transaction costs incurred are lost. The total investment needed can be expressed by:

$$\sum_{m=0}^{exit-1} k_{t_m} = K \quad (76)$$

As step functions are difficult to operationalize, a linear function is modeled instead.

$$k(t) = z * t; z > 0 \quad (77)$$

The function reflects the VC's investment behavior as small payments are made at the beginning and larger investments are made with maturing life cycle of the new venture. As it represents a continuous investment of the VC, no additional variable, such as initial investment at t_0 , is needed. The total money invested at t can be described by:

$$ck(t) = \int_{t_0}^t k(t) dt = \int_{t_0}^t (z * t) dt \quad (78)$$

³⁶ In terms of terminology, it is not differentiated between staging and milestones in this analysis.

Until the exit, the entire investment K is spent, which leads to the following condition:

$$ck(t) = \int_{t_0}^{t_{exit}} (z * t) dt = K \quad (79)$$

As the investment can be postponed, i.e., a change of the time of exit, z depends on K and t_{exit} , which results in the following side condition:

$$z = \frac{2 * K}{t_{exit}^2} \quad (80)$$

Side Condition Proof 1: see appendix

The total investment K can be divided in several tranches. It is assumed that staging has an impact on the entire investment depending on the number of tranches. It is derived that $\gamma(t)$ describes the influence of staging. It depends on the number of single investments, expressed by the number of occasions m , until expected exit and the total time of investment. With t_0 as the first time of investment, m_{max} represents the m -th occasion at t_{exit} . $\gamma(t)$ is supposed to present a non-linear convex and increasing function with value 1 at t_{exit} as at that time, there is no longer a positive impact of staging available. With a linear function of $m_{max} - 1$, a parabolic function $y(t) = a * t^2 + b$ and knowing that $y(t_{exit}) = 1$, it is derived:

$$\gamma(t) = \frac{\zeta * (m_{max} - 1)}{t_{exit}^2} * t^2 + ((-\zeta * (m_{max} - 1)) + 1) \quad (81)$$

If $m_{max} > 1$, then $\gamma(t) < 1$, which signals a positive effect on risk. Just before the exit, the staging influence becomes zero. Hence, staging has a positive effect on investments returns in the early stage. As required, if there is no staging, i.e., only one financing round, $\gamma(t)$ equals one with $m_{max} = 1$. Moreover, as the staging effect decreases in time (Krohmer et al., 2009), the staging function increases with maturity of the investment. ζ is a constant pre-defined coefficient of staging larger zero as $\gamma(t)$ is larger zero due to:

$$0 \leq (-\zeta * (m_{max} - 1)) + 1 \rightarrow \zeta \geq 0 \quad (82)$$

In the context of staging and multiple investments, one type of security, namely equity financing, which is common in the VC industry, is considered (Tykvova, 2007). This means that the contract between the VC and entrepreneur is a sharing contract with shares $s(t)$, with $0 \leq s(t) \leq 1$, for the entrepreneur and $(1 - s(t))$ for the VC at time t . During the investment, the ownership of the new venture is shifted from the entrepreneur to the VC. The VC anticipates the shares at exit according to future goals and stages. This is expressed by:

$$s(t) = 1 - \frac{ck(t)}{K} * \rho; 0 \leq \rho \leq 1 \quad (83)$$

with ρ representing the share the VC expects to acquire until exit. $s(t)$ is a concave and decreasing function of t . Before t_0 , $ck(t)$ is zero and the entrepreneur owns 100%. At exit, $ck(t) = K$, then the entrepreneur has $1 - \rho$ of shares left. As $ck(t)$ is not linear, the staging assumptions described above hold. ρ depends on the dilution the VC enforces. It is assumed that an optimal equity contract assisted by a staged financing strategy can lead to an optimal risk strategy for the VC.

9.2.2 Transaction Costs

In reality, VCs are infrequently updated with new information from a portfolio company. This information includes the valuation of the new venture, external market conditions, and past effort of the entrepreneur. In order to receive and analyze this information, monitoring effort of the VC is necessary. This also included involvement in strategic decisions and operational activities. The VC determines how actively the new venture is monitored at each time t_m . Monitoring effort is supposed to stay constant or decrease during the investment because of the maturity of the company and the learning of the VC. Moreover, less monitoring effort is allocated to the new venture if more stages are implemented and less money is spent per financing round. These involve constant levels of effort for monitoring of the VC, denoted by

$e_{mon}(t_m)$, with $0 \leq e_{mon}(t_m) \leq 1$, which represent expected absolute values determined at time t_m for the period of t_m until t_{m+1} . In order to operationalize the function of monitoring, the following expression is derived:

$$e_{mon}(t) = -m_{max}p * t + q \quad (84)$$

As monitoring cannot be negative, the following side conditions are identified:

$$p \leq m_{max} * \frac{1}{q * t_{exit}}; p \geq 0; 0 \leq q \leq 1 \quad (85)$$

Apart from monitoring, the VC must negotiate contracts, financing rounds and evaluate the new venture at each stage in order to derive an investment decision. Hence, the negotiation effort of the VC, $e_{ne}(t_m)$, with $0 \leq e_{ne}(t_m) \leq 1$, depends on how much negotiation effort is allocated to the new venture and on staging. The more stages that are expected until exit, the more negotiation is necessary. However, the negotiation effort can decrease, the longer the VC is involved with the entrepreneur and the new venture. Based on that, the following function for negotiation is derived:

$$e_{ne}(t) = -\frac{1}{m_{max}}y * t + w \quad (86)$$

Similar to monitoring effort, negotiation effort cannot be negative, leading to the following side condition:

$$y \leq m_{max} * w * \frac{1}{t_{exit}}; y \geq 0; 0 \leq w \leq 1 \quad (87)$$

the VC attempts to implement several contractual terms in the form of preference rights CR^{37} and reward structures in the form of pay-for-performance incentives PPF in order to reduce risk. In order to simplify the underlying assumptions, the level of both contractual rights is

³⁷ These terms include: anti-dilution protection, simple liquidations preference, vesting, and control and information rights.

limited to $0 \leq CR, PFP \leq 1$. If it is set to one, there are no contractual terms implemented.

For now, the level of impact is kept constant.

Monitoring and negotiation efforts cause costs for the VC, because time is spent and external advisors, such as lawyers or financial services firms, must be hired. These costs can be expressed by a constant cost factor κ of the VC per unit of effort. The aggregated costs for monitoring are expressed by:

$$c(e_{\text{mon}}(t)) = \int_{t_0}^t \kappa e_{\text{mon}}(t) dt \quad (88)$$

With $t_0 = 0$, the integral can be simplified leading to:

$$c(e_{\text{mon}}(t)) = \int_{t_0}^t \kappa e_{\text{mon}}(t) dt = -\frac{1}{2} m_{\text{max}} \kappa p * t^2 + \kappa q * t \quad (89)$$

Similarly, the negotiation costs are derived:

$$c(e_{\text{ne}}(t)) = \int_{t_0}^t \kappa e_{\text{ne}}(t) dt \quad (90)$$

With $t_0 = 0$, the integral can be transformed to:

$$c(e_{\text{ne}}(t)) = \int_{t_0}^t \kappa e_{\text{ne}}(t) dt = -\frac{1}{2 * m_{\text{max}}} \kappa y * t^2 + \kappa w * t \quad (91)$$

The total transaction costs for the VC can be determined by $\tau(t) = c(e_{\text{ne}}(t)) + c(e_{\text{mon}}(t))$ at t .

9.3 Development of Multi-Stage Risk Factors

Structuring a VC investment is a trade-off between financial risk reduction strategies, additional costs emerging by staging, monitoring, and negotiations, and increasing incentives for the entrepreneur. If the VC decides to spend money on the new venture, the goal is to

reduce risk while getting a high return on K or to limit a potential financial loss if the new venture fails. The model developed is based on discrete-time horizons, which are finite. Events, which might occur, are forecast at certain points of time and decisions can be made during one finite time span. The optimal speed of investment is characterized by a trade-off. A larger investment flow in the new venture might lead to faster success, but is also likely to decrease efficiency and therefore increase risk of the investment (Bergemann et al., 2009). Based on that, the risk factors and their development can be used in order to make assumptions about the optimal investment behavior, efficient allocation of resources, and weighting the implementation of risk-reducing strategies and transaction costs. Three types of risk accounting for total risk – internal, external and capital risk – which are described in detail in the subsequent sections are defined. Each risk type has a biunique risk function at t according to the actual risk level analyzed and the anticipated distribution of future risk. Regarding the risk quantification, it is not focused on the assessment of each single risk factor but instead on the risk functions and the risk-influencing mechanisms as well as their impact on risk in a multi-stage VC investment setting.

9.3.1 External Risk

The VC and the entrepreneur are equally confronted with certain external risk factors. As the determination of external risk has many influences and is not the focus of this investigation, a relative level of risk is assumed. The VC assumes a linear development of external risk. The external risk function as of t can be described by:

$$exRT(t) = -h * t + d \quad (92)$$

External risk cannot be negative. Therefore, the following side condition until exit is derived:

$$h \leq \frac{d}{t_{\text{exit}}}; 0 < d \leq 1, 0 \leq h \quad (93)$$

with h representing the coefficient of external risk function and d the intersection with the y-axis describing the initial level of risk. With a zero or negative slope, external risk is assumed to stay constant or decrease over time. Both variables are determined by the VC by separate relative risk-measurement models, e.g., Buchberger et al. (2013).³⁸ Despite the simplification of this function, it is important to note that the function is readjusted each time the new venture does not achieve the forecast goals.

The model considers that external risk can be reduced by risk-reducing strategies leading to an efficient external risk level $exRT_{eff}(t)$. This decreasing effect on the external risk is expressed by:

$$exRT_{eff}(t) = exRT(t) * ex\phi(t) \quad (94)$$

$ex\phi(t)$ represents the risk-reducing impact on external risk. As external risk factors are not under the control of the entrepreneur, pay-for-performance incentives are desirable as the entrepreneur is risk-averse and needs compensation for bearing the external risk (Dessein, 2005). Moreover, high external risk makes direct monitoring more difficult, leading to the pay-for-performance arguments (Kaplan & Stromberg, 2004; Prendergast, 2002). Higher external risk is related to stronger preference rights and tighter staging. The larger the external risk, the more staging can improve the risk position of the VC as the option to stop the investment and limit the amount of money spent is available (Bigus, 2006). Staging is also beneficial for the entrepreneur. With less external risk in later rounds, the cost of capital invested is lower and the entrepreneur receives a higher valuation with lower costs of equity (Witt & Brachtendorf, 2006). Preference rights can also limit exposure to external risk for the VC because the total loss of funds already invested is limited. Based on these insights and using the definition from the previous sections, the risk-reducing mechanisms on external risk can be modeled as follows:

³⁸ Additive multi-stage functions for single risk factors can be used in order to specify the external risk function.

$$ex\phi(t) = \gamma(t) * PFP * CR \quad (95)$$

PFP and CR represent the influence of pay-for-performance and preference rights. Once determined, it is assumed that they do not change over time as they have an intrinsic constant influence on the firm. As $ex\phi(t)$ represents a multiplier of external risk, its absolute impact increases with increasing external risk.

9.3.2 Internal Risk

In the established model, the approach of Kaplan and Stromberg (2004) is followed and agency risk is denoted as internal risk. When investing in a new venture, the VC tries to evaluate the total agency risk without considering potential risk-reducing mechanisms in the first step. As internal risk is divided into three agency-specific risk factors, the total internal risk function $inRT(t)$ is divided accordingly:

$$inRT(t) = inRT_{mh}(t) + inRT_{as}(t) + inRT_{hu}(t) \quad (96)$$

$inRT_{mh}(t)$ is the risk attributable moral hazard risk, $inRT_{as}(t)$ represents adverse selection risk, and $inRT_{hu}(t)$ expresses hold-up risk. The internal risk function $inRT(t)$ must have several attributes. At the time of investment, the entrepreneur contains a certain level of agency risk. σ represents a constant value and describes the level of hidden information and characteristics of the entrepreneur. It is constant over time and can only be estimated by the VC. It is assumed that, with the entrepreneur holding fewer shares $s(t)$, the agency risk increases due to less motivation. Moreover, external risk affects the entrepreneur and the respective agency risk. i is the coefficient of external risk influencing agency risk. If external risk can be shifted from the entrepreneur to the VC, internal risk is supposed decrease. Based on that, the following total internal risk function is derived:

$$inRT(t) = \left(\sigma * \frac{1}{s(t)} - i * (1 - s(t)) * exRT(t) \right) \quad (97)$$

In order to being able to differentiate between the three types of agency risk, the corresponding risk functions are expressed by:

Moral hazard:

$$inRT_{mh}(t) = a * \left(\sigma * \frac{1}{s(t)} - i * (1 - s(t)) * exRT(t) \right) \quad (98)$$

Adverse selection:

$$inRT_{as}(t) = b * \left(\sigma * \frac{1}{s(t)} - i * (1 - s(t)) * exRT(t) \right) \quad (99)$$

Hold-up:

$$inRT_{hu}(t) = c * \left(\sigma * \frac{1}{s(t)} - i * (1 - s(t)) * exRT(t) \right) \quad (100)$$

a, b, c , represent the distribution of the influence of each internal risk factor with $0 \leq a, b, c \leq 1$. In sum, they equal one. The VC can use several risk-reducing instruments in order to diminish internal risk. Similar to the external risk, the effective internal risk function depending on t is influenced by risk-reducing factors denoted by $in\phi(t)$. In contrast to external risk, the instruments used can influence the three agency risks in different ways. Therefore, a differentiation is necessary. Internal risk is related to the contractual terms used in VC investment contracts. It is argued that control is not a binary variable, i.e., the entrepreneur has no control (Kirilenko, 2001). Due to the negative impact on motivation, extensive preference rights are associated with a negative influence on total internal risk for the VC. By contrast, pay-for-performance incentives are assumed to have a positive impact. As to staging, the underlying real option also causes a positive impact for the VC as it give him time to learn about the entrepreneur. Hence, the factors influencing total internal risk can be expressed by:

$$in\phi_1(t) = PFP * \gamma(t) * \frac{1}{CR} \quad (101)$$

Moreover, after the first investment, moral hazard and hold-up risk can be mitigated through monitoring by the VC. If monitoring is used by the VC, it always represents a positive impact on risk. Therefore, the function representing the monitoring impact must be always smaller than or equal to one. As monitoring can be implemented until exit and with a linear monitoring function $e_{mon}(t)$, the following function for the impact of monitoring on moral hazard and hold-up risk is derived:

$$\begin{aligned} in\phi_2(t) &= \left(\frac{(1 - eff_{mon} * e_{mon}(t_{exit})) - (1 - eff_{mon} * e_{mon}(t_0))}{t_{exit}} * t \right. \\ &\quad \left. + (1 - eff_{mon} * e_{mon}(t_0)) \right) \\ &= \left(\frac{(-eff_{mon} * e_{mon}(t_{exit})) + (eff_{mon} * e_{mon}(t_0))}{t_{exit}} * t \right. \\ &\quad \left. + (1 - eff_{mon} * e_{mon}(t_0)) \right) \end{aligned} \quad (102)$$

eff_{mon} represents a constant coefficient, which determines the impact of the applied monitoring effort at the beginning of the investment. After investment, the impact of monitoring on internal risk depends on the development of $e_{mon}(t)$.

Based on these insights, effective internal risk function considering the risk-reducing instruments applied can be expressed by:

$$inRT_{eff}(t) = inRT(t) * in\phi_1 * ((a + c) * in\phi_2 + b) \quad (103)$$

9.3.3 Capital Risk

The notion of capital risk is introduced for two reasons. First, it reflects the staged capital invested by the VC. With more and faster investments made at the beginning of an investment period, capital risk is already high in the early stage of a new venture investment. Second, it limits the use of risk-reducing mechanisms, which are costly for the VC. If monitoring and staging is extensively implemented, the influence on external and internal risk is high. However, when considering the underlying transaction costs and limited resources that are present in a real world setting, an optimal allocation of resources and level of risk reduction mechanisms can be derived. If no risk-reducing instruments are applied by the VC, only the capital invested affects capital risk $capRT(t)$ expressed by:

$$capRT(t) = \theta * \frac{(ck(t))}{K} \quad (104)$$

θ denotes the coefficient of capital risk and is determined by the VC according to its influence compared to internal and external risk. As in this case, the entire investment K is invested at t_0 , the factor is constant over time.

If the VC implements risk-reducing mechanisms, the underlying transaction costs must be considered. It is determined that total effective capital risk $capRT_{eff}(t)$ includes the capital invested in the new venture according to staging and the transaction costs τ_{t_m} incurred through negotiation and monitoring. The capital risk increases with more capital invested in the new venture and spent on transaction costs. Therefore, the total effective capital risk function for the entire investment phase follows a continuously increasing curve. Following these assumptions, the effective capital risk at t can be expressed by:

$$capRT_{eff}(t) = \theta * \frac{(ck(t) + \tau(t))}{K} \quad (105)$$

9.3.4 Total Risk

After defining the risk functions of the single types of risk, total risk can be analyzed. The level of total risk of the new venture at time t is expressed by the risk function $RT(t)$.

$$RT(t) = exRT(t) + inRT(t) + capRT(t) \quad (106)$$

Hence, at first, a single-stage new venture investment with no risk-influencing factors, like contractual terms, staging and monitoring, is implied. The VC commits to invest $K = k_{t_0}$ with the expectation that the new venture becomes profitable at t_{exit} as staging, as a risk-reducing mechanism, is neglected in this scenario. The VC assesses the internal risks, external risks, as well as capital risks. Without an opportunity to reduce the risk factors, the total new venture risk $RT(t)$ and its development must be accepted and taken by the VC. As presented in the previous sections, the VC has several risk-reducing mechanisms available. Due to the assumptions modeled, these factors reciprocally condition different types of risk. If a certain risk type is reduced, other risks might increase or additional costs accrue, which mitigate the risk reduction activities. If it is assumed that the VC considers all available mechanisms, each risk factor is influenced accordingly. Hence, the VC determines the effective risk function following:

$$RT_{eff}(t) = exRT_{eff}(t) + inRT_{eff}(t) + capRT_{eff}(t) \quad (107)$$

9.4 Model Analysis

9.4.1 Propositions

Although the model developed can be analyzed in many contexts, it is focused on a few essential aspects of new venture risk assessment in a multi-stage setting. Further and more detailed analysis is subject to further research. In this section, several propositions are derived and tested according to the model of analysis. An interpretation of the insights gained is made in the subsequent section.

Internal and external risk are often analyzed separately (Kaplan & Stromberg, 2001). However, they influence each other as shown in the model. Due to this interdependency among other things, internal risk is not linear and might change during the investment period. Moreover, external risk and its development regarding the relative impact might change as well. Therefore, it can be assumed that internal risk can increase during the investment period because of changes of external risk leading to the following proposition:

Proposition 2.1: *If internal risk $inRT(t)$ is analyzed and no risk-reducing mechanisms are implemented, a potential increase of internal risk depends on the level of external risk of the new venture.*

Proof Proposition 2.1: *See appendix.*

It is assumed that the VC can decide how to allocate the capital investment through staging. Therefore, the time of exit can be postponed. Monitoring must be adjusted accordingly as the success of the entrepreneur and new venture can only be observed at a later stage, which reassures the VC regarding agency risk. Therefore, the relative influence of monitoring on internal risk might change as well. Based on the model developed, the following proposition is tested:

Proposition 2.2: *If the impact of monitoring on effective internal risk $inRT_{eff}(t)$ is analyzed, it increases with an increase of time until exit.*

Proof Proposition 2.2: *See appendix.*

Staging and monitoring are considered as substitutes in order to reduce internal risk (Tian, 2011). However, as a quantification of both influences on internal risk is challenging, a closer analysis is still missing. It is modeled that staging influences total internal risk, whereas monitoring impacts only post-investment agency risk. Moreover, among other issues, staging and monitoring depend on the number of financing rounds. Although, the influence of staging is anticipated to outperform monitoring with regard to internal risk considering the entire

investment phase, the number of financing rounds might influence when the relative impact of one factor outperforms the other one. Therefore, the following proposition is examined:

Proposition 2.3: *Provided that monitoring and staging are both implemented in order to reduce the internal risk in $RT_{eff}(t)$, the marginal impact of staging outperforms the marginal impact of monitoring earlier in the investment period if additional financing rounds are prevailing.*

Proof Proposition 2.3: *See appendix.*

It is analyzed that monitoring effort has a positive influence on internal risk; the more monitoring, the higher the impact. However, in reality, the monitoring effort for one new venture is limited due to the monitoring and screening activities of other portfolio companies. Moreover, the VC must analyze potential new investments. Therefore, it is important for the VC to be aware when an increase of monitoring does not compensate for the negative increase in capital risk due to higher costs. This relevance is increased if monitoring is theoretically outsourced to third party providers, which mitigate the limits of monitoring available. It is believed that there is one boundary, which can describe this optimization problem leading to the following proposition:

Proposition 2.4: *With both capital risk and internal risk influenced by monitoring, there is one threshold at which an increase of monitoring still justifies an increase of capital risk for the VC. When this threshold is exceeded, monitoring should not be used as a risk-reducing strategy anymore.*

Proof Proposition 2.4: *See appendix.*

Last, VCs frequently use staging in order to minimize risk. Nevertheless, little is known about the optimal staging process if other influencing variables are considered. With this model developed, an optimal staging process can be described. Staging has a positive effect on internal as well as external risk. One might derive from this that the more staging is implemented, the more risk is reduced. However, staging causes transaction costs in form of

negotiation, which increases capital risk for the VC. If staging is exaggerated, total risk will increase at a later stage of investment. For a VC, it is important to know, at what point the marginal increase of staging still compensates the increase of capital risk caused by this action. It is argued that the developed model can present one solution assuming the following proposition:

***Proposition 2.5:** With capital risk, external risk, and internal risk influenced by staging, there is one threshold at which an increase of staging still justifies an increase of capital risk for the VC. When this threshold is exceeded, staging should not be used as a risk-reducing strategy anymore.*

***Proof Proposition 2.5:** See appendix.*

9.4.2 Findings

The developed theoretical model of effective total risk, including external, internal, and capital risk, reveals the complexity of a multi-stage new venture risk assessment decision for the VC. The model developed also shows that a new venture investment is a long-term procedure with several variables impacting risk in the future. As there are several ways to minimize local risk, it can be assumed that there are also several minimums regarding global risk involved in the entire investment phase until exit. Multiple dependent and independent variables must be considered. Moreover, when deriving an optimal risk reduction strategy, the marginal influences of the risk-reducing mechanisms on efficient total risk are not easily observed. As a result, the VC must balance his options according to subjective judgments. It is shown that this model can be used to obtain a better understanding of these interdependencies and offers a solution for inefficient risk allocation. In this context, scholars and VCs should consider the complete investment path and the influencing factors involved, leading to the following holistic optimization problem for the VC:

$$\min \left(RT_{eff}(t) \right) = \min(exRT_{eff}(t) + inRT_{eff}(t) + capRT_{eff}) \quad (108)$$

Moreover, several propositions were tested in the previous sections. The specific findings and implications are manifold.

Proposition 2.1 shows that internal risk can increase due to external risk. This is an important insight for the VC. During the investment phase and with decreasing internal risk, VCs might disregard agency problems, although they might increase again up until the time of exit due to changes in external risk. As a result, the VCs must adjust their risk-reducing instruments, namely staging and monitoring accordingly.

The finding of proposition 2.2 has two main implications for the VC. First, it shows that postponing an exit by lengthening the investment period has a positive effect of the monitoring effort on internal risk. Second, if monitoring is less costly than other risk-reducing strategies, it should be focused on especially for long-term investments. For short-term investments, staging or contractual terms can outperform monitoring depending on the transaction costs occurred.

Proposition 2.3 implies that the VC can optimize the risk reduction strategy regarding transaction costs according to the number of financing rounds. If staging is less costly than monitoring for the VC, additional financing rounds increase the relative impact of staging with regard to internal risk at an earlier point of time during the investment. It also reduces transaction costs as less monitoring is needed in later rounds. Moreover, if staging is more expensive than monitoring, staging should be reduced earlier at a later stage. Last, the negative influence on internal risk is reduced, if the risk of adverse selection is assumed to be marginal compared to the other agency risks.

The proof of proposition 2.4 shows that the mathematical solution depends on several coefficients and influencing factors. Nonetheless, the model developed offers a comprehensive approach to analyzing the trade-off between monitoring effort including the

underlying positive risk-influencing mechanism and the increase of capital risk due to transaction costs. The result can be interpreted as follows. It is shown that the influence of the monitoring costs on capital risk depends on the monitoring function. The influence of monitoring effort on internal risk depends only on the monitoring effort at t_0 and t_{exit} , as the monitoring effort function is linear. κ is the external variable, which impacts $c(e_{\text{mon}}(t))$ and therefore $capRT(t)$. There will be a boundary of costs units for monitoring κ , where $capRT(t)$ increases disproportionately high compared to the risk-reducing mechanisms of monitoring on internal risk. In other words, the factors p and q determining the effort of monitoring function must be adjusted according to the impact on capital risk as a means to prevent that risk from being increased during the investment period, provided that costs units for monitoring κ are considered constant. With less staging, i.e., m_{max} is decreased, more monitoring costs must be spent during the investment period, which increases capital risk. Regarding internal risk, more staging contributes to the reduction of internal risk based on monitoring, i.e., the effect of staging reduces the need for monitoring, especially in the later phase of the investment. This confirms the assumption that staging is a substitute for monitoring. VCs can use these insights in order to make a comprehensive decision on monitoring.

Proposition 2.5 shows that in the model staging influences capital, internal, and external risk all depending on m_{max} . The influence of the negotiation costs on capital risk depends on the negotiation function. This is contingent on the general negotiation effort and on the number of stages m_{max} . With more staging, the negotiation costs increase, which increase capital risk. As described, κ is the variable, which impacts $c(e_{\text{ne}}(t))$ and $capRT(t)$. Therefore, there will be a threshold of κ where $capRT(t)$ increases disproportionately high compared to the risk-reducing mechanisms of staging on internal risk and external risk. Then, the factors y and w determining the level of negotiation effort must be adjusted to prevent that risk is increased during the investment period. Similar to external risk, $\gamma(t)$ has a direct and non-linear

decreasing impact on internal risk, which diminishes until exit. The influence of staging on external and internal risk depends on the number of maximum stages m_{max} anticipated by the VC and the time of exit. The latter only has impact in terms of the duration of investment. The longer the investment path, the longer staging represents a risk-reducing instrument for internal and external risk. At exit the impact is zero. The number of stages m_{max} has a direct impact on the staging influence. The more stages, the lower $\gamma(t)$ and the greater the impact on external and internal risk. While $\gamma(t)$ is convex during the investment path, the relative importance of negotiation cost with regard to capital risk decreases. The slope of the share of capital risk is concave as is shown in the numerator of the function of relative impact on capital risk. This leads to the conclusion that staging costs in the form of cost for negotiation can be neglected with maturing investments regarding the impact on total risk. The capital investments become decisive in a later stage. In this context, it is assumed that the impact of monitoring $in\phi_2$ and $c(e_{mon}(t))$, which both depend on m_{max} , are kept constant and are adjusted through p and q accordingly. These insights should be considered by the VC, when a staging decision is made.

9.5 Limitations

Like every theoretical model developed, the model of this analysis has some limitations. One limitation might turn out to be the assumptions made for determining the risk functions, as it was tried to simplify some variables in order to reduce model complexity. This might lower robustness of empirical proofs.

It is modeled that external risk is decreasing or constant during the entire investment period. It might be argued that this does not represent the development of new venture risk in reality as external risk in an entrepreneurial environment can also increase after t_0 . As the model developed relies on assumptions made by the VC, it is argued that a VC would not invest in a new venture if an increase of external risk is expected. In that case, the VC would wait and

analyze the development of the new venture and the external risk factors. This is supported by research, which shows that external risk is reduced with maturity of the firm (Balboa & Marti, 2004).

Moreover, it might be criticized that focus on total risk poses a conceptual problem to the model regarding diversification effects of VCs under real conditions. However, the VC market is far from perfect (Wright, 1998). Apart from illiquidity (Sahlman, 1990) and information asymmetry (Admati & Pfleiderer, 1994), the personal idiosyncratic risk of a VC cannot be fully diversified due to limited numbers of investments (Robinson, 1988). Additionally, it is shown that, for instance, diversification by investment stage does not represent a significant risk reduction instrument for VCs (Manigart et al., 2002). These market imperfections imply that idiosyncratic risk might be as important as market risk (Rea, 1989). Therefore, it is concentrated on total risk of the VC investment.

Syndication as a risk reduction strategy (Ferrary, 2009) is not considered in this model as only one VC is assumed. Through syndication, in general, less capital is invested per portfolio company, which makes diversification possible. However, syndication also incurs higher transaction costs because more screening and negotiation, and less monitoring per new venture is possible, which might limit the analysis of this model. Therefore, and as the established model considers total risk of the VC in the analysis, syndication is not considered.

It might be argued that classification according to internal risk as well as external risk and the introduction of capital risk is misleading. The entrepreneur might have more information about external factors, like market and competition, than the VC, which might influence agency risk. However, it is assumed that the VC can obtain the same information through due diligence activities (Kaplan & Stromberg, 2004). Last, this analysis attempted to implement all available theoretical and empirical insights on risk-reducing strategies of VCs, but there might be some relevant aspects not yet identified and incorporated.

10 Conclusion³⁹

10.1 Summary

This dissertation contributed to academic research and VCs alike by expanding the underdeveloped literature of new venture risk and cost of equity models, by addressing important topics in the field of VC decision theory, financial risk theory, as well as entrepreneurial finance, and by providing practical insights to VCs. The subsequent paragraphs give a brief summary of the objectives achieved and existent research gaps closed.⁴⁰

First, an extensive literature review is elaborated. Conventional and emerging markets cost of equity models and aspects of behavioral finance are reviewed. Afterwards, the new venture and the VC are analyzed. This includes the risk profile of new ventures, the relevance of idiosyncratic risk, as well as the cost of equity models used by VCs. Based on these two separate analyses, the drawbacks of existing cost of equity models when applied to new ventures are highlighted and discussed. This analysis contributes to current research discussions. It is shown that the new venture characteristics do rarely fulfill assumptions necessary for the application of existing cost of equity and risk models (Kerins et al., 2004). It is concluded that with a lack of available historical data, the existence of highly skewed, volatile return distributions (Cochrane, 2005), and a complex decision process (Zacharakis & Meyer, 1998), new venture cost of equity determination is a major challenge for VCs and existent cost of equity models cannot be applied. There are some approaches utilized in order to cope with these challenges of risk assessment and new ventures. VCs rely on the volatility

³⁹ This section contains elements of the unpublished working papers: Buchberger, A., & Grichnik, D. (2013): New Venture Risk Optimization: A Multi-Stage Approach for Venture Capital Firms, Unpublished Working Paper. / Buchberger, A., Grichnik, D., & Koropp, C. (2013): New Venture Risk Assessment for Venture Capitalists: An Analytic Hierarchy Process Model, Unpublished Working Paper.

⁴⁰ As the research contributions are described in detail in the respective sections, an extensive repetition of this content is avoided here.

of cash flows of similar companies, which is highly inaccurate due to the lack of information and limited comparability (Damodaran, 1999a; Jain & Nag, 1996).

Next, the new venture risk factors in the form of VCs' investment criteria, namely the entrepreneur, the market, the product and services, and financial aspects, are analyzed from a theoretical point of view. Institution-base theory (Peng, 2002) is used in order to explain possible differences with regard to the relevance of the examined investment criteria. An empirical meta-analysis concludes this analysis. The findings provide an appropriate overview of criteria used and their relevance in an international context, which is relevant for the development of a new venture cost of equity model. The analysis contributes to the several academic controversies, e.g., the debate of market versus entrepreneur as the most important investment factor in an international context (Zacharakis et al., 2007). Moreover, it is shown that new ventures are mainly influenced by non-quantitative risk factors. Qualitative criteria, such as management experience, expected market growth, and customer acceptance of the product, come to the fore with regard to new venture risk (Song et al., 2008). By contrast, investors financing established firms rely to a large extent on financial quantitative factors. However, with no long business history, new ventures do not possess financial data on which investors can rely (Damodaran, 1999a). Therefore, the determination of new venture risk is even more challenging. Qualitative and intangible factors prevalent cannot be easily quantified and integrated into a conventional cost of equity model. Hence, risk theory and decision theory are analyzed. Due to qualitative risk factors, VCs are forced to make subjective decisions during their risk evaluation process (Zacharakis & Meyer, 2000). They use simple ad-hoc procedures, which are vulnerable to biases and lack a methodic framework (Messica, 2008; Shepherd, 1999b). Research shows that predictions about new venture risk are often based on ad-hoc assessments, which are highly speculative and uncertain in practice as compared to structured decision models like decision trees or heuristics (Damodaran, 1999a; Zacharakis & Meyer, 2000).

Based on the findings of investment decision-making research as well as financial risk theory, and incorporating theoretical risk assessment insights, a relative risk model is developed, which addresses several challenges VC face while trying to objectively determine the level of risk and cost of equity. The model integrates a decision model and a risk model through the use of the analytic hierarchy process (Bernasconi et al., 2010; Saaty, 1987; Saaty, 1982, 2008a), the perception of the downside risk approach of new ventures (Estrada, 2004, 2008), and a developed risk aggregation method (Kerins et al., 2004; Müller, 2010). The methodology of the analytic hierarchy process is used as a basis for the risk model developed due to its ability to address the problems described above. The weights of the highest level of the hierarchy, called risk impact, are determined from existing empirical data or expert opinion. The correlations of the risk factors are incorporated in the model. After quantifying the level of risk and the corresponding impact on total risk, the identified risk factors are structured and, subsequently, the total downside risk of a specific new venture can be calculated. The results of the AHP can be integrated in a downside risk approach for young ventures using absolute input data, like market volatility, which are used as benchmarks in order to convert the relative total risk assessments into absolute risk levels. This leads to an important and novel approach of new venture risk assessment. If the risk assessment is conducted by several individuals, the results can be grouped. Based on this relative risk assessment model for new ventures, a new cost of equity model is set up. It is shown that similarities between new ventures and internet stocks or companies in emerging markets exist with regard to risk-return profile and market imperfection (Estrada, 2004; Sahlman, 1990). The total downside risk approach in order to determine the cost of equity of these firms is analyzed to provide a profound basis for the application to new ventures (Estrada, 2000). Therefore, the cost of equity model based on the downside risk approach (Estrada, 2006) is developed by integrating the elaborated relative risk model. It accounts for diversification of the VC by considering total as well as idiosyncratic risk.

This theoretical approach contributes to current research of entrepreneurial finance, decision theory, and risk analysis by (1) minimizing the challenges described, (2) incorporating and quantifying qualitative risk factors, (3) combining tangible as well as intangible elements, which is rarely considered in financial risk theory, (4) reducing biases by structuring the decision-making process of VCs and, thus, increasing risk assessment accuracy and comparability, which lead to higher returns, and (5) integrating the risk measure in an intuitive downside cost of equity model.

After developing a new venture risk and cost of equity model, the analysis is progressed to new venture risk reduction while considering the entire investment phase of a VC. With the prevalence of high agency risk (Fried & Ganor, 2006), significant external risk as well as capital risk, and the limited availability of a financial track record (Timmons & Spinelli, 2009), determining and optimizing risk exposure is a major challenge for venture capital firms during their investment decision process. First, the entire staged investment path, from first closing until exit, must be taken into consideration. Second, VCs exploit risk management mechanisms in the form of staging, contracting, and monitoring, which implies a trade-off between risk reduction and transaction cost elements. Despite its importance for VCs, entrepreneurial finance research still lacks a multi-stage approach.

The developed model is the first comprehensive, multi-stage risk approach for new ventures (Roorda et al., 2005). Until now, entrepreneurial finance research has neglected a consideration of the entire investment period, although VC engagements are long-term, high risk investments, which are not easy to liquidate once the investment is made (Sahlman, 1990). By introducing the notion of capital risk as an additional risk factor a VC must consider, the model contributes to filling this gap and can explain why and when certain risk-reducing mechanisms are preferable. Moreover, the model offers flexibility, which makes adjustments possible. By linking external, internal, and capital risk, this model offers a solution to analyzing the development of total new venture risk. Moreover, as research has

mainly concentrated on single factors, e.g., Hsu (2010), this model links several risk factors and influencing mechanisms. This section contributes to agency, decision and finance theory as it is the first analysis to link the staging option, principal-agent-risk, and other risk-influencing factors, such as contractual terms and monitoring, to one multi-stage risk decision model for VCs. Hence, the risk reduction model development contributes to current research by (1) establishing a comprehensive multi-stage risk model for VCs that considers venture-specific risk-influencing mechanisms, (2) introducing a new type of risk – capital risk – which offers important insights regarding the VC's staging and monitoring decision, and (3) deriving and proving several propositions.

These findings and contributions have several theoretical as well as practical implications and offer links to future research, which are described in the subsequent sections.

10.2 Theoretical Implications

10.2.1 New Venture Risk Assessment and Cost of Equity Model

The essential theoretical implications derived from the development of a new venture risk assessment and cost of equity model are diverse for theory in the fields of entrepreneurial finance, risk measurement, and decision making in a VC context.

(1) Scholars have called for the implementation of a venture-specific risk and cost of equity model (Messica, 2008; Woodward, 2009). The model developed contributes to this notion and fosters additional research in the field of new venture risk assessment. Insights into the few approaches already developed are provided, venture-specific characteristics and qualitative risk factors are emphasized, and a venture-specific risk and cost of equity model is presented. By addressing all important aspects of a new venture risk and cost of equity model, fellow researchers gain a comprehensive overview of interdependent factors and relevant behavioral adjustments necessary to derive an appropriate model. Qualitative factors, such as the management team, have a significant impact on business performance. Although these factors

influence larger firms as well, quantification through those firms' existing financial data is much easier compared to new ventures. The valuation of these risk factors is especially difficult for VCs, which is addressed by the elaborated model. Researchers can use this model to better understand empirical results which lack a theoretical basis.

(2) Several important aspects regarding modeling risk and new ventures are analyzed with this theoretical approach. Research shows that idiosyncratic risk plays a relevant role in entrepreneurial finance (Estrada, 2004; Kerins et al., 2004; Müller, 2008). The established model contributes to this by considering total risk. Propositions about risk factors, their coherence, and aggregation are derived and constituted in order to enable analysis of all factors influencing total new venture risk and their prevailing interdependencies (Fishburn, 1982; Szego, 2002). Moreover, the notion of the relative impact of risk, risk level, and factor risk is introduced; thus, scholars are provided with a new tool in order to analyze risk factors of new ventures from a new perspective. Furthermore, this differentiation makes the model of the analysis flexible with regard to the stage of investment as well as the availability of data concerning risk factors. By integrating a subjective weighting function, issues of risk perception in appropriate manner are addressed (Deligonul et al., 2008). As the model is developed in a modular manner, single items, such as the subjective weighting function, the ratio scale, the number of risk factors, and SR, can be easily revised. This flexibility allows for the adjustment of the model according to new future insights generated. Researchers can apply these elements to better grasp the differences between required and expected return.

(3) The risk and cost of equity models used in financial analysis of established firms imply that the attitude of an investor does not play a significant role in the assessment of risk. With equilibrium assumptions and no reason to quantify qualitative risk factors, it is common to construct risk and cost of equity models based only on quantitative data (Hallerbach & Spronk, 2002). By contrast, the established model accounts for facts prevailing in the venture capital industry. VCs must make qualitative decisions and do not act rationally, which ties in

with research in the domain of behavioral finance (Bossaerts, 2009; Hsu et al., 2009). Research on VC decision making has proved that not all important aspects have been considered in the literature. The methodologies of VCs' decision-making models are extended. The AHP has been implemented in many contexts (Saaty, 2008a). Although its advantages are proven by an increased accuracy of multi-criteria financial decision-making problems (Zopounidis & Doumpos, 2002), the AHP has not been applied to VCs. This analysis is the first to adjust it according to venture-specific characteristics and use it for venture capital risk assessment. Through this model, decision theory can enhance understanding of the VC's behavior.

(4) The model developed represents a new venture-specific cost of equity model. Many scholars deal with venture valuation and its obstacles, e.g., Messica (2008) and Damodaran (1999a). To estimate missing data, research uses consolidated IPO data of more or less comparable "young" firms (Müller, 2010). However, this highlights that benchmarking with publicly traded securities is not useful, as the correlations between public equity and venture equity are estimated to be very close to zero (Chen et al., 2002). The reliability of these cost of equity factors for the new venture can be doubtful. As a result, new models based on real option approaches (Steffens & Douglas, 2007) or adjusted existing techniques (Scherlis, Sahlman, Administration, & University, 1989) are implemented. However, the underlying complexity hinders the usage in theory and practice. The established model approaches this challenge one step ahead by concentrating on the risk assessment of new ventures and relying on a proven cost of equity model under similar market condition. By considering VC- and new venture-specific factors, the model developed offers new insights for theorists in financial research.

10.2.2 New Venture Risk Reduction Model

Apart from the specific insights derived through the particular propositions discussed in the findings section, the development of the new venture risk reduction model reveals several theoretical and practical implications.

(1) By introducing a new risk factor – capital risk – in addition to external and internal risk, the theoretical model shows that the financing and risk assessment decision is subject to timing and the value of funds invested. This can have significant influence on, but also explains, the behavior of VCs. Considering this, the model developed gives insights into several empirical results from a theoretical perspective and can offer explanations for contradictions. Furthermore, the model can be used as a theoretical basis regarding the behavior of the VC when analyzed in a risk assessment context.

(2) With regard to contract theory, there are mixed theoretical and empirical results in terms of contractual clauses and their relevance to VC risk optimization (Kaplan & Stromberg, 2004; Leisen, 2012). The model developed shows that the influence of pay-per-performance or cash flow rights is linked to other factors and must be analyzed in a holistic context. Due to the flexibility of this model, further contractual clauses can be added and unexplained empirical results of contract research can be linked to this model.

(3) Staging is important for VCs (Gompers, 1995; Hege et al., 2003; Krohmer et al., 2009; Tian, 2011). However, research has not analyzed staging in a comprehensive way by considering internal as well as external risk factors during the entire investment path. This analysis is used to reveal new findings as to when, how, and why staging is most efficient for the VC. Staging and monitoring are often regarded as substitutes (Tian, 2011). The model developed examines that a closer analysis is necessary as the influence can change during the investment period. Moreover, the length of the investment is meaningful. Similar results are found for monitoring as a risk-reducing strategy for VCs.

10.3 Practical Implications

10.3.1 New Venture Risk Assessment and Cost of Equity Model

The developed new venture risk and cost of equity model provides several practical implications for VCs.

(1) VCs use conventional non-venture-specific finance instruments, which often results in misleading, inaccurate, and biased estimates of cost of equity of new ventures (Damodaran, 1999a; Messica, 2008). By integrating both qualitative as well as quantitative risk factors and by concentrating on a forward-looking approach, this cost of equity model overcomes the challenges of the alternative models currently utilized. The model highlights all relevant risk factors for the VC, which prevents the neglect of important facts. It increases the accuracy of new venture investment decisions, heightens returns, and enhances risk management of venture capital funds. The better the risk and cost of equity assessment of each portfolio company, the better the risk profiles that can be set up and the more diversification effects are gained.

(2) The cost of equity model is flexible in several aspects, gives feedback and offers group consensus. As each individual has its own subjective weighting function, it is possible to adjust the model according to insights that were gained in the past. VCs can alter their valuation if new and relevant information is obtained. The model gives feedback for VCs while verifying similar companies with regard to comparability and consistency of the investors' decision. Last, the new venture cost of equity model arbitrates disagreements among VCs regarding the risk assessment of new ventures (Saaty & Peniwati, 2008).

(3) Further, this new venture risk model reduces the subjectivity of VCs. Investors are influenced by heuristics and biases (Zacharakis & Meyer, 1998). Through its structure and assumptions, the developed model gives guidance on investment decision making in order to avoid biases (Deligonul et al., 2008; Griffin & Varey, 1996), which increases the consistency

of a VC's decisions. Moreover, the model of this analysis emphasizes the complexity of the risk assessment process for the VC. Hence, the VC is made aware of all relevant aspects and risk factors necessary to analysis and assessment.

10.3.2 New Venture Risk Reduction Model

(1) This analysis offers major implications for VCs and entrepreneurs in practice. As in every industry, there is competition among VCs for the best new venture deals. Being able to assess the relevance of contractual rights, monitoring, and staging for the level of risk while also considering transaction costs, VCs can offer better terms to an entrepreneur, resulting in a competitive advantage. Depending on the risk tolerance and policy, the VC can adjust the terms negotiated and either increase or decrease the variable elements accordingly.

(2) The model developed shows that all risk functions developed have an impact on the optimal multi-stage risk reduction strategy of the VC. This also confirms that multi-stage risk assessment is a complex decision problem for the VC. Therefore, the model developed can be used as a decision aid. VCs can adjust the timing and criteria of staging according to the level of risk derived through the model and analyze the optimal staging process. With regard to optimal asset allocation, the VC is given insights concerning, which risk-reducing instruments should be used. The VC should choose the risk strategy that minimizes costs while also minimizing risk. If the positive marginal impact of one factor on risk is higher than the negative marginal impact on capital risk, that is the area to which assets should be allocated.

(3) During the investment decision process, VCs primarily focus on the direct risk factors of new ventures (Macmillan et al., 2002). Transaction costs are often neglected as they are considered insignificant initially compared to the investment (Gompers & Lerner, 2001b). However, the model developed shows that the longer the anticipated investment period, the greater the influence of transaction cost on capital risk. In addition, in that they have a significant influence on the trade-off between different risk reduction strategies, VCs should

start to analyze their costs κ . If these costs are considered, more effective decisions can be made and total risk reduced.

(4) Last, by modeling the impact of contractual, staging, and financial factors on new venture risk, the entrepreneur better understands the investment risk assessment and negotiation process of the VC. The entrepreneur can adjust his behavior accordingly to increase the likelihood of being funded.

10.3.3 New Venture Investment Criteria

Apart from the relevance to the relative risk and cost of equity model developed, the empirical findings have interesting implications for practitioners. Practitioners, such as VCs, can benefit from the empirical analysis of new venture investment criteria in several ways.

(1) The findings provide venture capitalists and business angels with an aggregated view of cultural differences regarding investment decisions in regional clusters differing from those in which they might operate at the moment (Shepherd & Zacharakis, 2002). VCs attempting to increase their potential investment portfolio by going abroad might face difficulties generating their target returns (Bruton et al., 2005); this risk can be reduced by accounting for the different institutions operating in individual markets. These institutions can include differences in legal regimes, development stage of capital markets, cognitive matters, norms, or broader geographic, i.e., cultural, factors.

(2) While many internationally operating investment firms implement firm-wide policies with regard to investment criteria and due diligence procedures, this analysis suggests that firms need to allow local branches to alter investment behavior and adapt to local situations to enable the proper assessment of risk (Farag et al., 2004). VCs entering a new country must reconsider the relative importance of local versus expatriates' experience and know-how (Lockett et al., 2002). When considering recruitment of investment specialists, it is highly relevant to stress the experience in receiving new venture-specific information in a certain

regional context. This is comprised of well-developed local networks and intensive cultural skills (Wright et al., 2004). By contrast, if investment managers were trained and gained experience in a different market, dealing with different institutional circumstances can be challenging and might increase the risk of failure. This also implies that new venture investment firms need more time to become familiar with the legal, cultural and cognitive environment of a new geographic area of possible investments. Gaining this local expertise gives the VC the opportunity to invest abroad more frequently and increases deal flow and performance (Schertler & Tykvová, 2010).

(3) VCs should also consider these factors analyzed for venture valuation and negotiations. As they are considered experts in identifying promising firms, investment decisions in foreign cultural regions should be reviewed according to the findings in this study. Similar to and extending previous findings (Zacharakis et al., 2007), this analysis concludes that professional institutions, such as venture capital associations or parent companies, can dictate new venture investment processes. However, the extent to which it is implemented depends, at least partly, on the institutions in which the investor as decision maker operates.

10.4 Research Outlook

During the analyses of this dissertation, the research gaps of entrepreneurial finance with regard to cost of equity and risk assessment models in a new venture context were recognized more than once. First, there are only few studies published, e.g., Kerins et al. (2004), Mantell (2009), Reid and Smith (2007), Van Gelderen et al. (2005), and Cotner and Fletcher (2000) and some unpublished working papers, e.g., Ewens (2009) and Ge et al. (2005), which address the topic of this dissertation. Second, scholars primarily concentrate on how to determine ex-post the cost of equity and the underlying risk of new ventures (Korteweg & Sorensen, 2010). Hence, there are still several directions in order to contribute to the field of research this dissertation focuses on. Future research that addresses the specific topics of this dissertation is described in the last three sections.

10.4.1 New Venture Risk Assessment and Cost of Equity Model

The theoretical model developed needs empirical verification in order to assess its reliability and prediction accuracy. A longitudinal study incorporating all necessary data of a new venture as well as its comparable companies can present a decent approach to empirical proof. The weight vectors determined by the risk model and the “actual” weight vectors given by empirical data can be compared through a compatibility index. This index can be expressed through a measure of compatibility of two matrices in the form of a Hadamard product:

$$\frac{1}{n^2} e^T A \circ W^T e = \frac{\lambda_{max}}{n} \quad (109)$$

where W^T is the transpose of a reciprocal weight matrix derived from the risk model. A is the matrix of the “actual” weights from empirical data. λ_{max} is the maximum eigenvalue. A good model has a ratio close to one or not more than 1,01. It is based on the notion that a 10% deviation is the upper end of acceptability (Saaty, 2008b).

Moreover, sensitivity and simulation techniques can be used to control and adjust subjective weighting functions, risk aggregation methods, benchmarking and error vectors. This includes what recent research has shown. The preference of individuals differs, changing the fourfold pattern of prospect theory (Kahneman & Tversky, 1979) if the alternatives are experienced through feedback or explained (Barron & Leider, 2009; Hau et al., 2009; Rakow & Newell, 2010). Therefore, a survey or similar procedure must account for these aspects, especially if experiments rather than real field research with market data are used for empirical analysis. Psychology research has shown that too much information, i.e., people are overloaded, leads to worse decisions (Paredes, 2003). Therefore, the load of information must be controlled in empirical tests. It is analyzed that even if investors have more information available than do other investors using a bootstrap decision model, the model outperforms (Zacharakis & Meyer, 2000).

The risk factors of new ventures necessary for the cost of equity model elaborated are still an unfulfilled area of entrepreneurship research. There are contradictory studies reporting success and failure prediction variables with no dominating theory existent (Lussier & Halabi, 2010). This includes the analysis of the theoretical foundation of correlation between risk factors. A holistic approach is still missing and involves several schools and disciplines of research. Single risk factors can be categorized and major management theories like resource-based theory and the structure-conduct-performance paradigm in industrial organization can analyze its theoretical as well as empirical relevance in the future (Ge et al., 2005).

Additionally, not all biases are considered in this model. In terms of prediction of risk tolerance, educational level, personal income level, occupation, and financial knowledge play a role (Grable & Lytton, 1999). Future proof should test these biases and assumptions with regard to the cost of equity model developed. Therefore, there is a wide scope remaining to refine the weighting function used. Personal experience can be an influential factor, a weighting function that must be adjusted for (Chou et al., 2010). There is proof that prior gains increase risk-taking, while prior losses reduce risk-taking (Massa & Simonov, 2005); empirical testing should control for these influences. Moreover, the subjective probability distribution can be adjusted according to the latest findings of the entrepreneur's risk valuation and perception (Deligonul et al., 2008).

There are many potential extensions, which might substantiate the risk and cost of equity model developed and improve its theoretical and empirical accuracy. An extension to multi-period settings and multi-stage decision models (Pflug & Römisch, 2007) would broaden the space of possible applications. Moreover, the consideration of risk-reducing strategies of the VC was excluded, which might alter total risk of the entrepreneur and the investor (Smith, 2009).

Last, an important aspect is the difference between the VC and the entrepreneur. Further research can adjust the model developed according to entrepreneur-specific characteristics

and, thereby, extend the group of addressable users. The distinct level of diversification (Kerins et al., 2004) and biases deviate from those of investors or non-shareholding managers (Busenitz & Barney, 1997).

10.4.2 New Venture Risk Reduction Model

Future research can extend and test the developed model in various ways. The findings of this model should be empirically analyzed in order to prove the assumptions and quantify the coefficients used. Hence, longitudinal studies can verify the model and provide further insights that will improve accuracy. If contradictory results are revealed, the model should be adjusted accordingly. In this context, the model can be extended and additional assumptions implemented with regard to the three risk factors and their development during the investment phase. Moreover, dynamic learning processes are not considered in the developed model. Future research should extend the model to the effects of experience (Bengtsson & Sensoy, 2011b) and reinforcement learning (Sutton & Barto, 1998). As individuals can simultaneously consider several reference points when making their decisions, a more detailed modeling might be necessary (Koop & Johnson, 2012). The tri-reference point theory (Wang & Johnson, 2012) that considers the effects of minimum requirements, status quo, and the impact of goals represents a decent model extension and specification. Furthermore, impacts of geography (Tian, 2011), the type of VC (Hirsch & Walz, 2013), portfolio effects, or syndication (Ferrary, 2009), each of which might have an impact on the model developed when applied in practice, are not considered. VCs invest in several new ventures that, combined, form a portfolio. These new ventures might be interdependent and decrease risk through portfolio diversification effects. A future multi-staged assessment model of risk must be adjusted with that in mind (Pendharkar, 2010). The propositions derived concentrated on single factors; further research can extend the findings by considering total effective capital risk and analyzing the marginal influence of the risk-reducing strategies simultaneously over the entire investment path. Lastly, venture valuation and the determination of the cost of

equity of new ventures are still underdeveloped (Boudreaux et al., 2011). Future research can apply this model in these contexts. Considering the flexibility as well as comprehensiveness of the model developed, research on cost of equity models for new ventures should include the insights gained through this study in order to contribute to more precise venture valuation methods and cost of equity determinations.

10.4.3 New Venture Investment Criteria

Many studies have examined the investment criteria of VCs and risk factors of new ventures (Macmillan et al., 2002; Song et al., 2008). Although their results are often significant, models with low explanatory power indicate that there are still factors not researched or adequately investigated (Kakati, 2003). Closing this gap by considering, in the first place, factors other than those identified by this empirical analysis that influence the general decision-making process, and, secondly, including cross-cultural issues, is suggested. Future cross-cultural primary research should test findings for moderators, such as stage of investment (Elango, Fried, Hisrich, & Polonchek, 1995; Hall & Hofer, 1993), firm sizes (Mishra & O'Brien, 2005), similarity bias (Franke et al., 2006), and overconfidence bias (Zacharakis & Shepherd, 2001). Additionally, the experience of the VC might play an important role (Hopp & Lukas, 2012; Shepherd et al., 2003).

When comparing the importance of investment criteria among different regions, studies on decision making with respect to risk perception (Goszczyńska, Tyszka, & Slovic, 1991; Teigen, Brun, & Slovic, 1988) and overconfidence and probabilistic thinking (McGill, 1995; Yates, Lee, & Bush, 1997; Yates & Whei, 1996) in a cultural context should be taken into consideration.

There is still space for additional theory development in an institutional context explaining the differences disclosed. Perception of risk is a relevant factor in this context. The assessment of losses and gains are differentially influenced by the cultural norms of uncertainty avoidance (Bontempo, Bottom, & Weber, 1997). People choose a riskier alternative either because of a

positive risk attitude or because of a lower perception of risk (Weber & Milliman, 1997). Low uncertainty avoidance cultures accept risk and ambiguity more easily. Hence, it is necessary to analyze the characteristics of institutional influences in detail.

The meta-analysis showed that further regional research must be undertaken in Africa and the Middle East. Little academic attention has been paid to these regions, although there are emerging activities with regard to the entrepreneurial finance environment (Frese et al., 2007). The gained findings could reveal further institutional differences and insights. Furthermore, institutions quickly change due to emerging industries or diverse political circumstances. There is a need to keep track of these changes and how they influence new venture investment behavior (Bruton et al., 2005). Longitudinal studies could accomplish this challenge (Wright et al., 2004).

Appendix

1. Sample Risk Assessment Model Calculation⁴¹

In order to illustrate how the new venture risk model can be applied by academics and practitioners alike, this use case is elaborated. A VC wants to assess the relative riskiness of a new venture in comparison to 3 firms (company 1-3). Data about six risk factors, namely market, management experience, product and innovation, team match, business model, and timing, are available. The risk factors impact each other according to the following matrix:

Appendix Figure 1

Type of Risk Correlation Matrix	<i>Market</i>	<i>Mgmt. Exp.</i>	<i>Product/ Innov.</i>	<i>Team Match</i>	<i>Business Model</i>	<i>Timing</i>
<i>Market</i>	1	0,5	0,3	0,5	0,8	1
<i>Management Experience</i>	0,5	1	0,7	0,9	0,6	0,7
<i>Product/Innovation</i>	0,3	0,7	1	0,7	0,3	0,8
<i>Team Match</i>	0,5	0,9	0,7	1	0,6	0,7
<i>Business Model</i>	0,8	0,6	0,3	0,6	1	0,2
<i>Timing</i>	1	0,7	0,8	0,7	0,2	1

Empirical studies or expert opinions have revealed the subsequent global impact factors:

Appendix Figure 2

Type of risk i		<i>Relative Impact Factor Uncorr.</i>	<i>Relative Impact Factor Corr.</i>
<i>Risk Factor 1</i>	<i>Market</i>	18,2%	18,3%
<i>Risk Factor 2</i>	<i>Management Experience</i>	24,2%	22,8%
<i>Risk Factor 3</i>	<i>Product/Innovation</i>	12,1%	13,2%
<i>Risk Factor 4</i>	<i>Team Match</i>	21,2%	19,9%
<i>Risk Factor 5</i>	<i>Business Model</i>	12,1%	14,3%
<i>Risk Factor 6</i>	<i>Timing</i>	12,1%	11,4%

The relative impact considering correlation is calculated by $I_{corr i}$. According to the information gained, the VC assesses the risk of the new venture by comparing each company with regard to one risk factor. This case leads to six subjective reciprocal response matrixes.

⁴¹ This section is based on an unpublished working paper by: Buchberger, A., Grichnik, D., & Koropp, C. (2013): New Venture Risk Assessment for Venture Capitalists: An Analytic Hierarchy Process Model, Working Paper.

Appendix Figure 3

Market	Venture	Comp 1	Comp 2	Comp 3
<i>Venture</i>	1	3	7	8
<i>Company 1</i>	0,33	1	5	7
<i>Company 2</i>	0,14	0,2	1	3
<i>Company 3</i>	0,13	0,14	0,33	1
Management Experience	Venture	Comp 1	Comp 2	Comp 3
<i>Venture</i>	1	4	3	5
<i>Company 1</i>	0,25	1	2	1
<i>Company 2</i>	0,33	0,5	1	2
<i>Company 3</i>	0,20	1,00	0,50	1
Product/Innovation	Venture	Comp 1	Comp 2	Comp 3
<i>Venture</i>	1	5	7	8
<i>Company 1</i>	0,20	1	2	4
<i>Company 2</i>	0,14	0,5	1	3
<i>Company 3</i>	0,13	0,25	0,33	1
Team Match	Venture	Comp 1	Comp 2	Comp 3
<i>Venture</i>	1	4	5	5
<i>Company 1</i>	0,25	1	2	2
<i>Company 2</i>	0,20	0,5	1	2
<i>Company 3</i>	0,20	0,50	0,50	1
Business Model	Venture	Comp 1	Comp 2	Comp 3
<i>Venture</i>	1	6	6	6
<i>Company 1</i>	0,17	1	2	3
<i>Company 2</i>	0,17	0,5	1	3
<i>Company 3</i>	0,17	0,33	0,33	1
Timing	Venture	Comp 1	Comp 2	Comp 3
<i>Venture</i>	1	2	3	2
<i>Company 1</i>	0,50	1	2	2
<i>Company 2</i>	0,33	0,5	1	3
<i>Company 3</i>	0,50	0,50	0,33	1

The subjective weighting function including the developed alteration for the AHP scale, adjusts the response matrix according to c_{kl} . Alpha and beta factors are set at 0,8 and 1,1 respectively. These parameters must be adjusted according to VCs' characteristics gained through empirical research. This results in the adjusted response matrix and the adjusted normalized response matrix. Exemplary, the matrixes for the risk factor “market” are presented here in detail.

Appendix Figure 4

Adjusted Response Matrix				
Market	Venture	Comp 1	Comp 2	Comp 3
Venture	1,00	3,10	7,64	8,45
Company 1	0,32	1,00	5,56	7,64
Company 2	0,13	0,18	1,00	3,10
Company 3	0,12	0,13	0,32	1,00

Appendix Figure 5

Adjusted Normalized Response Matrix							
Market	Venture	Comp 1	Comp 2	Comp 3	Total	Priority vector	Consistency
						RL	Measure
Venture	0,64	0,70	0,53	0,42	2,28	0,57	4,43
Company 1	0,20	0,23	0,38	0,38	1,19	0,30	4,36
Company 2	0,08	0,04	0,07	0,15	0,35	0,09	4,06
Company 3	0,08	0,03	0,02	0,05	0,18	0,04	4,05
						CI	0,076
						RI	0,9
						CR	0,084

Based on the adjusted normalized response matrix of one risk factor, the relative risk level can be calculated with the priority vector according to $(C - n * U) * w = 0$. To control for consistency, the consistency measure is calculated by $Cw = \lambda_{max}w$. If the matrix is perfectly consistent, the consistency measure will equal n. Hence, the consistency index CI will be zero. If the consistency ratio CR is above 0,10, then the VC has to revise his or her decisions. In the case above, the VC was consistent. Following this process for all risk factors leads to the additive model of factor risks for all companies analyzed by $RT_{k\text{ uncorrelated}}(X_{ki})$:

Appendix Figure 6

Risk Factor	Venture		Company 1		Company 2		Company 3	
	RL	RF corr.	RL	RF corr.	RL	RF corr.	RL	RF corr.
Market	0,57	0,10 RF	0,30	0,05 RF	0,09	0,02 RF	0,04	0,01 RF
Management Experience	0,57	0,13 RF	0,17	0,04 RF	0,15	0,04 RF	0,11	0,02 RF
Product/Innovation	0,67	0,09 RF	0,17	0,02 RF	0,11	0,01 RF	0,05	0,01 RF
Team Match	0,62	0,12 RF	0,17	0,03 RF	0,12	0,02 RF	0,09	0,02 RF
Business Model	0,66	0,09 RF	0,16	0,02 RF	0,12	0,02 RF	0,06	0,01 RF
Timing	0,41	0,05 RF	0,25	0,03 RF	0,21	0,02 RF	0,13	0,02 RF
Total Risk		0,59 RF		0,20 RF		0,13 RF		0,08 RF

This case shows that the new venture investigated has a relative factor risk of 0.59 compared to 0,2, 0,13, and 0,08 of company 1 to 3.

2. Proof of Propositions⁴²

Side Condition Proof 1:

$$ck(t) = \int_{t_0}^{t_{exit}} (z * t) dt = \left[\frac{1}{2} * z * t^2 \right]_{t_0}^{t_{exit}} = \frac{1}{2} z t_{exit}^2 = K \rightarrow z = \frac{2 * K}{t_{exit}^2} \quad (110)$$

Proof of Proposition 2.1:

With

$$inRT(t) = \left(\sigma * \frac{1}{s(t)} - i * (1 - s(t)) * exRT(t) \right) \quad (111)$$

and a transformation of $s(t)$

$$s(t) = 1 - \frac{ck(t)}{K} * \rho = 1 - \frac{K * t^2 * \rho}{t_{exit}^2 * K} = 1 - \frac{t^2 * \rho}{t_{exit}^2} \quad (112)$$

the internal risk function can be expressed by:

$$\begin{aligned} inRT(t) &= \sigma * \left(1 - \frac{1}{t_{exit}^2} * t^2 * \rho \right)^{-1} - i * \left(\frac{1}{t_{exit}^2} * t^2 * \rho \right) * (-h * t + d) \\ &= \sigma * \left(1 - \frac{1}{t_{exit}^2} * t^2 * \rho \right)^{-1} \\ &\quad - \left(\frac{i * (-h)}{t_{exit}^2} * t^3 * \rho + \frac{i * t^2}{t_{exit}^2} * \rho * d \right) \\ &= \sigma * \left(1 - \frac{1}{t_{exit}^2} * t^2 * \rho \right)^{-1} + \frac{i * h}{t_{exit}^2} * t^3 * \rho - \frac{i * \rho * d}{t_{exit}^2} * t^2 \end{aligned} \quad (113)$$

The first derivate of internal risk shows the slope of the function.

⁴² This section contains elements of the unpublished working paper: Buchberger, A., & Grichnik, D. (2013): New Venture Risk Optimization: A Multi-Stage Approach for Venture Capital Firms, Unpublished Working Paper.

$$\begin{aligned}
inRT'(t) = & \sigma * \left(1 - \frac{1}{t_{exit}^2} * t^2 * \rho\right)^{-2} * \left(\frac{2}{t_{exit}^2} * t * \rho\right) + 3 * \frac{i * h}{t_{exit}^2} * t^2 * \rho \\
& - 2 * \frac{i * \rho * d * t}{t_{exit}^2}
\end{aligned} \tag{114}$$

As the first two terms are positive, an increase of the internal risk depends on the level of $exRT(t)$.

Proof of Proposition 2.2:

The proposition can be proven by the effective internal risk function.

$$\begin{aligned}
inRT_{eff}(t) &= inRT(t) * in\phi_1(t) * ((a + c) * in\phi_2(t) + b) \\
&= inRT(t) * \left(PFP * \gamma(t) * \frac{1}{CR}\right) \\
& * \left((a + c) \right. \\
& * \left(\frac{(-eff_{mon} * e_{mon}(t_{exit})) + (eff_{mon} * e_{mon}(t_0))}{t_{exit}} * t \right. \\
& \left. \left. + (1 - eff_{mon} * e_{mon}(t_0)) \right) + b \right)
\end{aligned} \tag{115}$$

With

$$e_{mon}(t) = -m_{max}p * t + q \tag{116}$$

and

$$p \leq m_{max} * \frac{1}{q * t_{exit}}; p \geq 0; 0 \leq q \leq 1 \tag{117}$$

The first derivative $in\phi_2$ can prove the proposition:

$$\text{in}\phi_2(t_{\text{exit}})' = \left(-\frac{(\text{eff}_{\text{mon}} * (m_{\text{max}}p))}{t_{\text{exit}}^2} * t \right) < 0 \quad (118)$$

An increase of t_{exit} leads to a decrease of $\text{in}RT_{\text{eff}}(t)$ resulting in a higher positive risk reduction.

Proof of Proposition 2.3:

In order to prove the propositions, the marginal impact monitoring as well as staging must be analyzed through the first derivative.

$$\gamma'(t) = 2 * \frac{\zeta * (m_{\text{max}} - 1)}{t_{\text{exit}}^2} * t \geq 0 \quad (119)$$

$$\text{in}\phi_2'(t) = \left(\frac{(-\text{eff}_{\text{mon}} * e_{\text{mon}}(t_{\text{exit}})) + (\text{eff}_{\text{mon}} * e_{\text{mon}}(t_0))}{t_{\text{exit}}} \right) \geq 0 \quad (120)$$

As $e_{\text{mon}}(t_{\text{exit}}) \leq e_{\text{mon}}(t_0)$, $\text{in}\phi_2(t)'$ increases, which reduces the influence on $\text{in}RT(t)$.

$$\begin{aligned} & 2 * \frac{\zeta * (m_{\text{max}} - 1)}{t_{\text{exit}}^2} * t \\ & \geq \left(\frac{(-\text{eff}_{\text{mon}} * e_{\text{mon}}(t_{\text{exit}})) + (\text{eff}_{\text{mon}} * e_{\text{mon}}(t_0))}{t_{\text{exit}}} \right) \rightarrow t \\ & \geq \frac{t_{\text{exit}} \left((-\text{eff}_{\text{mon}} * e_{\text{mon}}(t_{\text{exit}})) + (\text{eff}_{\text{mon}} * e_{\text{mon}}(t_0)) \right)}{2 * \zeta * (m_{\text{max}} - 1)} \end{aligned} \quad (121)$$

Proof of Proposition 2.4:

The negative impact of monitoring costs on capital risk in comparison to the positive impact on internal risk can be calculated by analyzing the influence of the monitoring function on both equations:

$$\begin{aligned}
 capRT(t) &= \theta * \frac{(ck(t) + \tau(t))}{K} \\
 &= \theta * \frac{ck(t)}{K} + \theta * \frac{c(e_{mon}(t))}{K} + \theta * \frac{c(e_{ne}(t))}{K} \\
 &= \theta * \frac{ck(t)}{K} + \theta * \frac{-\frac{1}{2}m_{max}\kappa p * t^2 + \kappa q * t}{K} + \theta * \frac{c(e_{ne}(t))}{K}
 \end{aligned} \tag{122}$$

The derivative of p is accordingly:

$$capRT'(p) = \theta * \frac{-\frac{1}{2}m_{max}\kappa * t^2}{K} \tag{123}$$

And the effective internal risk function:

$$\begin{aligned}
 inRT_{eff}(t) &= inRT(t) * in\phi_1 * ((a + c) * in\phi_2 + b) = inRT(t) * (PFP * \gamma(t) * \\
 &\frac{1}{CR}) * \left((a + c) * \left(\frac{(-eff_{mon} * (-m_{max}p * t_{exit} + q)) + (eff_{mon} * (-m_{max}p * t_0 + q))}{t_{exit}} * t + \right. \right. \\
 &\left. \left. (1 - eff_{mon} * (-m_{max}p * t_0 + q)) \right) + b \right)
 \end{aligned} \tag{124}$$

The derivative of p is accordingly:

$$inRT_{eff}'(p) = inRT(t) * in\phi_1 * (a + c) * (eff_{mon} * t * m_{max}) \tag{125}$$

The marginal increase can be determined by the modulus of both derivatives , following:

$$\left| \theta * \frac{-\frac{1}{2}m_{max}\kappa * t^2}{K} \right| < |inRT(t) * in\phi_1 * (a + c) * (eff_{mon} * t * m_{max})| \tag{126}$$

Proof of Proposition 2.5:

With the effective capital risk function:

$$\begin{aligned}
 capRT_{eff}(t) &= \theta * \frac{(ck(t) + \tau(t))}{K} \\
 &= \theta * \frac{ck(t)}{K} + \theta * \frac{c(e_{mon}(t))}{K} + \theta * \frac{c(e_{ne}(t))}{K} \\
 &= \theta \\
 & * \frac{\frac{K}{t_{exit}^2} * t^2 + \left(-\frac{1}{2} m_{max} \kappa p * t^2 + \kappa q * t\right) + \left(-\frac{1}{2 * m_{max}} \kappa y * t^2 + \kappa w * t\right)}{K}
 \end{aligned} \tag{127}$$

The effective internal risk function:

$$\begin{aligned}
 inRT_{eff}(t) &= inRT(t) * in\phi_1 * ((a + c) * in\phi_2 + b) \\
 &= inRT(t) \\
 & * \left(PFP * \left(\frac{\zeta * (m_{max} - 1)}{t_{exit}^2} * t^2 + ((-\zeta * (m_{max} - 1)) + 1) \right) * \frac{1}{CR} \right) \\
 & * \left((a + c) \right. \\
 & * \left(\frac{(-eff_{mon} * (-m_{max} p * t_{exit} + q)) + (eff_{mon} * (-m_{max} p * t_0 + q))}{t_{exit}} * t \right. \\
 & \left. \left. + (1 - eff_{mon} * (-m_{max} p * t_0 + q)) \right) + b \right)
 \end{aligned} \tag{128}$$

And the effective external risk function:

$$\begin{aligned}
exRT_{eff}(t) &= exRT(t) * ex\phi(t) = exRT(t) * \gamma(t) * PFP * CR \\
&= exRT(t) \\
&* \left(\frac{\zeta * (m_{max} - 1)}{t_{exit}^2} * t^2 + ((-\zeta * (m_{max} - 1)) + 1) \right) * PFP \\
&* CR
\end{aligned} \tag{129}$$

The first derivatives of the function with regard to m_{max} , which represents the staging of the VC can be used to get a solution for the proposition.

With:

$$\begin{aligned}
capRT'_{eff}(m_{max}) &= \theta * \frac{(ck(t) + \tau'(m_{max}))}{K} \\
&= \theta * \frac{\left(-\frac{1}{2}kp * t^2 \right) + \left(\frac{1}{2 * m_{max}^2}ky * t^2 \right)}{K}
\end{aligned} \tag{130}$$

$$\begin{aligned}
inRT'_{eff}(m_{max}) &= inRT(t) * in\phi_1 * ((a + c) * in\phi_2 + b) \\
&= inRT(t) * PFP * \frac{1}{CR} \\
&* \left(\left(\frac{\zeta}{t_{exit}^2} * t^2 - \zeta \right) * ((a + c) * in\phi_2 + b) + \gamma(t) \right. \\
&* \left(\frac{(eff_{mon} * p * t_{exit}) - (eff_{mon} * p * t_0)}{t_{exit}} * t + eff_{mon} * p \right. \\
&* \left. \left. * t_0 \right) \right)
\end{aligned} \tag{131}$$

$$\begin{aligned}
exRT'_{eff}(m_{max}) &= exRT(t) * ex\phi'(m_{max}) \\
&= exRT(t) * \gamma'(m_{max}) * PFP * CR \\
&= exRT(t) * \left(\frac{\varsigma}{t_{exit}^2} * t^2 - \varsigma \right) * PFP * CR
\end{aligned} \tag{132}$$

Therefore:

$$\begin{aligned}
&\left| \theta * \frac{\left(-\frac{1}{2} kp * t^2 \right) + \left(\frac{1}{2 * m_{max}^2} \kappa y * t^2 \right)}{K} \right| \\
&\leq \left| inRT(t) * PFP * \frac{1}{CR} \right. \\
&\quad * \left(\left(\frac{\varsigma}{t_{exit}^2} * t^2 - \varsigma \right) * ((a + c) * in\phi_2 + b) + \gamma(t) \right. \\
&\quad * \left(\frac{(eff_{mon} * p * t_{exit}) - (eff_{mon} * p * t_0)}{t_{exit}} * t + eff_{mon} * p \right. \\
&\quad \left. \left. * t_0 \right) \right) + exRT(t) * \left(\frac{\varsigma}{t_{exit}^2} * t^2 - \varsigma \right) * PFP * CR \left| \right.
\end{aligned} \tag{133}$$

3. Detailed Results of the Venture Capital Risk Criteria Analysis

EP Ability to Evaluate and React to Risk/Courage

I. Descriptive and t-statistics									
	Sample Size	Mean ES		Std. Dev.		t-value			
		SZ	IV	SZ	IV	SZ	Sig.	IV	Sig.
Total	1027	4,29	4,32	0,25	0,25				
Anglo	439	4,19	4,23	0,23	0,25				
Asia	248	4,16	4,17	0,19	0,13				
Europe	340	4,52	4,55	0,15	0,16				
T-test: Anglo - Asia						0,27		0,52	
T-test: Europe - Asia						3,61	*	4,71	*
T-test: Anglo - Europe						2,80	*	2,53	*
* significant difference at 97,5%									

EP Appropriate Personality for Business

I. Descriptive and t-statistics									
	Sample Size	Mean ES		Std. Dev.		t-value			
		SZ	IV	SZ	IV	SZ	Sig.	IV	Sig.
Total	1191	3,09	4,88	0,91	0,54				
Anglo	549	2,97	3,29	0,98	1,33				
Asia	166	3,94	4,99	1,02	0,10				
Europe	476	2,93	3,10	0,55	0,56				
T-test: Anglo - Asia						1,87		3,64	*
T-test: Europe - Asia						1,60		10,05	*
T-test: Anglo - Europe						0,07		0,23	
* significant difference at 97,5%									

EP Articulation Capability/Motivation

I. Descriptive and t-statistics									
	Sample Size	Mean ES		Std. Dev.		t-value			
		SZ	IV	SZ	IV	SZ	Sig.	IV	Sig.
Total	1320	3,81	4,01	0,76	0,86				
Anglo	653	3,81	3,97	0,94	1,06				
Asia	248	4,02	4,30	0,69	0,66				
Europe	419	3,69	3,73	0,37	0,39				
T-test: Anglo - Asia						0,54		0,77	
T-test: Europe - Asia						1,18		2,09	
T-test: Anglo - Europe						0,35		0,60	
* significant difference at 97,5%									

EP Attention to Detail

I. Descriptive and t-statistics									
	Sample Size	Mean ES		Std. Dev.		t-value			
		SZ	IV	SZ	IV	SZ	Sig.	IV	Sig.
Total	736	3,49	3,70	0,41	0,55				
Anglo	268	3,45	3,75	0,36	0,61				
Asia	128	3,87	4,04	0,52	0,50				
Europe	340	3,37	3,41	0,31	0,31				
T-test: Anglo - Asia						1,30		0,74	
T-test: Europe - Asia						1,80		2,35	
T-test: Anglo - Europe						0,38		1,10	
* significant difference at 97,5%									

EP Capability of intense Effort

I. Descriptive and t-statistics									
	Sample Size	Mean ES		Std. Dev.		t-value			
		SZ	IV	SZ	IV	SZ	Sig.	IV	Sig.
Total	908	4,43	4,47	0,18	0,19				
Anglo	409	4,40	4,44	0,19	0,18				
Asia	159	4,48	4,47	0,19	0,18				
Europe	340	4,44	4,53	0,15	0,21				
T-test: Anglo - Asia						0,72		0,26	
T-test: Europe - Asia						0,38		0,49	
T-test: Anglo - Europe						0,40		0,77	
* significant difference at 97,5%									

EP Educational Level

I. Descriptive and t-statistics									
	Sample Size	Mean ES		Std. Dev.		t-value			
		SZ	IV	SZ	IV	SZ	Sig.	IV	Sig.
Total	543	3,79	3,95	0,75	0,67				
Anglo	249	4,22	4,22	0,31	0,31				
Asia	149	4,10	4,12	0,24	0,26				
Europe	145	2,74	2,61	0,58	0,60				
T-test: Anglo - Asia						0,64		0,55	
T-test: Europe - Asia						4,31	*	4,64	*
T-test: Anglo - Europe						5,59	*	5,99	*
* significant difference at 97,5%									

EP Financial/Analytical Skills

I. Descriptive and t-statistics									
	Sample Size	Mean ES		Std. Dev.		t-value			
		SZ	IV	SZ	IV	SZ	Sig.	IV	Sig.
Total	446	3,66	3,70	0,93	1,04				
Anglo	192	3,01	2,76	1,03	1,10				
Asia	164	4,30	4,36	0,33	0,28				
Europe	90	3,87	3,96	0,43	0,39				
T-test: Anglo - Asia						2,93	*	3,47	*
T-test: Europe - Asia						1,70		1,80	
T-test: Anglo - Europe						1,34		1,77	
* significant difference at 97,5%									

EP Managerial Skills

I. Descriptive and t-statistics									
	Sample Size	Mean ES		Std. Dev.		t-value			
		SZ	IV	SZ	IV	SZ	Sig.	IV	Sig.
Total	945	4,33	4,32	0,44	0,40				
Anglo	537	4,46	4,49	0,32	0,32				
Asia	184	4,32	4,33	0,23	0,22				
Europe	224	4,02	4,03	0,61	0,44				
T-test: Anglo - Asia						0,93		1,12	
T-test: Europe - Asia						1,24		1,65	
T-test: Anglo - Europe						1,88		2,45	*
* significant difference at 97,5%									

EP Marketing Skills

I. Descriptive and t-statistics									
	Sample Size	Mean ES		Std. Dev.		t-value			
		SZ	IV	SZ	IV	SZ	Sig.	IV	Sig.
Total	308	4,06	4,20	0,37	0,38				
Anglo	108	4,41	4,43	0,30	0,30				
Asia	110	3,88	3,88	0,12	0,12				
Europe	90	3,86	3,89	0,35	0,34				
T-test: Anglo - Asia						4,03	*	4,20	*
T-test: Europe - Asia						0,12		0,03	
T-test: Anglo - Europe						2,39		2,41	
* significant difference at 97,5%									

EP Technical Skills

I. Descriptive and t-statistics									
	Sample Size	Mean ES		Std. Dev.		t-value			
		SZ	IV	SZ	IV	SZ	Sig.	IV	Sig.
Total	340	4,08	4,18	0,34	0,36				
Anglo	66	4,33	4,37	0,21	0,21				
Asia	184	4,11	4,15	0,34	0,37				
Europe	90	3,84	3,85	0,25	0,25				
T-test: Anglo - Asia						1,00		0,95	
T-test: Europe - Asia						1,26		1,29	
T-test: Anglo - Europe						2,57		2,76	
* significant difference at 97,5%									

EP Social Skills/Trustworthiness

I. Descriptive and t-statistics									
	Sample Size	Mean ES		Std. Dev.		t-value			
		SZ	IV	SZ	IV	SZ	Sig.	IV	Sig.
Total	249	4,47	4,66	0,49	0,37				
Anglo	150	4,60	4,71	0,35	0,25				
Asia	48	3,69	3,70	0,27	0,27				
Europe	51	4,84	4,84	0,37	0,37				
T-test: Anglo - Asia						3,16	*	4,53	*
T-test: Europe - Asia						3,43		3,49	
T-test: Anglo - Europe						0,62		0,46	
* significant difference at 97,5%									

EE Demonstrated Leadership

I. Descriptive and t-statistics									
	Sample Size	Mean ES		Std. Dev.		t-value			
		SZ	IV	SZ	IV	SZ	Sig.	IV	Sig.
Total	885	4,11	4,20	0,32	0,31				
Anglo	355	4,09	4,18	0,29	0,28				
Asia	194	4,03	4,11	0,34	0,31				
Europe	336	4,18	4,29	0,33	0,33				
T-test: Anglo - Asia						0,31		0,40	
T-test: Europe - Asia						0,76		1,00	
T-test: Anglo - Europe						0,45		0,57	
* significant difference at 97,5%									

EE Industry/Market Experience

I. Descriptive and t-statistics									
	Sample Size	Mean ES		Std. Dev.		t-value			
		SZ	IV	SZ	IV	SZ	Sig.	IV	Sig.
Total	1214	4,33	4,37	0,67	0,69				
Anglo	543	4,20	4,21	0,91	0,92				
Asia	271	4,30	4,29	0,44	0,44				
Europe	400	4,52	4,63	0,17	0,20				
T-test: Anglo - Asia						0,33		0,25	
T-test: Europe - Asia						1,25		1,86	
T-test: Anglo - Europe						0,92		1,16	
* significant difference at 97,5%									

EE Investors Familiarity with Entrepreneur/Team/Business

I. Descriptive and t-statistics									
	Sample Size	Mean ES		Std. Dev.		t-value			
		SZ	IV	SZ	IV	SZ	Sig.	IV	Sig.
Total	811	2,63	3,19	1,19	1,46				
Anglo	320	2,26	1,97	0,92	0,84				
Asia	190	3,60	4,26	1,20	0,97				
Europe	301	2,41	3,30	1,11	1,45				
T-test: Anglo - Asia						1,88		3,83	*
T-test: Europe - Asia						1,44		1,21	
T-test: Anglo - Europe						0,20		1,54	
* significant difference at 97,5%									

EE References of Entrepreneur/Team

I. Descriptive and t-statistics									
	Sample Size	Mean ES		Std. Dev.		t-value			
		SZ	IV	SZ	IV	SZ	Sig.	IV	Sig.
Total	833	2,81	2,85	0,71	0,80				
Anglo	358	2,52	2,46	0,59	0,68				
Asia	190	3,32	3,46	0,60	0,57				
Europe	285	2,82	2,97	0,70	0,75				
T-test: Anglo - Asia						2,30	*	2,76	*
T-test: Europe - Asia						1,19		1,18	
T-test: Anglo - Europe						0,73		1,11	
* significant difference at 97,5%									

EE Success Track Record

I. Descriptive and t-statistics									
	Sample Size	Mean ES		Std. Dev.		t-value			
		SZ	IV	SZ	IV	SZ	Sig.	IV	Sig.
Total	1276	3,58	3,56	0,65	0,75				
Anglo	528	3,23	2,99	0,80	0,86				
Asia	268	3,69	3,74	0,29	0,27				
Europe	480	3,92	4,05	0,33	0,29				
T-test: Anglo - Asia						1,61		2,49	*
T-test: Europe - Asia						1,15		1,69	
T-test: Anglo - Europe						1,41		2,04	
* significant difference at 97,5%									

F Easy Liquidation possible

I. Descriptive and t-statistics									
	Sample Size	Mean ES		Std. Dev.		t-value			
		SZ	IV	SZ	IV	SZ	Sig.	IV	Sig.
Total	1674	3,29	3,06	0,78	1,00				
Anglo	831	3,40	3,11	0,77	1,10				
Asia	194	3,65	3,75	0,65	0,69				
Europe	649	3,05	2,75	0,76	0,82				
T-test: Anglo - Asia						0,75		1,45	
T-test: Europe - Asia						1,76		2,71	*
T-test: Anglo - Europe						1,02		0,82	
* significant difference at 97,5%									

F High expected return (within 5 years)

I. Descriptive and t-statistics									
	Sample Size	Mean ES		Std. Dev.		t-value			
		SZ	IV	SZ	IV	SZ	Sig.	IV	Sig.
Total	1560	3,40	3,54	0,80	1,16				
Anglo	694	3,53	3,09	0,80	1,11				
Asia	217	3,64	3,84	0,57	0,75				
Europe	649	3,18	3,82	0,81	1,18				
T-test: Anglo - Asia						0,37		1,79	
T-test: Europe - Asia						1,44		0,04	
T-test: Anglo - Europe						0,96		1,42	
* significant difference at 97,5%									

F Investment as first round Investment**

I. Descriptive and t-statistics									
	Sample Size	Mean ES		Std. Dev.		t-value			
		SZ	IV	SZ	IV	SZ	Sig.	IV	Sig.
Total	149	1,77	1,83	0,53	0,59				
Anglo	67	1,70	1,70	0,84	0,84				
Asia	27	2,85	2,85	0,66	0,64				
Europe	55	1,33	1,33	0,19	0,19				
T-test: Anglo - Asia									
T-test: Europe - Asia									
T-test: Anglo - Europe									
* significant difference at 97,5%, ** no t-values as only one study per region									

F No follow-on investments expected

I. Descriptive and t-statistics									
	Sample Size	Mean ES		Std. Dev.		t-value			
		SZ	IV	SZ	IV	SZ	Sig.	IV	Sig.
Total	1151	2,40	2,60	0,84	0,77				
Anglo	694	2,60	2,71	0,88	0,74				
Asia	128	2,06	2,09	0,32	0,35				
Europe	329	2,13	2,04	0,78	0,77				
T-test: Anglo - Asia						1,17		1,54	
T-test: Europe - Asia						0,17		0,12	
T-test: Anglo - Europe						0,98		1,54	
* significant difference at 97,5%									

F Size of Investment

I. Descriptive and t-statistics									
	Sample Size	Mean ES		Std. Dev.		t-value			
		SZ	IV	SZ	IV	SZ	Sig.	IV	Sig.
Total	615	3,04	2,96	0,60	0,76				
Anglo	545	3,05	2,96	0,63	0,79				
Asia	70	2,95	2,93	0,05	0,05				
Europe	0								
T-test: Anglo - Asia						0,22		0,04	
T-test: Europe - Asia									
T-test: Anglo - Europe									
* significant difference at 97,5%									

M Existing distribution channel

I. Descriptive and t-statistics									
	Sample Size	Mean ES		Std. Dev.		t-value			
		SZ	IV	SZ	IV	SZ	Sig.	IV	Sig.
Total	587	2,80	2,71	0,96	0,97				
Anglo	67	1,44	1,44	0,64	0,64				
Asia	149	3,72	3,72	0,78	0,78				
Europe	371	2,67	2,55	0,72	0,68				
T-test: Anglo - Asia						2,62		2,62	
T-test: Europe - Asia						2,10		2,42	*
T-test: Anglo - Europe						1,56		1,49	
* significant difference at 97,5%									

M High market growth rate (expected)

I. Descriptive and t-statistics									
	Sample Size	Mean ES		Std. Dev.		t-value			
		SZ	IV	SZ	IV	SZ	Sig.	IV	Sig.
Total	1650	3,72	3,70	0,83	0,96				
Anglo	738	3,44	3,42	1,11	1,20				
Asia	291	4,24	4,31	0,45	0,44				
Europe	621	3,80	3,83	0,25	0,30				
T-test: Anglo - Asia						2,25	*	2,35	*
T-test: Europe - Asia						2,37	*	2,52	*
T-test: Anglo - Europe						0,83		0,89	
* significant difference at 97,5%									

M Investors Familiarity with Market

I. Descriptive and t-statistics									
	Sample Size	Mean ES		Std. Dev.		t-value			
		SZ	IV	SZ	IV	SZ	Sig.	IV	Sig.
Total	1099	2,59	2,31	0,69	0,81				
Anglo	712	2,54	2,08	0,81	0,83				
Asia	128	2,89	3,05	0,52	0,53				
Europe	259	2,58	2,60	0,11	0,13				
T-test: Anglo - Asia						0,76		2,09	
T-test: Europe - Asia						0,97		1,42	
T-test: Anglo - Europe						0,09		1,05	
* significant difference at 97,5%									

MLittle Competition

I. Descriptive and t-statistics									
	Sample Size	Mean ES		Std. Dev.		t-value			
		SZ	IV	SZ	IV	SZ	Sig.	IV	Sig.
Total	1090	2,83	2,53	0,86	0,92				
Anglo	587	2,74	2,34	1,08	0,97				
Asia	163	3,32	3,40	0,58	0,64				
Europe	340	2,76	2,73	0,18	0,16				
T-test: Anglo - Asia						1,28		2,50	*
T-test: Europe - Asia						2,05		2,28	*
T-test: Anglo - Europe						0,05		0,88	
* significant difference at 97,5%									

MMarket stimulated by the Product/Service

I. Descriptive and t-statistics									
	Sample Size	Mean ES		Std. Dev.		t-value			
		SZ	IV	SZ	IV	SZ	Sig.	IV	Sig.
Total	930	3,01	2,97	0,55	0,74				
Anglo	517	2,97	2,83	0,60	0,78				
Asia	163	3,43	3,55	0,63	0,63				
Europe	250	2,84	2,83	0,05	0,05				
T-test: Anglo - Asia						1,40		1,91	
T-test: Europe - Asia						1,25		1,53	
T-test: Anglo - Europe						0,29		0,01	
* significant difference at 97,5%									

MMarket Size

I. Descriptive and t-statistics									
	Sample Size	Mean ES		Std. Dev.		t-value			
		SZ	IV	SZ	IV	SZ	Sig.	IV	Sig.
Total	242	4,21	4,23	0,20	0,16				
Anglo	124	4,20	4,16	0,12	0,12				
Asia	109	4,23	4,28	0,26	0,17				
Europe	9	4,33	4,33	0,16	0,16				
T-test: Anglo - Asia						0,15		0,87	
T-test: Europe - Asia						0,35		0,27	
T-test: Anglo - Europe						0,94		1,24	
* significant difference at 97,5%									

M Creation of a new market by Product/Service

I. Descriptive and t-statistics									
	Sample Size	Mean ES		Std. Dev.		t-value			
		SZ	IV	SZ	IV	SZ	Sig.	IV	Sig.
Total	1147	2,78	2,78	1,08	1,21				
Anglo	523	2,80	2,56	1,24	1,31				
Asia	163	3,00	3,10	0,57	0,63				
Europe	461	2,68	2,98	1,02	1,17				
T-test: Anglo - Asia						0,39		1,00	
T-test: Europe - Asia						0,72		0,24	
T-test: Anglo - Europe						0,21		0,69	
* significant difference at 97,5%									

PS Existing Market (Acceptance) for Product

I. Descriptive and t-statistics									
	Sample Size	Mean ES		Std. Dev.		t-value			
		SZ	IV	SZ	IV	SZ	Sig.	IV	Sig.
Total	1061	3,54	3,58	0,65	0,77				
Anglo	402	3,26	3,22	0,77	0,95				
Asia	268	3,84	3,89	0,51	0,50				
Europe	391	3,63	3,71	0,47	0,51				
T-test: Anglo - Asia						1,82		1,82	
T-test: Europe - Asia						0,80		0,67	
T-test: Anglo - Europe						1,03		1,12	
* significant difference at 97,5%									

PS Existing Prototype

I. Descriptive and t-statistics									
	Sample Size	Mean ES		Std. Dev.		t-value			
		SZ	IV	SZ	IV	SZ	Sig.	IV	Sig.
Total	828	3,63	3,80	0,50	0,63				
Anglo	303	3,65	4,06	0,74	0,89				
Asia	194	3,54	3,57	0,33	0,37				
Europe	331	3,65	3,77	0,23	0,30				
T-test: Anglo - Asia						0,38		1,39	
T-test: Europe - Asia						0,61		0,92	
T-test: Anglo - Europe						0,00		0,63	
* significant difference at 97,5%									

PS High degree of Innovation

I. Descriptive and t-statistics									
	Sample Size	Mean ES		Std. Dev.		t-value			
		SZ	IV	SZ	IV	SZ	Sig.	IV	Sig.
Total	1478	3,20	3,50	1,01	0,87				
Anglo	437	3,20	3,51	1,07	0,97				
Asia	350	3,62	3,88	0,97	0,72				
Europe	691	2,99	3,26	0,93	0,81				
T-test: Anglo - Asia						0,98		1,08	
T-test: Europe - Asia						1,56		1,94	
T-test: Anglo - Europe						0,44		0,59	
* significant difference at 97,5%									

PS Protected Product

I. Descriptive and t-statistics									
	Sample Size	Mean ES		Std. Dev.		t-value			
		SZ	IV	SZ	IV	SZ	Sig.	IV	Sig.
Total	1443	3,26	3,32	0,77	0,95				
Anglo	605	3,06	3,23	1,10	1,32				
Asia	268	3,51	3,62	0,36	0,37				
Europe	570	3,35	3,31	0,22	0,16				
T-test: Anglo - Asia						1,17		0,84	
T-test: Europe - Asia						0,99		1,93	
T-test: Anglo - Europe						0,62		0,14	
* significant difference at 97,5%									

T Perfect Team Match

I. Descriptive and t-statistics									
	Sample Size	Mean ES		Std. Dev.		t-value			
		SZ	IV	SZ	IV	SZ	Sig.	IV	Sig.
Total	349	4,17	4,21	0,27	0,27				
Anglo	140	3,98	3,98	0,11	0,11				
Asia	68	4,35	4,40	0,32	0,28				
Europe	141	4,28	4,36	0,25	0,21				
T-test: Anglo - Asia						1,83		2,43	
T-test: Europe - Asia						0,34		0,20	
T-test: Anglo - Europe						1,91		2,86	*
* significant difference at 97,5%									

Subject Index

A		D	
Actuarial models	119	Deductive cost of equity models	19
Adopted CAPM	28	Definition of behavioral finance	32
Affect	33	Definition of entrepreneur.....	16
Agency risk	52	Definition of factor models	23
Aggregation of risk	103	Definition of venture	16
Analytic hierarchy process.....	123	Descriptive decision models	113
Arbitrage pricing theory	24, 25	Descriptive statistics	85
B		Disjunctive model	120
Beliefs	32	Downside CAPM	150
Benchmark risk	156	Downside risk measure	31
Biases	114	Downside risk of ventures.....	101
Bootstrap models	119	E	
Business risk	53	Efficient market hypothesis	32
C		Entrepreneur as investment decision criterion	56
Capital allocation line	22	Entrepreneurial Experience.....	57
Capital asset pricing model	21	Equal weighting models.....	120
CAPM	<i>See</i> Capital asset pricing model	Erb-Harvey-Viskanta model	31
Computational decision methods	113	Explanatory cost of equity models.....	19
Conjunctive model	120, 121	F	
Consistency index	126	Fama-French 3 Factor Model.....	26
Consumption-based CAPM	34	Formal institutions	65
Copula function.....	146	G	
Cost of capital	13	Global CAPM	28
Cost of debt.....	15	Godfrey-Espinosa approach.....	30
Cost of equity	15	Group decision making	128, 150
Cost of equity models	19	H	
Cost of equity models in emerging market	48	Hadamard product.....	200
Cost of equity rates used by investors and entrepreneurs	43		

Harvey's Proposal.....	30	Preferences.....	32
Heuristics.....	114	Prescriptive decision models.....	114
I			
Idiosyncratic risk.....	40	Product as investment decision criterion.....	60
Informal institutions.....	65	Psychophysical function.....	140
Institutionalization of venture capital.....	66	R	
Institution-based theory.....	63	Rank preservation.....	126
International CAPM.....	29	Returns of ventures.....	53
Investment decision criteria.....	55	Risk benchmark.....	155
K			
Kurtosis.....	14	Risk modeling.....	98
L			
Local CAPM.....	29	Risk preference.....	95
Lower partial moment.....	102	Risk Preference.....	95
M			
Market as investment decision criterion.....	59	Risk theory.....	95
Mathematical models.....	117	Risk-value models.....	97
Maximum eigenvalue.....	125	S	
Meta-analysis.....	80	Security market line.....	22
Modigliani and Miller.....	14	Separable representation.....	127
N			
Noise vector.....	156	Single Factor Model.....	23
Normative decision models.....	113	Skewness.....	14
O			
Objective risk measure.....	96	Square root formula.....	105
Operational risk.....	53	T	
P			
Perceived Risk.....	95	Total risk.....	152, 158
Portfolio theory.....	101	T-test.....	85
R			
S			
T			
U			
V			
V			
Venture differences.....	16	Utility function.....	155
Venture downside risk.....	101	V	
Venture financing.....	17	Venture differences.....	16
Venture risk.....	52	Venture downside risk.....	101
Venture risk profile.....	35	Venture financing.....	17
		Venture risk.....	52
		Venture risk profile.....	35

Affirmation – Statutory Declaration

Last Name: Buchberger

First Name: Alexander

Affirmation – Statutory Declaration

According to § 10 No. 7 of the Doctoral Studies' Guide Lines

(As Amended on the 5th March 2008)

I hereby declare, that the

Dissertation

submitted to the Wissenschaftliche Hochschule für Unternehmensführung (WHU) Otto-Beisheim-Hochschule was produced independently and without the aid of sources other than those which have been indicated. All ideas and thoughts coming both directly and indirectly from outside sources have been noted as such.

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The following persons helped me gratuitous / non-gratuitous in the indicated way in selecting and evaluating the used materials:

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Further persons have not been involved in the preparation of the presented dissertation as regards contents or in substance. In particular, I have not drawn on the non-gratuitous help of placement or advisory services (doctoral counsels / PhD advisors or other persons). Nobody has received direct or indirect monetary benefits for services that are in connection with the contents of the presented dissertation.

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