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THE APPLICATION OF THE RISK-FREE RATE OF RETURN IN ESTONIA: A SURVEY OF FINANCIAL INDUSTRY PRACTICES

Bachelor's Thesis

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I have written this bachelor's thesis independently. Any ideas or data taken from other authors or other sources have been fully referenced.

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Introduction

"He who is not courageous enough to take risks will accomplish nothing in life"
– Muhammad Ali

In July of 2009, the bank of Sweden lowered its overnight deposit rates to -0.25%—effectively charging the retail banks of the country to pay the central bank to look after their money (Sveriges Riksbank, 2009). Foreshadowing what was to come. In 2021, some $14.8T worth of bonds, 21.6% of debt issued by governments and companies in the world, was trading with negative yields (Financial Times, 2021). As the primary proxy for risk-free rate of return used in academia and practice, sub-zero long-term yields have had resonating repercussions for the concept of risk-free rate of return and its usage in practical contexts.

The risk-free rate of return is a fundamental piece in the valuation equation—a key component in calculating the cost of capital (CAPM), and thus the discount rate for valuing a company's cash flows (Koller et al, 2019). In addition, the risk-free rate of return is an imperative input to the cost of capital model because it doesn't only determine the y-intercept, but also influences the slope of the capital asset pricing model (CAPM). Practitioners are facing confusion and unprecedented dilemmas in the calculation of discount rates, which have been pushing valuations towards infinity (Bianco, 2019). In the context of valuations, the risk-free rate of return is a factor often overlooked—scantly researched— yet of high importance. The importance of the risk-free rate in practice, and its lack of attention in academia makes it a pressing research need. Previous studies on analyst practices in Estonia have been done under different circumstances (i.e. positive long term sovereign bond yields), such as Ahlberg (2015), or have focused on quantifying analysts' numerical view on the risk-free rate of return and equity premia in Estonia such as Fernandez's yearly surveys (2017; 2018; 2019; 2020; 2021)—and have followed a strongly quantitative and structured research design. This study aims to answer the "why?"—as well as the "what?".

The purpose of this thesis is to enhance the understanding of analyst practices of deriving the risk-free rate of return under current macroeconomic circumstances, and to compare and contrast against previous empirical research in Estonia. In order to achieve the research aim of this thesis, an explanatory sequential mixed-methodology research design has been employed. This has taken the form of a quantitative survey, and in-depth qualitative semi-structured interviews. This survey has been disseminated among professionals, and academics in Estonia, and interviews have been conducted with select sample members. The

expected research outcome of this thesis will be to fill the research gap found encompassing the practices of analysts and academics in Estonia in deriving the risk-free rate of return in practice.

Due to the scope of the bachelor's thesis, there exist limitations to the reach of this research. This thesis will solely focus on the derivation or calculation of the risk-free rate of return in practice through proxies and does not aim to research the use of risk-free rate in practice (*ex post*) or cover the wider study of equity premia and cost of equity calculations. This thesis will solely focus on the proxies used for the risk-free rate of return, data sources, organizational factors surrounding the derivation, the subsequent risk-free rate of return in quantitative terms, and any adjustments made therein.

The theoretical section of this paper will cover the building blocks of risk-free rate of return in chapter 1.1, the various proxies used to approximate risk-free rate of return in practice in chapter 1.2, and finally cover previous empirical research on the risk-free rate of return in Estonia in chapter 1.3. The theoretical section aims to fulfill research tasks a, b, and c.

The empirical section of this paper aims to fulfill research tasks d, and e. In Chapter 2.1. the author will describe in detail the data and methodology used. In chapter 2.2. the data will be analyzed, presenting the results of the research undertaken, this will include a summary of findings, comparison to previous studies, and generalizations to the population based upon the collected observations.

Research aim:

A. The aim of this thesis is to gain an understanding of what risk-free rate of return practitioners in the field of finance in Estonia are utilizing, why they are using it, how they have arrived at this rate, and to compare their practices against previous empirical research, and academic literature.

Research tasks:

A. To introduce and define the risk-free rate of return, and its usage in financial models and theory.
B. To describe and analyze the estimation of the risk-free rate of return through various common and uncommon proxies.
C. To bring out, compare, and contrast the results of previous empirical research on the risk-free rate of return in Estonia.

D. To design and conduct research on practitioners and academics to gain understanding as to how the risk-free rate of return is being derived in practice, quantify the risk-free rate of return used in Estonia.
E. To draw conclusions about practitioner estimation of the risk-free rate of return in Estonia, comparing and contrasting current practices with previous research, and to provide suggestions for further research.

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1. Theoretical Foundations of The Risk-Free Rate of Return in Finance

1.1. The Role of The Risk-Free Rate of Return in Finance

The risk-free rate of return has been extensively used throughout financial theory; it could even be considered a fundamental input that has widespread use in practical contexts. Sharpe (1964), and Lintner (1952) stood on the shoulders of Markowitz (1952) to develop the CAPM (*"Capital Asset Pricing Model"*) that utilized the risk-free rate of return, market beta, and the equity risk premium to calculate a cost of equity. Subsequently, in 1973, Black & Scholes developed an option pricing model that incorporated the risk-free interest rate to estimate the value of financial derivates. The risk-free rate of return is an essential input for calculating the discount rate (WACC) used to discount the expected free cash flows generated by a firm to estimate its value (Vernimmen, 2014). In summary, the risk-free rate of return has permeated modern financial theory, and thus is a critical input for practitioners in the financial sector.

In the study of corporate finance, practitioners and academics assume that there exists an investment which provides a guaranteed return to investors. As the returns from this investment are guaranteed and do not vary—the assumed volatility of this investment is equal to zero. In theory, the return from this risk-free asset will be positive due to the assumption that in the long run, investors are not interested in a certain negative return (Damodaran, 2010). Figure 1 illustrates the distribution of returns for a risk-free investment.

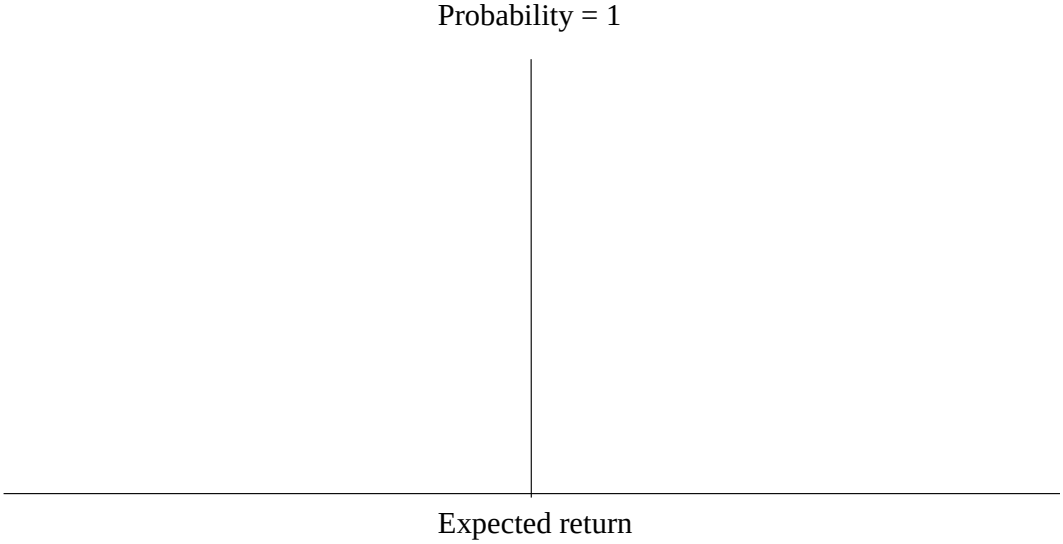

Fig 1. *Probability distribution for a risk-free investment*

Source: Compiled by the author from Damodaran (2020)

In order to better understand a risk-free asset, we must take a step back and understand what risk is. Naturally, investors acquire or obtain assets that have an expected

rate of return over some holding period of *t*. The actual returns made over the holding period can vary from the expected returns. Risk is the variance between expected and actual returns (Vernimmen, 2014). A hypothetical risk-free asset has no variance between expected and actual returns—therefore bringing the total risk of the asset to 0. (Damodaran, 2020)

In order for a risk-free asset to be considered risk-free, and be of use in practice, it must not include the following financial risks. Firstly, a risk-free asset does not have a risk of default. (Hull, 1993). Secondly, it does not have reinvestment risk—meaning that the duration of the asset is matched in practice (Damodaran, 2008). Thirdly, there is no prepayment risk. Prepayment risk is usually mitigated through fixed payment dates, or maturities (Damodaran, 2020).

Table 1.
Types of Risk

Type	Summary	Source
Default (or Credit) Risk	Default risk is the failure to meet financial obligations. This risk comes from the possibility that the counterparty may default.	Hull (2015) & Damodaran (2020)
Reinvestment Risk	The risk that cash flows coming for an investment cannot be invested at the same interest rate.	Damodaran (2020); Fabozzi & Ramsey (1997)
Prepayment Risk	Risk of the counterparty repaying their debt early—thereby decreasing holding period and rate of return.	Damodaran (2020)

Source: Compiled by the author on the basis of cited papers

The existence of a risk-free asset in reality is something of a debate itself. Some scholars, Damodaran (2010) for example, state that no real asset satisfies all the requirements of a risk-free asset—because it is not possible to eliminate all financial risk. Therefore, in practice, the risk-free rate of return can only be estimated or approximated. In addition, when we discuss the risk-free rate of return, we refer to a nominal risk-free rate of return which is equal to the real risk-free rate of return plus a premium for inflation (Damodaran, 2020). This means that the real risk-free rate of return is the nominal risk-free rate of return minus an inflation premium. Table 1 presents a summary of the aforementioned risks.

Due to the subjective element in estimating the risk-free rate of return questions have been raised as to the suitability of the commonly used government bonds as a proxy for the risk-free rate of return in the Euro-zone and in Estonia. This is due to the following issues:

"Risk-free" Euro denominated bonds have yielded negative real and nominal returns. CapitalIQ (2016) has found that the yields of many euro-zone sovereign bonds had negative yields in real terms. This is calculated by subtracting inflation expectations from nominal yields. This translates into loss of investor purchasing power. A phenomenon that contradicts time preference that actors prefer direct over delayed consumption (Frederick et al., 2002). Financial theory tells us that to delay consumption, investors need inflationary and real compensation. Fisher (1930) states that the aforementioned aspects compensate investors for the time-value of money (TVM), and the decrease in buying-power. A potential counterargument that explains continued investment into negative yielding bonds is that corporates do not have access to superior insured, and safe instruments.

As interest rates have reached sub-zero nominal and real levels, complications arise in the calculation of the present values of cash flow streams, —and they become increasingly sensitive to the discount rate (World Bank, 2015). This becomes a concern when valuing assets and liabilities. This issue is also exasperated in the negotiation of fair value in a legal context. It has been argued that prolonged periods of sub-zero interest rates can lead to strong ambiguities in valuations (World Bank, 2015).

A stark rise in sovereign default risk in the aftermath of the European debt crisis, and recent geopolitical developments. Though traditionally government default has been a virtually ignored risk, factors unique to the euro-zone bring default risk closer to mind. Euro-zone members issue sovereign bonds, but do not have control over the money supply—this power is in the hands of the European Central Bank (ECB, 2014). This could be interpreted as individual euro zone countries not being able to print their way out of default, due to the centralization of money supply at the ECB. In addition, after the 2008 crisis, credit risk of select European governments has increased substantially (ECB, 2014). Additional concerns could be raised about default risk due to the Russian invasion of Ukraine, and the default risks associated with security considerations of bond issuers. Bond yields in eastern Europe (Ukraine, Belarus, Romania, Hungary) had already seen sharp depression in yields, and showed some of the most negative real yields in Europe in the rising of tensions—and in the face of the most diverse and complex political and economic risks (Reuters, 2021).

In some countries, and currencies, an obstacle to determining the risk-free rate of return is that no bonds are issued in the local currency. For example, these states opt for loans from international financial institutions such as the IMF or World Bank—bypassing the financial markets. If the country does not issue bonds (or does not issue suitable bonds), there are two solutions: a) to use a discount rate assessed from a developed money market (Instead

of local currency) and then to turn the cash flows into the currency at which the discount rate was assessed. b) to assess the discount rate in the local currency—which still leaves the issue of approximating the risk-free rate of return. (Boskovska, 2013; Damodaran, 2020).

In the case of Estonia, it has issued debt but has been rated AA- outlook positive by S&P, which is 'investment grade' but still holds a certain level of risk premium due to its less than AAA rating—meaning that analyst direct usage of Estonian bonds as a risk-free rate of return proxy is likely not widespread (Damodaran, 2020; Rahandusministeerium 2021a). In addition, bonds have been issued three times since independence (Rahandusministeerium, 2021b).

In conclusion, the risk-free rate of return is a fundamental piece of contemporary financial theory, with its applications permeating critical aspects of finance in a practical context in terms of valuation, investment performance benchmarking, and more. Key market dynamics have recently affected the estimation of the risk-free rate of return in Estonia and distanced the connection between the academic literature and practical contexts. These key dynamics have been the estimation of the risk-free rate of return in developing markets, the decrease in nominal and real bond yields in AAA bonds in the eurozone, and changes in sovereign risk expectations in the market.

1.2. Alternatives for Estimating the Risk-Free Rate of Return in Practice

In this sub-chapter we achieve research task B, through bringing forward to the reader an overview of the key proxies utilized to estimate the risk-free rate of return in a practical—European—context. In this section, we will cover the most common proxy: AAA sovereign bond yields, followed by a collection of less common proxies. Those proxies covered are the European short-term rate (ESTER, or formerly 'EURONIA'), generalized collateral financing trade (GC REPOs), and retail fixed rate deposits with an example from the Estonian context.

1.2.1. Sovereign bonds

Sovereign bonds are essentially debt instruments that are issued by sovereign entities (or simply governments) that may have periodic payments throughout the duration of the debt, and finally the repayment of the bonds par value upon expiration or achieving maturity. Generally, sovereign bonds are issued in the currency of the country of issue—though exceptions exist (e.g. brazil has issued bonds denominated in USD (Reuters, 2020)). The yields (and ratings) differ between issuers just as they may differ between corporate issuers. The factors affecting the yields are determined by the risk profile of the issuer, this means that a governments perceived default risk and liquidity risk, etc. affect yields. Historically,

within the EuroZone, the Bund (Bonds issued by the German government) has had the lowest yield due to the lowest amount of risk associated with it (Ejsing et al., 2015)

In developed countries, government bonds have been used as the risk-free rate of return proxy, due to their perceived creditworthiness. Governments of developed countries are regarded as creditworthy due to the ability to raise taxes, and theoretically due to control over the money supply (i.e. able to print money in order to meet financial obligations) (Damodaran, 2008; Dacorogna & Coulon, 2013). As mentioned earlier, these properties are not universal, and in the European context. The financial crisis of 2007-2009 has brought out concerns regarding the credit or default risk of developed countries. Credit agencies have downgraded several countries, and simultaneously credit default spreads have risen (CapitalIQ, 2016) The rise in credit default spread has highlighted the rise in default risk of previously considered "risk-free" assets. A Credit default spread indicates the perceived probability of default of an entity (Hull & White, 2013). While the default risk is not exorbitant, it does exist—and contradicts the aforementioned belief that developed sovereigns are wholly exempt from it.

In summary, government bonds resemble the theoretical risk-free asset due to the absence of prepayment and reinvestment risk. The absence of reinvestment risk is evident through the use of zero-coupon bonds which accrue interest and pay interest upon maturity or expiration. The lack of periodic payments removes the existence of interest until reaching maturity—this is evident through the use of bond duration, which financial theory states that duration of zero-coupon bonds is equal to the maturity of said bond which removes interest risk (Vernimmen, 2014). Concluding, due to sovereign bonds' lack of default, reinvestment, and prepayment risk—their yields are a clear proxy for the risk-free rate of return.

1.2.2 Overnight-Indexed Swaps

Overnight Indexed Swaps (OIS) are financial instruments available to large institutions that allow them to 'swap' or exchange the interest rates on outstanding debt without the need to restructure/refinance or enter legal discussions about the underwriting of loans from other institutions (Hansen, 2017). The reason why it is called an 'overnight' indexed swap is because normally these swaps involve an institution swapping an overnight interest rate and the second is swapping a fixed short-term interest rate. Most major currencies have an overnight market—though the market construction can differ substantially from currency-to-currency (ECB, 2022b).

A vanilla interest rate swap includes the swap of a variable cash flow stream for a fixed one, or vice versa. Normally, interest rate swaps involve agreeing to a set fixed rate on

the principal for an agreed upon time horizon. This translates into receiving a floating or variable interest rate for the same agreed upon time horizon. These standard swaps are built so as to have a net present value of 0 at T_0 which implies that no cash flows are being interchanged at the commencement of the contract. Equation 1 is built by finding the equilibrium point of the fixed rate swap. (Vernimmen, 2012)

$$PV\left(\prod_{t=1}^{T}(1+Floating_t)-1\right)=PV[(1+Fixed)^T-1] \quad (1)$$

In Europe, the ESTER or euro short term rate is the new name of the EONIA (Euro overnight index average) (Reuters, 2021a; ECB, 2022b). In the EuroZone, the ESTER is the floating component (see formula 2) of the swap. The ECB (2022b p.1) describes the ESTER as "The euro short-term rate (€STR) is a rate which reflects the wholesale euro unsecured overnight borrowing costs of euro area banks". A Euro overnight indexed swap is an interest rate swap on the basis of the ESTER. The floating rate described previously is calculated by calculating the (shorter maturity) ESTER rate or by retrieving the geometric average of the rate over a set period (Credit Suisse, 2001; Hull, 1990). As of January 2022, the European Central Bank has determined that the market convention for actual days of the ESTER (or EONIA) is the Actual/360 days market convention (ECB, 2022b). Equation 1 illustrates the Euro overnight indexed swap floating interest rate on the basis of the daily compounded ESTER, where n_t is the number of market operation days between day t and the closest or following operational market day. (Edu-risk international, 2015):

$$Floating\ Rate=[\prod_{t=1}^{T}(1+((n_t\,ESTER_t)/360)\,]-1 \quad (2)$$

The suitability of OIS as proxies of the risk-free rate of return is due to the following points:

A. Lack of credit risk. When OIS are compared to continually refreshed overnight loans between highly rated banks—OIS are equally as creditworthy. Overnight borrowing is considered to be without credit risk—including the OIS (Hull, 2015).
B. No prepayment risks. Prepayment risk is not present due to no actual exchange of notional occurring during the contract in question (Credit Suisse, 2001).
C. Removable reinvestment risk. OIS are exposed to reinvestment risk, which is their primary drawback when being considered as a suitable proxy for the risk-free rate of return. They are exposed to reinvestment risk due to the fact that these swaps are settled on a yearly basis, and again upon reaching maturity (Credit Suisse,

2001). Intermediate payments create reinvestment risk due to the uncertainty created by unknown fluctuations in the return of the investment of these cash flows. These intermediary cash flows can be mitigated through the use of 'Bootstrapping'—the identical process utilized to construct accrual bonds (Sharpe et al., 1998).

In summary, the euro denominated overnight indexed swap can be considered an alternative to estimating the risk-free rate of return due to its lack of credit risk, prepayment risk and a reinvestment risk that is mitigatable through bootstrapping.

1.2.3. General Collateral Financing Trades (GCF)

General collateral financing trades or general collateral repurchase agreements (repo) are a repo contract in which the lender of funds is willing to accept, as collateral, any type of treasury and/or other similar asset (Federal Reserve Bank of New York, n.d.). Repurchase agreements, or repos, are basically a short-term loan made by banks that have large quantities of financial instruments on their balance sheets (Fleming & Garbade, 2003). More specifically, these repos are "repo contract is the sale of an asset combined with a forward contract that requires the original seller to repurchase the asset at a future date for a pre-specified (repurchase) price" (Gottardi et al., 2019 pp. 2). General collateral (GC) is made up of high quality, low risk, liquid instruments/assets that are similar (primarily instruments which are backed by a sovereign) (Vernimmen, 2014).

$$\begin{aligned} P_s(1 + r\left(\frac{T}{360}\right) &= P_r \\ r\left(\frac{T}{360}\right) = \frac{P_r}{P_s} - 1 &= \frac{P_r - P_s}{P_s} \\ r = \frac{P_r - P_s}{P_s}\frac{360}{T} & \end{aligned} \tag{3}$$

Equation 3 describes the derivation of the repo rate (r) through calculating the difference between the price of sale (P_s) and the repo price (P_r), for the given period T (Hull, 2015).

GCFs can be considered to be a proxy for the risk-free rate of return due to their lack of credit, reinvestment, and prepayment risk. Credit risk is absent because GCFs are overcollateralized (Fleming & Garbade, 2003). There exists a small exposure to credit risk due to the market movements of the collateral (e.g. if the collateral has interest rate risk such as coupon paying sovereign bonds)—which is normally also resolved due to the aforementioned overcollateralization of GCFs. Reinvestment or prepayment risk are absent

due to GCFs lack of intermediate coupons and due to a fixed maturity (Fleming & Garbade, 2003). GCFs are a proxy for the risk-free rate of return due to their low financial risk.

1.2.4. Consumer Fixed-Term Deposits

A potential unconventional proxy for the risk-free rate of return can be an adjusted bank savings rate for which the savings are insured by the state. For example, in Estonia one of the highest yielding fixed-term deposits is Holm Bank. Interest rates at this bank can range up to 2.5% annually (Holm Bank, 2022). Naturally, this for this to be considered risk-free it has to have no default risk. Holm deposits, just like those of any accredited financial institution in Estonia, are protected by the Deposit Guarantee Sectoral Fund of the Guarantee Fund (Tagatisfond) in amount up to €100,000. This is similar to the FDIC insurance available to banks in the United States, differing primarily in the amount covered (FDIC, 2022). The accrued interest can be withdrawn at the end of the investment period— removing any reinvestment risk, and theoretically any prepayment risk. The drawbacks of utilizing this as a proxy are its limitation in terms of quantity (limited to €100,000 of which the total is calculated based upon the cumulative accounts held at said bank).

In summary, the aforementioned proxies are not collectively exhaustive. There exist additional proxies for the risk-free rate of return available in the market—or combinations of financial instruments which fit the bill of a proxy i.e. absence of default, reinvestment, and prepayment risk. In this sub-chapter we have discussed common proxies which are utilized in calculating the risk-free rate of return in practice, expanded upon what makes them a proxy, and brought out the theoretical framework behind these proxies.

1.3. Application of The Risk-Free Rate of Return in Practice –Previous Research

This sub-chapter will cover previous empirical research on the risk-free rate of return in Estonia. Due to the size of the Estonian research apparatus, specificity of this topic, and recent development of negative real bond yields—relevant previous empirical research is limited. Previous empirical research on this topic is characterized by being undertaken under previous macroeconomic circumstances, following a scope focused on the cost of capital as a whole, or covering Estonia as part of a larger European- or world-wide survey on quantitative inputs.

Searching the keywords in title, for recent papers from 2015 to present, “Risk-Free Rate” on Google Scholar yields 65 results. The key words “Discount rate” and “survey” yield 4 results, “risk-free rate” and “survey” yield only 7 relevant papers. A search within the contents of articles including the key words “risk-free rate”, “survey”, and “Europe” yields an astounding 13,000 results—of which a minority of results have the intended relevancy.

Within the European landscape, many surveys on the cost of capital, risk-free rate of return, or similar topics have been conducted, e.g. Moizer & Arnold (1984), Vydržek & Soukupová (2012), and Bancel & Mittoo (2014). For the purposes of this study, and due to the specificity of the area of focus—Estonia— a small collection of seven papers & studies will be utilized as key empirical literature. These studies are Kantšukov & Loemaa (2012), Ahlberg (2015) and Fernandez et al. (2017 through 2021) (Fig 2).

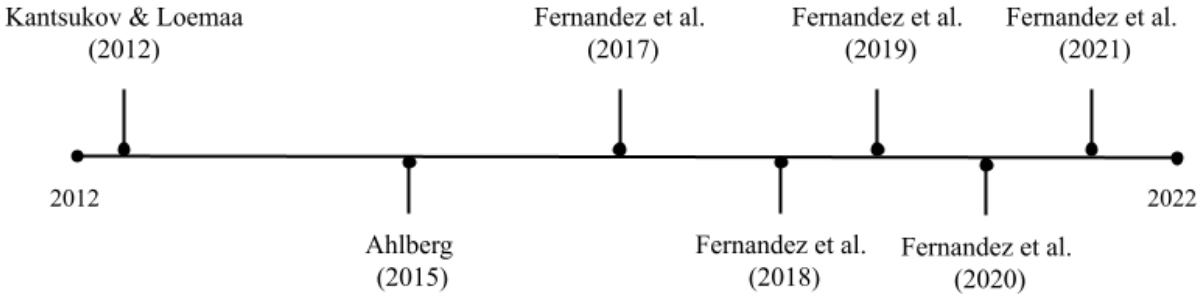

Fig 2. Timeline of previous research on the risk-free rate of return in Estonia.
Source: Compiled by the author

Surveys on the cost of capital, and thus risk-free rate of return have surveyed the landscape and compared practices to financial theory. Generally, the focus has been upon the choice of risk premium as in Fernandez et al's (2017, 2018, 2019, & 2020) annual world-wide survey which began to include Estonia in 2017 or inputs for deriving the cost of capital (Kantšukov & Loemaa, 2012). In the monumental survey of European finance practitioners Bancel & Mittoo (2014), the risk-free rate of return and the difficulties for choosing a proxy are brought out, which were further elaborated upon by Ahlberg (2015) in their survey of practitioners. Kantšukov & Sander (2016), analyzed valuation practices in Estonia, focused on analyst adjustments made (or lack thereof) in a DPT system, and raised questions as to how practitioners choose a suitable risk-free rate of return proxy—but did not include in depth questions about the risk-free rate of return in their survey. Kantšukov & Loemaa (2012) brought questions of choice of proxies for inputs. Ahlberg (2015) is the most comprehensive study on the risk-free rate of return in practice in the Estonian context—and has brought findings that coincide with the aforementioned Kantšukov & Loemaa (2012). In general, previous research on the topic has focused on different aspects surrounding the risk-free rate of return, and not a comprehensive picture—save Ahlberg (2015). For example, Fernandez et al. (2021) has focused on collecting descriptive statistics on Estonian analyst's estimated risk-free rate of return (alongside market betas, and equity premia). Kantšukov & Loemaa made substantial findings in the realm of the risk-free rate of return but their scope covered the cost of capital and thus scratched the surface of practices. Bancel & Mittoo (2014) covered only

valuations practitioners with a CFA or similar designation and covered all of Europe. Table 2 summarizes the scope of the previous empirical research relied upon by this study.

Table 2.
Overview of previous empirical research

Author(s)	Focus of research			
	Risk-free rate of return	Market Risk Premia	Market Beta	Taxation
Ahlberg T. (2015)	X			
Kantšukov & Loemaa (2012)	X	X	X	X
Fernandez (2017 to 2020)	X	X	X	

Source: Compiled by the author on the basis of studies mentioned

All in all, previous research has identified key practices, and areas for research, for example: Kantšukov & Loemaa (2012) found that after the financial crisis of 2008, analysts in Estonia received an assumption shock—leading to a rise in using the Estonian CDS in estimating the risk-free rate of return and risk premiums. Ahlberg (2015) was able to further confirm the conclusions drawn by Kantšukov & Loemaa (2012)—but also to dive deeper into the other factors surrounding the risk-free rate of return.

Ahlberg (2015) estimated the risk-free rate of return in March of 2015 to be between 1.16% and 1.53%, with questionnaire results showing that there is no constant solution to deriving the risk-free rate of return in practice. Fernandez (2017; 2018; 2019; 2020; 2021) has quantified the descriptive statistics of the risk-free rate of return utilized in Estonia by analysts from 2017 to 2021. Ahlberg (2015) showed a strong preference among analysts for German AAA sovereign bonds with a 10-year maturity—noting that practices had changed after the financial crisis of 2008, but also showed that some analysts are utilizing instruments with short maturities (1 – 9 years)—which may go against financial theory. In general, empirical research on risk-free rate of return has noted that practices have changed significantly after the financial crisis of 2008, and that the choice of proxy depends significantly upon the purpose (Ahlberg, 2015; Kantšukov & Loemaa, 2012).

In summary, while previous empirical research is limited there have been significant efforts to uncover analyst practices in Estonia. Those studies which have taken depth into the topic have been done under vastly different environments such as Ahlberg (2015), and Kantšukov & Loemaa (2012). These studies have benchmarked key areas surrounding the risk-free rate of return such as maturity, proxies, estimated rates, and context of usage. Previous empirical research provides essentially a “control” from which this study will be able to compare and contrast results in order to identify developments, changes, and that

which has remained with the changes in the macroeconomic environment which have been brought out previously.

2. The Risk-Free Rate of Return in Practice in Estonia

2.1. Data & Methodology

In achieving the aim of this thesis, that is: to gain an understanding of what risk-free rate of return practitioners in the field of finance in Estonia are utilizing, why they are using it, and how they have arrived at this rate, and to finally compare their practices against previous surveys, and financial theory. In order to achieve the research aim, a mixed methods methodology has been employed in the form of a questionnaire and interviews. The methodology utilized is an *explanatory sequential mixed-methods research design*. Collected data has been processed using a combination of Excel, and qualitative analysis methods.

The purpose of this chapter is to bring out in detail the research design for achieving the thesis aim in order to provide a roadmap for future research, and outline the steps taken to achieve these results. In addition, careful steps have been taken to maintain reliability and the validity of data collection methods, as well as the results. In this section, the aim is to bring forward to the reader the following:

a. Methodology employed;
b. Dates and geography of data collection;
c. Description of target population;
d. Description of sample frame and sample methods (e.g. survey strategy); and
e. Risks and limitations to methodology.

The quantitative methodology for this thesis was chosen on the basis of Ahlberg (2015), Kantšukov & Sander (2016), and Kantšukov & Loemaa (2012). The aforementioned studies have implemented a questionnaire-based methodology in achieving similar aims of collecting information from Estonian practitioners and academics. In addition to the questionnaire, interviews have been included in the methodology in order to assess key areas of focus identified on the basis of the questionnaire results—implementing research triangulation to leverage research efforts (Tashakkori & Teddlie, 2010; Creswell, 2022). Interviews have been chosen as a secondary methodology due to the necessity of open questions and the suitability of interviews in collecting subjective information that cannot be captured by closed question questionnaires (Creswell, 2022).

Pictured in Fig. 3 is the research methodology employed in achieving the aim of this thesis. Research methodology employed has taken a mixed-methods approach through the use of data triangulation. An initial quantitative questionnaire followed by in-depth interviews to answer questions related to areas of interest discovered through the initial questionnaire.

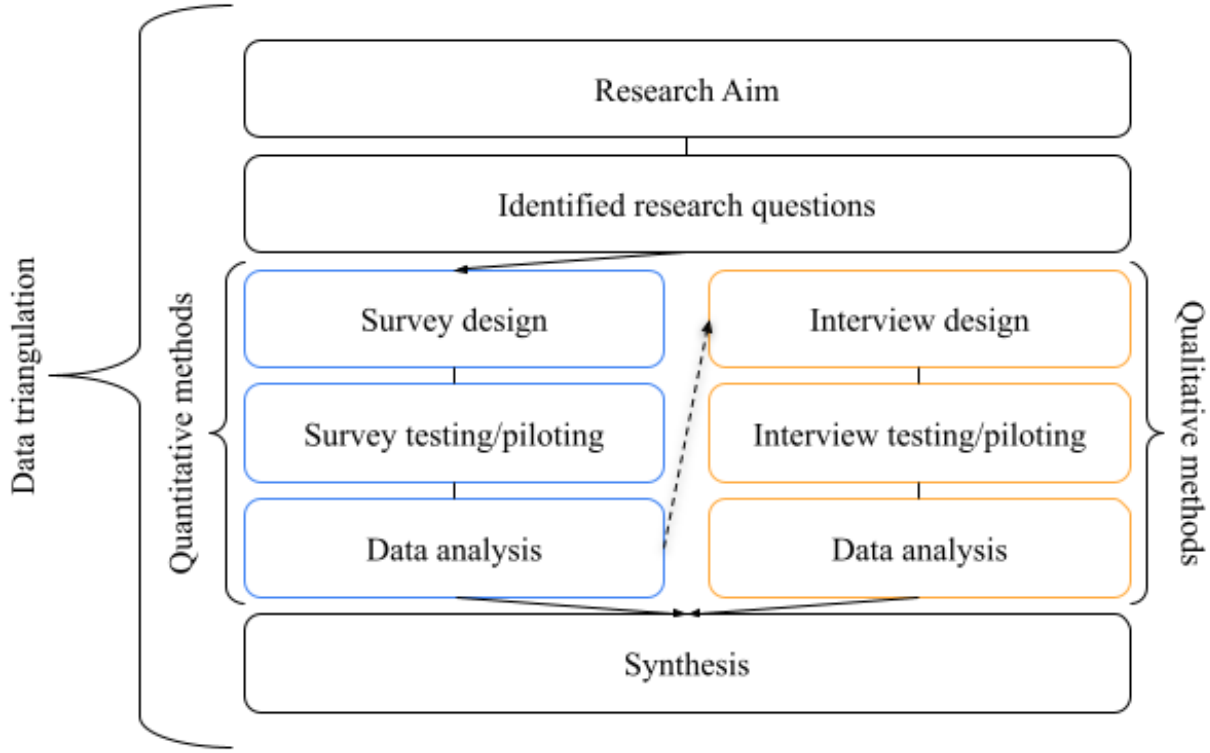

Fig 3: Explanatory sequential mixed-methods research design diagram

Source: Compiled by the author

Upon identifying key research questions, a questionnaire (or survey), was designed, tested, and disseminated to the target sample gathering a sample size of 32 with respondents in various fields such as Investment Banking, M&A, Valuations, Transaction Services, etc. Upon the collection, processing, and analysis of the data collected, further research needs were triangulated in order to gain a fuller understanding of analyst practices. These research needs were identified as being achievable through a structured interview. Interviews were conducted (upon designing, piloting and testing) with a select sample size of 4 in order to gain further depth into adjustments made upon the risk-free rate of return. This utilized methodology has been successful in achieving the research aim.

2.1.2. Mixed-Methods: Quantitative Approach

In the following sub-chapter, the methodology of the quantitative research will be discussed and brought out the reader.

Initial quantitative research in the form of a questionnaire has resulted in a data set with a sample size of 32. The methodology choice has allowed for a high response rate of 32% and has had an overwhelmingly positive response from respondents who have expressed their interest in this topic—and emphasized the research gap that this thesis aims to fill.

For the achieving the aim of this thesis, the survey (Appendices A & B) was disseminated to a target group that can be defined as individuals with a role directly involved

with practical utilization of the risk-free rate of return, primarily in the following categories (in order of largest to smallest): Transaction Services (27%) , M&A (25%), Valuations (19%), Private Equity (15%), Venture Capital (4%), Academia (5%), Investment Banking (4%), Equity research (2%).

The final questionnaire consisted of 19 questions, consisting of four themes: demographic information (Theme I), theory test (Theme II) the risk-free rate of return in practice (Theme III), organizational factors (Theme IV). These consisted of write-ins, multiple choice with single possible answer, and multiple choice with multiple selections possible. This survey took approximately 5-10 minutes to complete. The questionnaire was implemented in two language formats—English and Estonian. Upon initial screening, it was found that offering the survey in both languages had a superior response rate, and a more positive reaction from recipients. In order to optimize reliability and validity of the end result, as well as maximize the response rate—the survey was made anonymous. It was also offered to respondents to share the final results upon completion of this thesis. The survey was conducted from February 15th, 2022 to April 5th, 2022.

For the purposes of this study, it was aimed to include as diverse of a sample as possible, covering as many sub-fields as present in Estonia. The survey itself, was shared through the "Google Forms" platform, and distributed via professional channels, either through LinkedIn, personal connections, and through 2nd hand dissemination via the target organization's HR department. Contact letters in English and Estonian have been included in Appendices C and D. In turn, the chosen channels and form have yielded a large array of companies, diverse roles (e.g. M&A, Investment Banking, etc.), with the advantage of providing diverse perspectives, aiming for results that are generalizable to the population of financial analysts as a whole in Estonia.

A target minimum number of respondents of 30 was chosen for the questionnaire. This target was on the basis of Kantšukov & Sander (2016), as this initial survey on valuation practices in Estonia included a sample size of 32 respondents. The aforementioned study (Kantšukov & Sander, 2016) established 32 as a substantial sample size that can be considered representative of the Estonian financial sector. Moizer & Arnold (1984) surveyed 204 analysts in the United Kingdom—a population 52 times larger than Estonia's, and Vydržek & Soukupová (2012), a large study of analyst practices in Czechia included a sample of 45—and were considered representative of their respective populations. Bancel & Mittoo (2014) conducted a Europe-wide survey and chose to only analyze those countries with greater than 10 responses. For these reasons, the author has concluded that 30 responses

are an appropriate target sample size, especially when taking into account the relative size of the Estonian financial sector, and country population.

The targets were chosen based upon their current or past experience in finance roles with high or regular utilization of the risk-free rate of return. These translated into fields that utilize the risk-free rate of return through the usage of the capital asset pricing model (CAPM), option pricing model (Black-Scholes), Investment performance metrics (Sharpe's or Treynor's ratios), etc. Key target fields were identified and resulted in Transaction Services, Valuations, M&A, Investment Banking, Venture Capital, Private Equity, Academia, and other fields with a smaller footprint in Estonia e.g. Equity Research, or Asset Management.

While most of these fields' utilization of the risk-free rate of return is self-explanatory—the fields of Transaction Services and Venture Capital require additional clarification as to why they were targeted:

A. **Transaction Services (TS):** Transaction Services can be generalized as practitioner's in conducting financial due diligence, restructuring services, transaction support, etc. While not directly involved with utilizing the risk-free rate of return—there is significant overlap between transaction services professionals, and valuations. For example, only 35.7% of "Transaction Services" respondents described their role as only transaction services. In addition, 57% of "Transaction Services" professionals identified as utilizing the risk-free rate of return usually, or more than two times in every 6-month period.
B. **Venture Capital**: Practitioners in the field of Venture Capital have been targeted only in the Series A and onwards. This is due to the lack of financial modelling done by seed and pre-seed venture capital analysts (Gompers, P, Gornall, W, Kaplan, S. & Strebulaev, A, 2016). While Venture Capital professionals are technically a sub-set of private equity, but for the purposes of this study—they have been treated as a separate category due to the marked difference in culture, firm size, and assets being valued.

Surveys of this type have many limitations. For example, surveys tend to measure the respondent's beliefs—not actions (Bancel & Mittoo, 2014). In addition, they face a non-response bias, and cannot adjust for respondents' demographic variables that can influence final results (Creswell, 2022). In order to minimize the risks involved with this research method, demographic data has been collected in order to compare across different dimensions whether practices are affected by these factors. For example, we hypothesize that a

respondent with 10 years of experience in valuations may be more familiar with computing the cost of capital—thus the risk-free rate of return—when compared with a fresh graduate with only 'textbook knowledge'.

In approaching the reliability and validity of data collected, a methodical approach was taken on the basis of the monumental paper by Krosnick & Presser, (2009). This took the form of an initial survey design, subsequent usability test, primary pilot with test subjects, followed by a large-scale dissemination among target subjects. In addition, theory questions (Theme II) were included in the survey in order to assess a) the knowledge of respondents on the topic, and b) assure the overall validity of end results. The rate at which respondents answered both questions correctly was 94%, which supports that the knowledge of the retrieved sample on the topic was relatively strong. It should also be brought out that no respondents answered both theory questions incorrectly.

Analysis of results has been conducted through the use of Excel version 16.36. This software has been chosen due to its compatibility, and wide-spread use—in order to allow for further ease of replicability of the study. The data collected through the aforementioned Google Forms survey has been translated and consolidated into a single English language format and transformed into a processable dataset. The following analyses have been done:

a. Descriptive statistics analysis of the estimated risk-free rate of return by respondents, and other numerical data.
b. Tabulation of categorical and nominal data.

A collection of risks and limitations have been identified in the collected sample, that should be brought out to the reader to provide an understanding of the limitations of this study. While the collected sample is rich in diverse fields and covers a variety of viewpoints—there exist key risks in regard to the sampling. These are the following:

A. **Selection bias**. Due to practical constraints in reaching the target sample, the distribution channel of the survey will naturally have selection biases. This may present itself in the form of people more interested in financial theory responding to the survey, and thus providing a slight skew to the final result. Additional commentary provided by respondents has shown that respondents are disproportionately interested in the topic. Ilmanen (2003) has brought out an argument that survey results tend to be optimistic, arguing that they tell the reader more about the respondents expected vs. required returns.
B. **Concentration in professional services demographic (Transaction Services, Valuations).** Due to high concentration of respondents from professional services firms (e.g. PwC, EY, KPMG, Grant Thornton, etc.)(Fig. 5), and their relatively higher number

of employees routinely utilizing the risk-free rate of return, as well as accessibility to respondents—respondents from this demographic have a higher concentration in the sample. While understanding if this is representative of Estonia's financial sector is unclear, this should be noted to the reader in order to provide clarity of any generalizations made about practices.

In summary, in achieving the aim of this thesis data was collected from the target population of financial analysts and academics in Estonia, that has in turn yielded a data set composed of 19 questions, following four themes (demographics, theory, the risk-free rate of return in practice, and organizational factors). The methodology for completing the quantitative section of analysis has been described in this sub-chapter, and the results of which will be further elaborated in the following chapter (2.2).

2.1.2. Mixed-Methods: Qualitative Approach

In the following sub-chapter, the methodology of the qualitative research undertaken will be discussed and brought out the reader. The qualitative methodology makes up the second part of the exploratory sequential mixed methods research design for achieving the aim of this thesis. Qualitative semi-structured interviews have been conducted on the basis of the results of the analysis of the quantitative dataset. fig, 4 illustrates an overview of the qualitative research model.

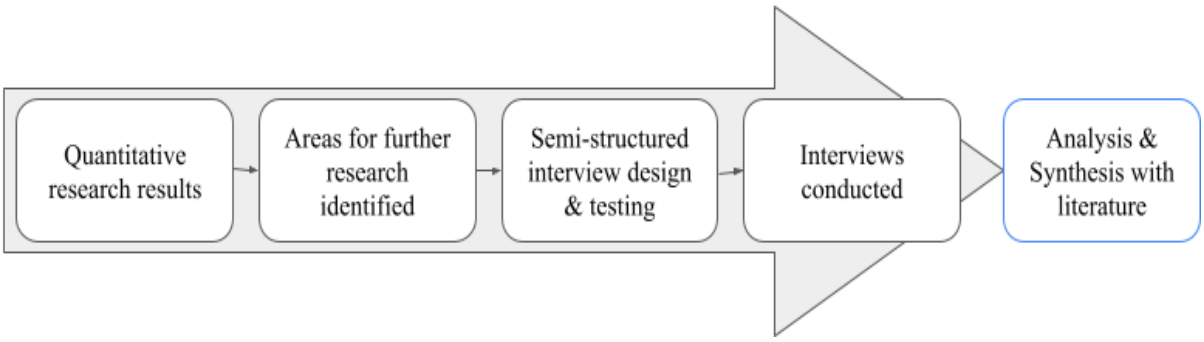

Fig 4. Qualitative methodology process model

Source: Compiled by the author

Upon completion of the quantitative data analysis, the following key areas were identified for further research:

A. Adjustments made to the risk-free rate of return proxy (due to the COVID-19 pandemic, the war in Ukraine, or other factors)
B. Changes in analyst practices in determining the adequate risk-free rate of return for valuation of projects of different size or duration.

Interviews were conducted in order to gain further depth of understanding in the aforementioned areas and thus a semi-structured interview format with 8 questions, and two themes were constructed. Due to the triangulation approach taken from the beginning of the data collection process, a small sample of 4 subjects was selected. The interview structure (Appendix E) was not maintained and follow up or clarifying questions were directed towards subjects. Due to the subjectivity, and objectives of the interviews—follow up questions, and clarification questions were deemed to be appropriate and necessary to achieve the research aim and in line with semi-structured interview literature.

In order to ensure the connection between methodology, subjects, and theory—an improvement process was utilized. This essentially meant that upon initially outlining the interviews structure and developing an array of questions aimed at answering the research needs, the question set was piloted on test subjects. This meant that the data for the test subject was not included in the final analysis but acquired knowledge from this test was included to improve the questions asked, and to narrow the scope of the interview. This improvement process allowed the questions to be more narrowly aligned with the aims of the research, and to simplify the analytical process.

The sample included in this section was comprised of four subjects. These four subjects were selected from the previous sample in the quantitative section. The sampling strategy included sending private messages to the list of the previous targets, with a request for a follow up short-form interview of roughly 15 minutes. Naturally, the response rate was substantially lower, but 4 subjects agreed to the fully anonymous interview. It should be noted that there exist risks with the sampling strategy such as the non-response bias (Creswell, 2022). The interviews were conducted from April 25th,2022 to May 1st, 2022.

Through triangulation on the basis of the literature and quantitative data analysis, the topics to be covered through the in-depth semi-structured interviews —this has been done in order to increase the agreement and validation of results (Tashakkori, & Teddlie, 2022; Murdock, 2017). On the basis of Fernandez's (2020) "Normalized" Risk-Free Rate: Fiction or Science Fiction?" , and the findings though the quantitative analysis, it was determined that the adjustments made to the risk-free rate of return used as an input in valuations was a key area to establish further depth upon. This topic is highly debated, with one side (e.g. Grabowski et al., 2017) suggesting that normalization of the risk-free rate of return and equity premia is a necessary adjustment, whilst the aforementioned Fernandez (2020) is strongly opposed to these actions. There is no academic consensus on the topic, and little to no

research has been done on the practices done by Estonian analysts. The content included in the interview, i.e. the content of the questions that were asked encompassed two themes:

A. Theme I(b): Adjustments to the risk-free rate of return in practice (5 questions).
B. Theme II(b): Size and duration discounts/premia (1 question).

The data collected through the semi-structured interviews took the form of qualitative data in transcripts. These transcripts were transcribed by the author ad verbatim, so as to avoid biases in summarization, as prescribed in the research literature (Tashakkori, & Teddlie, 2022).

The risks involved in the explanatory sequential mixed methods methodology, and the semi-structured interviews should be brought out to the reader. Firstly, the sample size in the second research phase, the semi-structured interviews, is small. This means that the data collected will not be fully representative, though through the use of triangulation the risks involved with this have been minimized to a certain extent. In addition, the mixed-methods methodology has the limitation of time and inconsistency. This means that while more data is better, the inconsistencies between combining quantitative and qualitative data sources have been shown to be substantial and may limit the results of this study (Creswell, 2022).

Analyses to be conducted on the collected data will be under the form of a narrative analysis. This will involve identifying key areas of similarity, and to connect this information with the first-research phase, the quantitative analysis, and with the literature (Murdoch, 2017). This analysis is especially fitting due to the greater mixed-methods research design which has been used to pinpoint areas of focus in the qualitative research (Tashakkori & Teddlie, 2022). We are looking to understand what these interviewees are doing in common when it comes to making adjustments to the risk-free rate of return used as an input in their CAPM, Option pricing, or others.

In conclusion, the second research phase of the mixed-methodology research design has been a collection of targeted interviews, on the topics brought out in this section (2.1). The risks involved in this choice in research methods has been brought out to the reader, including mitigations in place—primarily in the form of research triangulation. The analyses conducted on the collected data have been described, with the results of which shall be described in the analysis section of this thesis.

2.2. Results of Empirical Research

The objective of this chapter is to provide substantive data analysis, present the results, and provide a discussion through comparison to previous empirical research in order

to achieve the research tasks D and E. This objective will be accomplished through providing the reader within depth analysis of data collected from research phases I (quantitative) & II (qualitative) while comparing and contrasting against key literature as brought out in theoretical chapters 1.1, 1.2, and 1.3. Analyses of collected data will cover the following:

a. Demographic data (Theme I);
b. Theory (Theme II)
c. The risk-free rate of return (Theme III)
d. Organizational factors (Theme IV); and
e. Interviews (Theme I(b), and Theme II(b))

Analyses were conducted on a sample size that consisted of 33 individuals, which was made up of 82% Males, and 18% Females. The gender distribution is roughly in line with population data collected in other countries. For example, Ireland's financial sector follows a similar distribution with roughly 75% Male, and 25% Female (Central Bank of Ireland, 2020). The collected sample was highly educated, with 48% holding a bachelor's degree, 42% a master's degree, 6% a high school diploma, and 3% a doctorate. The level of respondents whose highest educational level completed was high-school was mostly present among respondents from the Venture Capital sub-sector, who had actually completed multiple years of higher education—but not finished their degree program. The level of experience in finance in the sample, either in a professional academic setting or as a practitioner), had a mean of 7.8 and a median of 6 years of experience. Compared to previous studies, the level of experience is corresponding to studies conducted by Kantšukov & Loemaa (2012) whose sample had an arithmetic mean of experience of 7 years. Bancel & Mittoo (2014) had similar results with over 80% of respondents having at least 5 years of experience. This implies that the age distribution is similar to the aforementioned studies—increasing confidence in the generalization of results.

The fields of occupation as self-described by the respondents (multiple answers possible), is shown in Fig 5. The composition of area of practice was substantially weighted towards transaction services, M&A, Valuations and Private Equity. This was likely due to the accessibility of these professionals, and due to the relative concentration of these occupations in the Estonian financial sector.

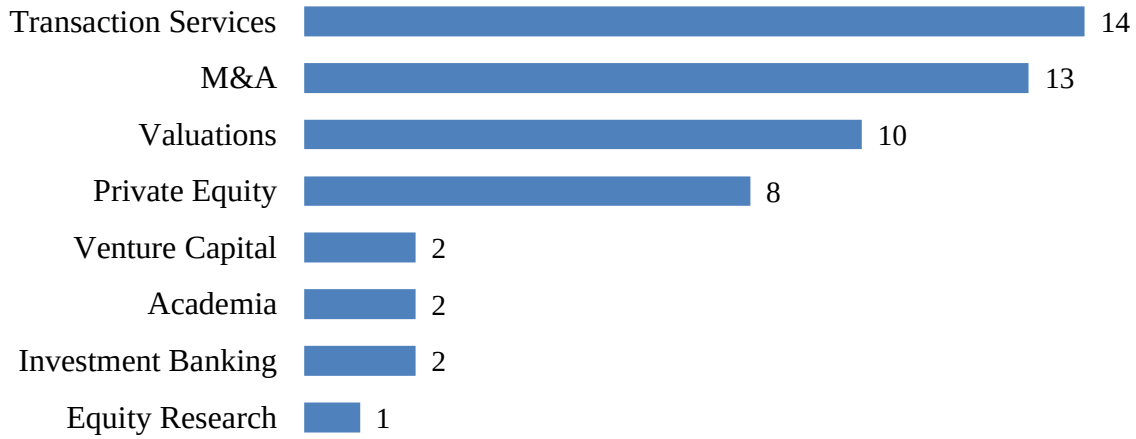

Fig 5. Survey respondent's self-reported field of occupation (in number of selected options)
Source: Compiled by the author

While the firms and names of the individuals interviewed and surveyed were kept fully anonymous—we have the ability to see what size of organizations they currently worked at and infer firm type through area of activity. From largest to smallest categories, "Medium" (50 to 249 people) for 12 respondents, "Small" (10 to 49 people) for 8 respondents, "Large" (250+ people) for 7 respondents, and "Micro" (1 to 9 people) for 5 respondents. More than half of respondents worked at fairly large organizations with more than 50 employees.

As briefly mentioned in chapter 2.1, two questions designed to test theoretical knowledge of the subject were included in the survey—as theme II. These questions consisted for example of: "*The expected risk premium on a stock is equal to the expected return on the stock minus the*:". These questions taken on an aggregate level had a 96% pass rate, when considering both answers to the results needed to be correct. No respondent responded to all theoretical questions incorrectly. While an established practice of "knowledge test" questions in cost of capital surveys is not present—the author has included this data in the questionnaire to improve the validity of results, and to better understand respondents' theoretical knowledge.

The sample's utilization of the risk-free rate of return was primarily for the CAPM (88%) (i.e. cost of equity computation), the evaluation of investment performance (6%) (E.g. Sharpe/Treynor Ratios), and the option pricing model (6%) (i.e. the Black-Scholes option pricing model). This is especially interesting due to its connotation as to the respondent's primary work area. Option pricing is a strongly under researched area in Estonia, and this presents an opportunity for further research given that the existence of this practice has been documented now, and in previous studies. The results of the context in which the risk-free

rate of return is primarily used is in line with the results of Ahlberg (2015) where it was found that 66% of responses coincided with the discount rate calculation or CAPM as the main context of use. It should be noted that Ahlberg (2015) had multiple selections possible on this question, and thus is not fully comparable.

In fig. 6 descriptive statistics pertaining to the estimated rate used by survey respondents can be seen. The arithmetic average of 0.58% is in line with German 10-year sovereign bond yield during the period of responses. While this cannot be directly compared with previous studies due to the variability of yields across time—the range of the data set is similar to Ahlberg (2015). When compared to Ahlberg (2015) respondents are more concentrated in the lower (closer to 0) end of the distribution at this point in time and are effectively utilizing a risk-free rate of return closer to 0. Additionally, the findings reconcile with the results of Fernandez (2021), the latest survey by Fernandez, which found a similar range (0.00%-2.90%) to what was found by this survey (0.00% to 2.47%). The aforementioned further elaborates upon the practices of analysts in adjusting the risk-free rate of return to 0.00% as found through interviews. This practice seems to be especially prevalent when faced with negative yields on the German 10-year bond.

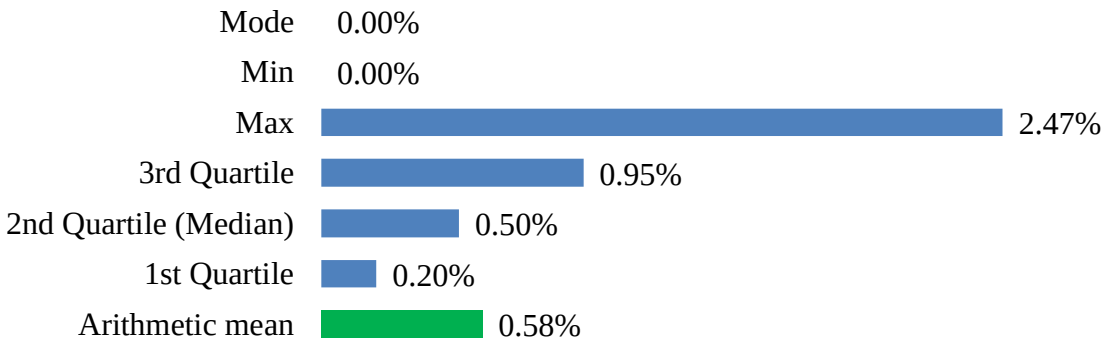

Fig 6. Estimated risk-free rate of return used by respondents

Source: Compiled by the author

As previously mentioned, adjustments made by respondents to the risk-free rate of return used in practice was a key research area in the second research phase. One out of four respondents answered that they are making qualitative adjustments to the risk-free rate of return used in their inputs. Adjustments made corresponded to an adjustment to 0.00% on the basis of the German 10-year bond yield. While the respondent clarified that this was an adjustment made in the aftermath of the negative yields starting in 2014, and that their colleagues in other Baltic offices (Latvia & Lithuania) made the same adjustment to 0.00%. This was made due to a negative intercept in the CAPM formula leading to technical problems in cost of equity estimation, and due to a perceived disconnection between German

bond yields, and the "actual" risk-free rate of return as the respondent elaborated. One out of four responded as to making no adjustments to their risk-free rate of return in practice, though a common practice was to use an arithmetic average monthly rate—which coincided with the results of the data source responses from the first research phase (quantitative survey). Two out of four subjected responded as to including country-risk premia in the estimation of the risk-free rate of return—and considered this the only adjustment made. This practice was also found to be taking place among Estonian analysts by Kantšukov & Loemaa (2012). Analysts cited Damodaran as the source for the country risk premium being utilized, and this practice is in line with Damodaran (2020) when discussing the estimation of the risk-free rate of return in a no-bond issue country—through the use of (adj.) credit default spreads (CDS).

Respondents views on the dependence of the risk-free rate of return on project size, and duration during the second research phase (interviews) were fairly uniform. Through narrative analysis, it was able to be seen clearly that respondents acknowledged and supported a dependence on project characteristics, as well as the investors access to funds on the effective risk-free rate of return in practice. Three out of four subjects expressed a strong opinion on the existence and preeminence of this dependence, while one subject expressed having a neutral view on the subject due to lack of research on the specific topic. The three subjects who expressed their views on the dependence emphasized that project duration will affect the proxy being used, which is further backed by the quantitative survey results which show that ca. 30% of respondents chose a sovereign yield with a duration matching the cash flows of the project in question. Largely, the choice in the maturity of proxies is largely irrelevant past the 10-year stage, as generally yield curves are flat past a 10-year maturity. (Bruner et al., 1998). Though in the valuation of a project with a duration of less than 10 years—the choice in maturity becomes of more importance.

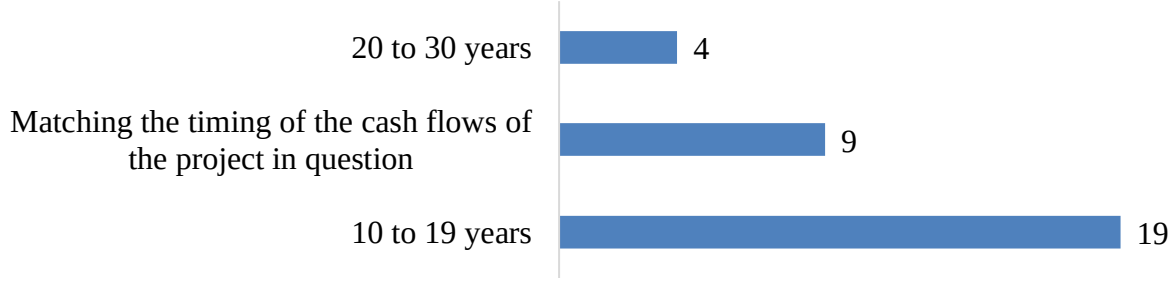

Fig 7. Survey responses on the duration of proxy of risk-free rate of return
Source: Compiled by the Author

The results of this questionnaire in the maturity of sovereign debt instruments is able to be contrasted against the findings of Ahlberg (2015). Analyst practices may have changed

since the aforementioned study. In 2015, analyst practices included a usage of bonds with a substantially shorter maturity (1 to 9 years) whereas in the sample of this study, this response received 0 out of 33. In addition, analysts seem to have developed a stronger preference for bonds with a maturity of 20 to 30 years, when compared to Ahlberg (2015), where only 1 out of 31 respondents preferred bonds of this duration. Strong analyst preference for bonds with a duration of 10-19 years remains still the most common attitude. This may have been an outcome of institutional learning, and development of theoretical knowledge as the use of short duration bills (1-9-year maturity) as an input for the CAPM is not aligned with financial theory.

Overwhelmingly, 31 out of 33 (94%) respondents in the collected survey sample answered that they utilize long-term sovereign bond yields as their proxy of choice in deriving the risk-free rate of return in the Estonian context. The remaining two respondents (6%) identified as utilizing credit default swaps as their proxy for calculating their input. Both individuals who responded as utilizing CDS's as a proxy use an estimated risk-free rate of return of 1% and 1.5% respectively—substantially above the median of 0.5% and 3rd quartile of respondents.

Among the sample, there is a strong preference for German sovereign bond yields as a proxy, with 28 out of 32 (1 missing response) respondents choosing German bonds over Estonian (3 out of 32), United States treasuries (1 out of 32), and Belgian bonds (0 out of 32). When compared to previous detailed results by Ahlberg (2015), strong analyst preference for German bond yields remains, while a decrease in usage of American treasuries, and a null result for Belgian bond yields/usage of other foreign country bonds (these practices were present previously). It should be noted as well that there existed previous practices in using Estonian private company debt instruments as a proxy which when unadjusted using credit default spreads would go against financial theory (Damodaran, 2020; Ahlberg, 2015)

As self-reported by respondents, the sources utilized by the respondents to retrieve data of their chosen proxies (Fig. 8) were varied. This is especially of interest due to the differing methodologies used by each source in presenting bond yields. With some sources presenting yields as a monthly average such as the ECB, or Bloomberg as the current trading figures. Though it should be noted that multiple responses on this question were possible—15.15% provided multiple responses. While the reasoning for usage of the ECB as a source is self-explanatory, we are very interested in the usage of Damodaran as a source for bond yields, or in a more practical case—credit default spreads and country risk premia. As of January 5th, 2022, Damodaran (2022) has published the rates for Estonia's credit default

spread (0.60%) and country risk premium (0.70%). The usage of the Damodaran data coincides with a practice found through the second research phase (interviews)—which has been described previously. It is possible that this practice may be more widespread and warrants deeper research.

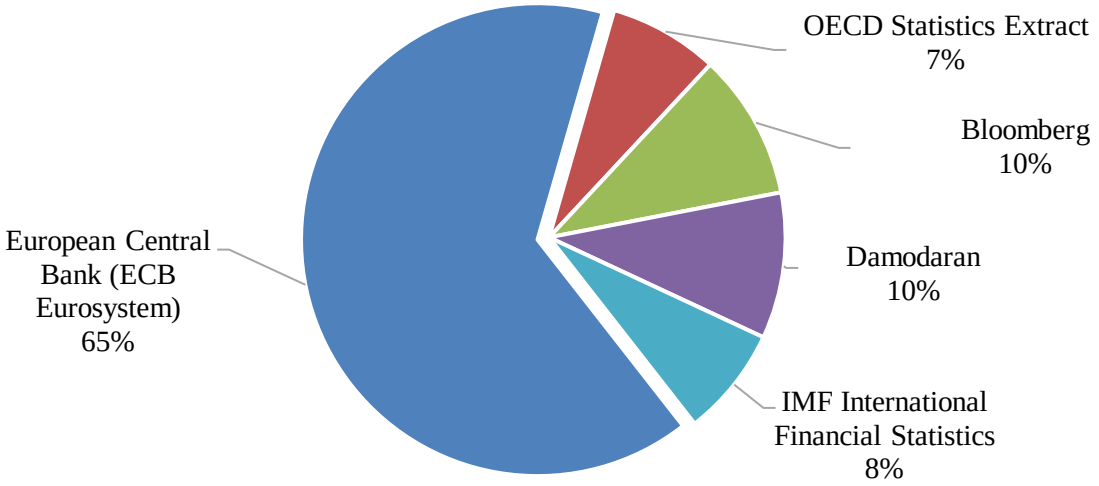

Fig 8. Sources for data on risk-free rate of return proxies by survey respondents
Source: Compiled by the author based upon survey conducted

50% of valid responses (24 valid responses in total) identified that one person in the organization is responsible for the recurring calculation of the risk-free rate of return, the other 50% responded that more than one person was responsible. As per the interview data collected, this is generally treated as an in-house updating model that is utilized for either CAPM or investment performance measurement. One responded provided in depth information about the in-house WACC (CAPM) model and identified that this model was updated manually by an analyst, under manager approval, with the monthly average yield of the German 10-year bond, utilizing as a source the ECB Eurosystem data. In the survey, 19 out of 33 respondents responded that an analyst is responsible for calculating the risk-free rate of return used by a team, or organization. 11 out of 33 responded that multiple team members were responsible, or followed a chain of command in the calculation of the rate, an example response would be “Analyst, Associate, Partner” in the case of one of the interviewees in which an analyst was tasked with the calculation by an associate, but the partner established certain adjustments on the rate inputted into the model.

Lastly, all respondents (100%, 33 out of 33) expressed agreement to the conditions regarding the survey (Appendices A & B), which allowed the use of data collected to be anonymized and utilized for research purposes in this thesis.

Through the aforementioned analyses and data processing, the following key findings have been identified:

A. The usage of country risk premia in making adjustments to the risk-free rate of return found by Kantšukov & Loemaa (2012) still exists and may be widespread.
B. A practice common among many respondents (dataset included a mode of 0.00%) of utilizing a 0.00% risk-free rate of return in response to the dynamics brought out in the introduction of this thesis. Interviews brought clarity insofar as the reasoning behind this practice, as it was clearly reasoned to be in response to negative German bund yields.
C. Analyst practices appear to have changed in terms of the choice of maturity of selected sovereign bond proxies. This has translated into a stronger use of bonds with a maturity of 20-30 years and weakened use of short duration (1 to 9 years) when compared to analyst practices found in 2015 by Ahlberg (2015). Strong preference for instruments with a maturity of 10-19 years is still present.
D. The use of credit default spreads as a means of adjusting foreign sovereign bond yields to match the Estonian context is a practice still in use and was in use in 2012 as found by Kantšukov & Loemaa (2012). Practices in the utilization of Damodaran (2022), as a source have highlighted future research possibilities in this specific practice.

In summary, this section has brought out key changes in analyst practices due to changes in the operating environment, compared and contrasted these developments against previous research conducted by Ahlberg (2015), Bancel & Mittoo (2014), Kantšukov & Loemaa (2012), and Fernandez (2021). In this section, research tasks D and E have been completed, and brought out to the reader. The author has analyzed data collected, connected the results to previous literature and drawn conclusions from the information in alignment with the aforementioned research tasks i.e. generalizations about analyst views, practices, common proxies, and the risk-free rate of return in Estonia as a whole.

Conclusion

In summary, through this study, we have uncovered the changes and current practices in the application of the risk-free rate of return by practitioners in Estonia. On an aggregate level, Estonian practitioners still prefer the use of German bonds with a maturity of 10-years. In addition, we have discovered and mapped out new practices, such as the relatively widespread utilization of a 0.0% risk-free rate of return—which has begun to be practiced in response to negative yields. We have uncovered some minor changes in the maturities of bonds utilized as proxies, a small usage of Estonian bonds, and further confirmed findings regarding the use of CDS and country risk premia from Kantšukov & Loemaa's (2012) study on the cost of capital in Estonia. Altogether, this study has mapped the current practices in the financial sector in relation to the past—and this is key in filling the identified research gap in understanding of practitioners in Estonia under current circumstances.

Through the literature review we have shown that the risk-free rate of return is a concept that has permeated modern finance from its initial conception. It is utilized as an input in quintessential models of contemporary finance such as the CAPM (Vernimmen, 2014), the Black-Scholes option pricing model (Black & Scholes, 1964), and Sharpe & Treynor ratios (Vernimmen, 2014), to name a few. Previous research suggests that among Estonian practitioners, the most common proxy that has been utilized is the German 10-year bond yield. Developments in the macroeconomic arena such as Estonia's issuance of bonds in 2020, Quantitative easing leading to sub-zero bond yields of AAA European issuers, rising credit default spreads, and the War in Ukraine— have been hypothesized to have affected practices in the industry.

Through reviewing empirical research on the risk-free rate of return in practice, we have uncovered that previous studies on analyst practices in Estonia have been conducted under different circumstances (i.e. positive long term sovereign bond yields), such as Ahlberg (2015), or have focused on quantifying analysts' perspective on the risk-free rate of return and equity premium such as Fernandez (2017; 2018; 2019; 2020; 2021). It has been brought out that no substantial research on the estimation of risk-free rate of return in Estonia has been conducted since Ahlberg (2015).

In this study, an exploratory sequential mixed methodology has been utilized to collect data from 33 practitioners and conducted 4 semi-structured interviews. This methodology can be broken down into two parts: a quantitative questionnaire phase, and a

subsequent targeted qualitative semi-structured interview phase intended to uncover in more detail adjustments made by practitioners to proxies.

The key findings of the analysis of data collected have been that while the macroeconomic environment has changed quite substantially, analysts' practices have not changed in a comprehensive way. Regardless of this, practices have changed, and have changed in response to macroeconomic developments. Key findings from research conducted are the following:

A. We have found that practices involving the use of country risk-premia adjustments to German bond yields is still present.
B. A practice of utilizing a 0.00% risk-free rate of return in response to negative real and nominal yields of traditional sovereign bond proxies has been uncovered.
C. Additionally, practices in terms of the choice in maturity of sovereign bond proxies have changed substantially—leading to a more pronounced use of 20 to 30 year maturity bonds, and a decreased use of 1-9 year maturity instruments.
D. The use of credit default spreads to adjust the 10-year German bond yield to reflect the Estonian context found by Kantšukov & Loemaa (2012) was found to still be common and may be widespread. This practice has been combined with practice A.

A potential field of further research is the aforementioned use of credit default spreads and country risk premia (points A & D) in estimating the risk-free rate of return in the Estonian context—a practice that has been uncovered and found to be relatively widely practiced. The exact practice, and theoretical framework surrounding this practice should be mapped and compared to financial theory. The alignment with academic literature and financial theory is especially of interest.

In conclusion, through the analysis of data collected through quantitative and qualitative research methodologies, the author has been able to identify current practices and the aforementioned changes, which have contributed towards achieving this thesis by providing an understanding of current analyst practices in estimating the risk-free rate of return in the Estonian context. Through achieving this aim, analyst practices have been identified—both that which has stayed the same and that which has changed when compared against previous studies. Lastly, through achieving the research aim of this thesis, the intended research gap has begun to be filled, and suggestions for further research to continue the development of academic knowledge in the field have been provided.

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Appendix A
English-Language Survey

Theme I. Risk-free rate of Return: Demographic information

1. What is your gender?
- Female
- Male
- Prefer not to answer

2. What is your age?
Write-in:……..

3. What is your highest level of completed education? *
- High School
- Vocational/Trade School
- Bachelor's Degree
- Master's Degree
- Doctoral degree
- Prefer not to answer
- Other:

4. Which of the following options most accurately describes your current role (multiple selections possible)? *
- M&A
- Private Equity
- Venture Capital
- Academia
- Valuations
- Investment Banking
- Other:

5. How many years of experience do you have as a practitioner and/or academic in finance?
Write-in: ……..

Theme II. Risk-free rate of return: Theory

6. Which of the following risks are NOT found in a risk-free asset? *
- Reinvestment risk
- Credit (Default) risk
- Prepayment risk
- All of the above are correct

7. The expected risk premium on a stock is equal to the expected return on the stock minus the: *
- Expected market rate of return
- Risk-free rate

- Inflation rate
- Standard deviation
- Variance

Theme III. Risk-free rate of return in practice

8. How often do you use the risk-free rate of return? *
- Rarely (once or twice every 6 months)
- Usually (more than twice every 6 months)

9. In what context do you most commonly utilize the risk-free rate of return in Estonia? *
- CAPM (i.e. cost of equity computation)
- Option pricing (e.g. Black Scholes model)
- Evaluation of investment performance (e.g. Sharpe/Treynor ratio)
- Other:

10. What proxy do you use to derive the risk-free rate of return in Estonia as of 2022? *
- Long-Term Sovereign Bond Yields (e.g. US treasury bills, German Sovereign Bonds, etc.)
- Credit Default Swaps (CDS)
- Euro Overnight Index Average Swap (EONIA)
- Generalized Collateral Repurchase Agreement Rate
- Other:

11. If using long-term sovereign bond yields as a proxy, which country's bonds do you use?
- United States Treasury Bond yield
- German Sovereign Bond yield
- Belgian Sovereign Bond yield
- Other:

12. What is the maturity of the financial instrument used as a proxy in determining the long-term risk-free rate in Estonia? *
- 1 to 11 months
- 1 to 9 years
- 10 to 19 years
- 20 to 30 years
- Matching the timing of the cash flows of the project in question
- Other:

13. What source or database do you use to retrieve your risk-free rate of return proxy in Estonia? *
- European Central Bank (ECB Eurosystem)
- IMF International Financial Statistics
- OECD Statistics Extract
- World Bank Open Data
- Other:

14. What do you estimate as the current risk-free rate in Estonia?

Write-in: ……..

Theme IV. Risk-free rate of return: Organizational factors

15. At your organization, how often is the risk-free rate of return recalculated? *
- Monthly
- Quarterly
- Yearly
- Other:

16. Is there a single risk-free rate of return used throughout your organization (e.g. your firm's valuations team uses the same risk-free rate of return as the M&A team)? *
- Yes
- No
- Don't know
- Does not apply

17. In general, is only one person responsible for calculating the risk-free rate of return at your organization? *
- Yes
- No
- Don't know
- Does not apply

18. What is/are the seniority of this/these person(s)? (multiple selections possible) *
- Analyst
- Associate
- Manager
- Don't know
- Does not apply
- Other:

19. I consent to having the information submitted to this survey processed for research purposes. I consent to the publishing of research produced using the information submitted to this survey.
- I Agree
- I disagree

Appendix B
Estonian-Language Survey

Theme I. Riskivaba tulumäär: Demograafiline info

1. Mis on sinu sugu?
   - Naine
   - Mees
   - Eelistage mitte vastata

2. Mis on teie vanus?
   Write-in: ……

3. Milline on teie kõrgeim haridustase?
   - Keskkool
   - Kutsehariduskool
   - Bakalaureusekraad
   - Magistrikraad
   - Doktorikraad
   - Eelista mitte vastata
   - Muu:

4. Milline järgmistest võimalustest kirjeldab kõige täpsemalt teie praegust rolli (võimalik mitu valikut)?
   - M&A
   - Erakapital (Private Equity)
   - Riskikapital (Venture Capital)
   - Academia
   - Valuations
   - Investeerimispangandus (Investment Banking)
   - Muu:

5. Mitu aastat on teil praktik ja/või akadeemiline kogemus rahanduses?
   Write-in: …….

Theme II. Riskivaba tulumäär: Teooria

6. Milliseid järgmistest riskidest EI OLE leitud riskivabas varas?
   - Reinvesteerimisrisk (Reinvestment risk)
   - Krediidirisk (Default risk)
   - Ettemaksurisk (Prepayment risk)
   - Kõik eelnev on korrektne

7. Lõpeta lause: Aktsia oodatav riskipreemia on võrdne aktsia oodatava tootlusega miinus...:
   - Eeldatav turu tootlus
   - Riskivaba tulumäär
   - Inflatsioonimäär
   - Standardhälve
   - Variatsioon

Theme III. Riskivaba määr: Praktika

8. Kui sageli kasutate riskivaba tootlust?
- Harva (kord või kaks korda iga 6 kuu järel)
- Tavaliselt (rohkem kui kaks korda iga 6 kuu järel)

9. Millises kontekstis kasutate Eestis kõige sagedamini riskivaba tootlust?
- CAPM (st. omakapitali arvutamise kulud)
- Optsiooni hind (nt Black Scholesi mudel)
- Investeeringute tulemuslikkuse hindamine (nt Sharpe'i ja Treynori suhe)
- Muu:

10. Millist proportsiooni kasutate Eesti riskivaba tootluse tuletamiseks alates 2022. aastast?
- Pikaajalised suveräänsed võlakirja tootlused (nt USA riigivõlakirjad, Saksa riigivõlakirjad jne)
- Credit Default Swaps (CDS)
- Euro Overnight Index Average Swap (EONIA)
- Generaliseeritud tagatisega tagasiostulepingu määr
- Muu:

11. Kui kasutate pikaajalise riigivõlakirjade tootlust proksina, siis millise riigi võlakirju kasutate?
- Ameerika Ühendriikide riigikassa võlakirjade tootlus
- Saksa riigivõlakirjade tootlus
- Belgia riigivõlakirjade tootlus
- Muu:

12. Milline on finantsinstrumendi lõpptähtaeg, mida kasutatakse pikaajalise riskivaba intressimäära määramisel Eestis?
- 1 kuni 11 kuud
- 1 kuni 9 aastat
- 10 kuni 19 aastat
- 20 kuni 30 aastat
- Vastavus projekti rahavoogude ajastusele
- Muu:

13. Millist allikat või andmebaasi kasutate oma riskivaba tootluse puhvri hankimiseks Eestis?
- Euroopa Keskbank (ECB Eurosystem)
- IMF International Financial Statistics
- OECD Statistics Extract
- World Bank Open Data
- Muu:

14. Mida hindate Eesti praeguse riskivaba intressimäärana?
Write-in: ……

Theme IV. Riskivaba tulumäär: organisatsioonilised tegurid

15. Kui sageli arvutatakse teie organisatsioonis riskivaba tootlust ümber?

- Kord kuus
- Kord kvartalis
- Kord aastas
- Muu:

16. Kas teie organisatsioonis on kasutusel üks riskivaba tootlus (nt. Teie ettevõtte hindamismeeskond kasutab sama riskivaba tootlust kui M&A meeskond?
    - Jah
    - Ei tea
    - Ei kehti

17. Üldiselt, kas ainult üks isik vastutab teie organisatsiooni riskivaba tootluse arvutamise eest?
    - Jah
    - Ei tea
    - Ei kehti

18. Mis on/on selle/nende isiku staaž? (võimalik mitu valikut)
    - Analyst
    - Associate
    - Manager
    - Ei tea
    - Ei kohaldu
    - Muu:

Theme V. Riskivaba küsitlus: teabejagamisleping

19. Nõustun sellele uuringule esitatud teabe töötlemisega teadusuuringute eesmärgil. Nõustun uuringule esitatud teabe põhjal valminud teadustöö avaldamisega.
    - Nõustun
    - Ei nõustu

Appendix C

Contact Letter in English

Hi **[**Subject name**]**!

Hope all is well.

My name is Samuel. I'm currently doing my Thesis on financial services in Estonia—and I'm collecting data from practitioners currently working in the industry. Would you be interested in filing out a quick 5-minute multiple choice survey on how you approach the risk-free rate in practice? The survey is completely anonymous.

It would be great to include your perspective in the study.

Estonian questionnaire: [Survey Link]
English questionnaire: [Survey Link]

Thank you!

Samuel J. Pierce

Appendix D

Contact Letter in Estonian

Tere [Insert Subject Name]!

Loodan et kõik hästi.

Ma tegelen meie valdkonna uurimistööga ja pöördun inimeste poole, et mõista, kuidas me riskivaba tulumäära kasutame. Oleks väga huvitav kuulda [Insert field of expertise] perspektiivi! Uuring on täiesti anonüümne.

Kas oleksite huvitatud selle teema kohta mõnele küsimusele vastamisest?

Küsimustiku kestus: ca. 3-4 minutit
Eesti keeles: [Survey Link]
Inglise keeles: [Survey Link]

Aitäh!

Samuel J. Pierce

Appendix E

Interview Structure

Risk-free Rate of Return in Estonia

Introduction: Hygiene factors

1. The results of this interview shall be anonymous and will not include any personal identifiers (firm, name, etc.). By answering the questions included in this interview, you consent to having the information processed for research purposes. Your contribution is appreciated.

Theme I: Adjustments to the risk-free rate of return

2. Through the use of which proxy are you, or your organization, deriving the risk-free rate of return in your field of practice?
3. When utilizing this proxy, are you adjusting the rate before coming to a final figure? If so, what adjustments are you including? Please elaborate.
4. Have you made any adjustments in the aftermath of the COVID-19 Pandemic? If, so, what adjustments have you made?
5. Have you made any adjustments due to the war in Ukraine? If, so, what adjustments have you made?
6. Why have you chosen to adjust the rate? Or why have you not chosen to do so?

Theme II: Size premia

7. In your opinion, does the risk-free rate of return depends on the size of the investment? E.g. the possible risk-free rate of return for an investment of $50k will be the same as for an investment of $950M.
8. In your opinion, does the risk-free rate of return depends on the duration of the investment?

Resümee

Riskivaba tulumäära rakendamine Eestis: rahandussektori praktikate uuring

Samuel James Pierce Ceseña

Riskivaba tulumäära näol on tegu kontseptsiooniga, mis on alates selle tulekust levinud terves tänapäevases rahandussektoris. Seda kasutatakse sisendina fundamentaalsetes rahanduse mudelites nagu CAPM, Black-Scholesi optsiooni hindamise mudel, Sharpe & Treynori suhe, tuues välja vaid mõned. Käesolev uuring keskendub riskivaba tulumäära praktilisele hindamisele Eesti kontekstis.

Valitsuse võlakirjad on olnud kõige laialdasemalt aktsepteeritud ja kasutatud asendusnäitajad (inglise keelest *proxy*), et ennustada riskivaba tulumäära. Eesti praktikute poolt kõige sagedasemalt kasutatavaks asendusnäitajaks on olnud Saksamaa 10-aastaste võlakirjade intressimäär. Tulenevalt mitmetest makroökonoomilistest arengutest nagu 2020. aastal Eestis võlakirjade välja laskmine, QE tõttu Euroopa AAA võlakirjade väljastajate võlakirjade intressimäära negatiivseks muutumine, tõusev krediidiriski levik (CDS) ja sõda Ukrainas on riskivaba tulumäära hindamine muutunud analüütikute jaoks märkimisväärselt keerulisemaks. Selle uuringu eesmärk on saada ülevaade praeguse hetke levinuimatest praktikatest analüütikute seas Eestis, sealhulgast sellest, missuguseid asendusnäitajaid, andmete päritoluallikaid, konteksti, kohandamise põhimõtteid ja organisatsioonilisi tegureid kasutatakse riskivaba tulumäära hindamisel.

Selleks, et käesoleva töö eelnevalt välja toodud eesmärgini jõuda, kasutati 33 valdkonna praktikult andmete kogumiseks järjestikust kombineeritud metodoloogiat. Metodoloogia saab jaotada kahte peamisesse faasi: kvantitatiivne küsimustiku faas ja sellele järgnenud kvalitatiivne pooleldi struktureeritud intervjuude läbiviimise faas, mille kaudu prooviti saada veelgi täpsemaid andmeid mõistmaks analüütikute praktikaid asendusnäitajate kohandamisel.

Kirjeldatud metoodikal kogutud andmete tulemused on võimaldanud saavutada antud tööle seatud sisulise eesmärgi. Analüütikute riskivaba tulumäära hindamise praktikad on kaardistatud ja neid on võrreldud varasemate uurimistulemustega. Peamised uurimistulemused näitavad, et kuigi makroökonoomiline keskkond on märkimisväärselt muutunud, siis analüütikute praktikas märkimisväärseid muutuseid toimunud ei ole. Riigi riskipreemia kohandamine Saksamaa võlakirjade intressimäärade põhjal on jätkuvalt kasutatav praktika. Samuti näitavad uuringu tulemused, et tulenevalt AAA valitsuse võlakirjade negatiivsetest intressimääradest kasutatakse 0.00% riskivaba tulumäära. Lisaks on märkimisväärselt muutunud valitsuse võlakirjade prokside tagasimaksetähtaja valik. Sagenenud on 20- ja 30-

aastase tagasimaksetähtajaga võlakirjade kasutamine ja vähenenud 1-9-aastase tagasimaksetähtajaga võlakirjade kasuks otsustamine. Samuti on jätkuvalt tavapärane ja sage praktika 10-aastaste Saksa võlakirjade intressimäärade Kantšukovi & Loemaa (2012) loodud Eesti konteksti kohandamisel CDSi kasutamine.

Võimalik uurimisteema edasiarenduskoht on CDSi ja riigi riskipreemia kasutamine hindamaks riskivaba tulumäära Eesti kontekstis. See on praktika, mis eksisteerib ja on tulemuste põhjal järeldades võrdlemisi laialdaselt levinud. Kaardistada tuleks selle praktika täpne meetod ja teoreetiline raamistik ning võrrelda seda veelgi põhjalikumalt rahandusteooriaga.

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