BAI Diversifikation zählt.

Sondernewsletter BAI-Wissenschaftspreis 2016

Inhalt

Sehr geehrte Damen und Herren,

vor nunmehr sechs Jahren entschloss sich der Bundesverband Alternative Investments e. V. (BAI), wissenschaftliche Arbeiten im Bereich der Alternativen Investments zu fördern und hat damals zu diesem Zweck den BAI-Wissenschaftspreis ins Leben gerufen.

Einer der damaligen Hauptgründe für diese Förderung war, dass das Wissen über Alternative Investments sowohl in der Breite als auch in der Tiefe nicht ausreichend war. In weiten Teilen der Öffentlichkeit, der Politik, der Medien aber auch auf Seiten der Investoren herrschen oftmals Missverständnisse hinsichtlich Nutzen und Risiken von Alternative Investments. Mit dem Wissenschaftspreis will der BAI einen Anreiz für Studenten und Wissenschaftler in Deutschland schaffen, Forschungsarbeit in diesem für Investoren wichtigen Bereich zu leisten.

Am 19. Oktober 2016 wurde der sechste BAI-Wissenschaftspreis für exzellente wissenschaftliche Arbeiten im Bereich Alternative Investments vergeben. Die Preise wurden in Frankfurt von dem für das Ressort Weiterbildung zuständigen BAI-Vorstandsmitglied Prof. Dr. Rolf Tilmes sowie dem Gremiumsmitglied Prof. Dr. Mark Mietzner von der Zeppelin Universität Friedrichshafen an die Gewinner überreicht.

In der Kategorie Masterarbeiten überzeugte die Arbeit von Anna Weinheimer zum Thema „European infrastructure debt as an attractive asset class for institutional investors“. Die Masterarbeit befasst sich mit den Risiken und Chancen europäischer Infrastrukturanleihen als einer Anlageklasse für institutionelle Investoren. Zudem setzt sie sich mit der Illiquidität der Anlagen in Infrastrukturprojekte auseinander, die für viele Investoren aktuell als eines der Haupthemmnisse für das Investieren in Infrastrukturprojekte gilt. Eine in der Arbeit durchgeführte empirische Analyse von europäischen Unternehmensanleihen mit einem Rating von „Aaa“ bis „A3“ (Moody's Rating) hat die Hypothese, dass sogar Unternehmensanleihen aus Infrastruktursektoren eine höhere Illiquidität als Unternehmensanleihen aus anderen Sektoren haben, bestätigt. Die auf einer statistischen Regression basierende Analyse hat auch gezeigt, dass sich die Illiquidität von Infrastrukturanleihen in entsprechend höheren Prämien widerspiegelt. Die gewonnenen Erkenntnisse können eine wichtige Grundlage für weitere Analysen von Projektanleihen aus dem Infrastruktursektor bilden.

In der Kategorie Dissertationen überzeugten das Gremium diesmal gleich zwei Arbeiten von hoher wissenschaftlicher Qualität. Zum einen wurde die Arbeit von Dr. Daniel Wurstbauer zum Thema: „Infrastructure Investments – Empirical Evidence on an Emerging Asset Class“ ausgezeichnet. Die Arbeit beschäftigt sich in drei separaten Forschungspapieren mit jeweils verschiedenen empirischen Fragestellungen rund um Infrastrukturinvestitionen und deren Investitionscharakteristika. Es konnte gezeigt werden, dass Infrastrukturinvestitionen tatsächlich einen guten Schutz gegen Inflation bieten. Weiterhin konnten die weithin verbreiteten Bedenken bzgl. der Einführung der Solvency-II-Richtlinie und deren negativen Einfluss auf Infrastrukturinvestitionen mithilfe einer innovativen Portfoliomodellrechnung relativiert werden. Mit einer signifikanten Verschiebung der Anlagequoten ist nicht zu rechnen, es ist sogar – je nach Kapitalisierung der Versicherungsunternehmen – eine höhere als in der Praxis vorzufindende Anlagequote realisierbar. Abschließend präsentiert die Arbeit die ersten empirischen Ergebnisse zur Bepreisung von gelisteten europäischen Infrastrukturunternehmen und zeigt, dass herkömmliche Asset-Pricing-Modelle allein nicht ausreichen, um die Renditen vollständig zu erklären.

Die zweite Arbeit stammt von Dr. Dominik Wolff zum Thema: „Empirical Studies on Asset Management: Multi Asset Portfolio Optimization, Return Prediction Models and Fixed Income Hedging Strategies“. Die kumulative Dissertation befasst sich theoretisch und empirisch mit den verschiedenen Bereichen des Asset Managements. In einem Beitrag werden verschiedenen Portfolio-Allokationsstrategien untersucht und die "out-of-sample" Performance getestet. Es zeigt sich, dass das sog. Black-Litterman-Modell unter den untersuchten Verfahren die höchsten risikoadjustierte Renditen erzielt und zudem geringere Tail-Risiken und breiter diversifizierte Portfolios aufweist. Ein zweiter Beitrag untersucht den Nutzen von Rohstoffen in der Asset Allokation. Die empirischen Analysen deuten eindeutig darauf hin, dass Edelmetalle, Industriemetalle und Energierohstoffe das Rendite-Risiko-Profil klassischer Aktien-Anleihen Portfolios verbessern. Eine Anlage in Lebensmitteln

(Vieh- und Agrarprodukte) ist hingegen nicht erforderlich, um effiziente Portfolios zu konstruieren. In der dritten Studie werden Prognosemodelle für Aktienmärkte untersucht, die fundamentale, makroökonomische und technische Indikatoren nutzen. Die empirischen Ergebnisse belegen, dass Asset-Allokationen auf Basis statistisch-mathematischer Prognosemodelle passive Investments signifikant schlagen und zudem besser abschneiden als optimierte Portfolios, die historische Mittelwerte als Renditeprognose verwenden. Zwei weitere Publikationen der Dissertation beschäftigen sich mit dem Risikomanagement von Bond-Portfolios während der Staatsschuldenkrise in Europa und insbesondere mit der Absicherung der damit verbundenen Risiken mit Derivaten.

In der Kategorie „Sonstige Wissenschaftliche Arbeiten" gewann die von Prof. Dr. Mietzner besonders hoch gelobte Arbeit „Market Maturity and Mispricing" von Dr. Heiko Jacobs, der bereits mehrere Auszeichnungen für seine wissenschaftlichen Arbeiten erhalten hat. Auf Basis von mehr als 100 Millionen Aktienrenditen und 11 bekannten Long/Short-Querschnitts-Anomalien untersucht die Studie das Ausmaß von auf Fehlbewertungen basierender Renditevorhersagbarkeit in 45 Ländern. Die Ergebnisse widerlegen dabei die weitverbreitete Annahme, dass Aktienmärkte in Schwellenländern (wie China oder Indien) notwendigerweise ineffizienter sind als Aktienmärkte in entwickelten Ländern (wie die USA oder Deutschland). Diese Resultate implizieren, dass die Suche nach long/short Alpha auf Basis von öffentlich verfügbaren Informationen in entwickelten Ländern erfolgversprechender sein könnte.

Der BAI dankt allen Bewerbern und den Gremiumsmitgliedern, ohne deren Mithilfe die Realisierung dieses Preises nicht möglich gewesen wäre, herzlich.

Zusammenfassungen der Gewinnerarbeiten, Informationen zum Gremium und einige Fotos der Preisvergabe finden Sie in dieser Sonderausgabe des BAI Newsletters.

Wir möchten an dieser Stelle noch darauf hinweisen, dass Arbeiten für den Wissenschaftspreis 2017 ab sofort bis zum 28. Februar 2017 beim BAI eingereicht werden können.

Wir wünschen eine spannende Lektüre!

Bundesverband Alternative Investments e. V.

Impressionen der Preisvergabe

BAI-Wissenschaftspreis 2016

BAI-Vorstandsmitglied Prof. Dr. Rolf Tilmes

Gremiumsmitglied Prof. Dr. Mark Mietzner


Preisträgerin Kategorie Masterarbeiten:
Anna Weinheimer

Preisträger Kategorie Sonstige wissenschaftliche Arbeiten:
Dr. Heiko Jacobs

Preisträger Kategorie Dissertationen: Dr. Dominik Wolff,
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I. Introduction

In the current low interest rate environment in Europe, the interest of institutional investors in infrastructure as an asset class is increasing. Investors can invest in infrastructure through two common investment channels: directly either on the corporate or the project level, or indirectly through various intermediaries such as infrastructure funds. Equity and debt, in the form of bonds and loans, are commonly-used as investment instruments that can be traded either publicly or privately. Each investment channel and instrument of investing in infrastructure has its specific benefits and issues. Infrastructure debt could be especially attractive for such long-term oriented investors as insurance companies and pension funds, since long-term infrastructure debt offers not only relatively high yields but also potential maturities matching investors' long-term liabilities, such as life insurance and pension plan obligations.

There are some limitations that institutional investors currently face when investing in infrastructure projects. A review of the relevant literature (Nelson / Pierpont 2013 and Kaminker et.al. 2013) has shown that illiquidity is a major barrier to direct investment in infrastructure for many institutional investors. However, the main constraints is not the illiquidity itself but rather investor's inexperience and uncertainty in dealing with illiquidity, and increased illiquidity costs due to strict financial regulations in Europe. An asset's liquidity can be understood as "the ability to trade large quantities quickly at low costs and with little price impact" (Panayides et. al. 2013). Two main sources of illiquidity are market microstructure and asset-specific illiquidity. Illiquidity due to market microstructure is linked to the market's failure to provide appropriate liquidity to an asset, such as high transaction costs or any information search frictions (Hibbert 2009). It has been proved that liquidity does vary over time and is conditional on total market liquidity (Acharya et. al. 2013). Asset-specific illiquidity can be due to any underlying illiquidity of the assets of a company or a project. Ortiz-Molina and Phillips (2014) found that illiquidity of real assets held by a firm can significantly increase the firm's total capital costs. Benmelech and Bergman (2009) prove the same impact on costs of debt. Ortiz-Molina and Philips (2014) suppose that such increase in capital costs can be explained through a decrease in the firm's flexibility to react to changing business situation.

Infrastructure bonds exhibit commonly both types of illiquidity: illiquidity due to market microstructure frictions and asset-specific illiquidity. Therefore even infrastructure corporate bonds are assumed to show higher illiquidity than non-infrastructure corporate bonds. This is mainly due to asset-specific illiquidity, the illiquidity of real assets held by infrastructure companies.

Though liquidity cannot be measured directly, there are many indirect liquidity measures. Bid-ask-spread is the most used measure of liquidity and is an illiquidity proxy that is related to transaction costs, one of the main drivers of the illiquidity premium (Hibbert et. al. 2009). It is calculated as an average difference between ask and bid prices for a certain security in a certain period of time (e.g. day, month etc.).

Investors who hold less-liquid assets for a long period are expected to earn an illiquidity premium (Hibbert et. al. 2009). Reduced-form approach is one of the common methods of illiquidity premium estimation that are typically used in the bond market (Van Loon 2014 and Hibbert et. al. 2009), and is suitable for analysis of different illiquidity types (for example of time-dependent and time-constant illiquidity components). Reduced-form models are regression-based models that involve regression analysis of observed asset price or yields on one or several illiquidity proxies. Statistically significant coefficients can be then interpreted as proxies for illiquidity premiums. Different assets are expected to have different illiquidity premiums, dependent on their liquidity characteristics and on overall market conditions (Hibbert et. al. 2009).

II. Methodology and data description:

The goal of the empirical part is to analyze whether infrastructure corporate bonds from Eurozone countries have higher illiquidity costs than other corporate bonds, and whether illiquidity costs of infrastructure bonds are properly priced. The analysis was done for a sample of active

corporate bonds that are traded in Euro and whose issuers are from Eurozone countries. For purpose of simplicity only bonds with fixed coupons are considered and convertible bonds are excluded from the data set. The data set is obtained from Thomson Reuters DataStream for the time period between 1 October 2009 and 1 October 2014 at 1 December 2014. Transportation and Construction sectors were denoted as infrastructure sectors and others as non-infrastructure sectors. Thus, in the data sample 48 percent of bonds belong to infrastructure and 52 percent - to non-infrastructure sectors. Analysis is done in two steps and with help of a reduced approach. The method is analogous to that of van Loon (2014). A brief description of variables used in the regressions of both steps is provided below in the **Table 1.**

Table 1: Variable description

Dependent variables	
BAS	monthly bid-ask-spread, in percent of the bid price
Yield	monthly yield over German government bonds, in percent of the face value
Independent variables	
RBAS	filtered monthly bid-ask-spread, in percent of the bid price
D	monthly duration, in years
Amount	amount issued, in millions
Rating	bond's rating, coded from 1 to 19, "Aaa" =1 and "Caa3" = 19
Sen	= 1 if bond has any seniority, 0 otherwise
Guar	= 1 if bond has any guarantee, 0 otherwise
Call	= 1 if callable bond , 0 otherwise
Infra	= 1 if bond is from infrastructure sector, 0 otherwise

Since institutional investors often invest only in investment grade bonds, the empirical part is done for investment grade rating and for „BBB-„ rating.[12] It is expected that liquidity behavior of bonds with best ratings and worst ratings differ significantly. The bonds are therefore divided into two groups (AAA-A and BBB groups). The AAA-A group includes Moody's ratings from "Aaa" to "A3"; the group BBB - ratings from "Baa1" to "Baa3".

In first step, a proxy for total illiquidity is regressed on bonds' fundamentals (such as duration, amount issued, rating, seniority, guarantees, call features) as well as on a dummy variable for infrastructure sectors. The model was used in the regression is described in equation (1).

$$BAS_t = \beta_0 + \beta_1 \times D_t + \beta_2 \times Amount + \beta_3 \times Rating + \beta_4 \times Call + \beta_5 \times Sen + \beta_6 \times Guar + \beta_7 \times Infra + u_t \quad (1)$$

Where t is the analyzed time period (month and year) and is between October 2009 and October 2014; β_o is the intercept of the regression, β_j are regression coefficients for each variables (j =1… 7). The regression's residuals u_t is assumed to be the illiquidity filtered from the bonds' specific illiquidity (illiquidity caused by market microstructure) and is used in the regression of step 2 under the name $RBAS_t$.

The goal of this first-step regression is to analyze whether infrastructure bonds have higher illiquidity than non-infrastructure bonds. Coefficient estimations for each variable represent the level of their contributions to total illiquidity.

In the second step, the bond's yields over risk-free rates are regressed on the bond's fundamentals and on a dummy variable for infrastructure sectors (similar to step 1) as well as on the filtered illiquidity proxy [3].

[1] The same analysis for bonds with ratings worse than „BBB-" is provided in the master's thesis

[2] Further ratings will be denoted in accordance to S&P rating scale: AAA for „AAA+" - „AAA-„ and AA for „AA+" – „AA-„ as well as A for „A+„ – „A-„

[3] Yield is regressed on filtered (residual) illiquidity instead of on total illiquidity in order to exclude any correlation between independent variables in the regression

$$Yield_t = \beta_0 + \beta_1 \times D_t + \beta_2 \times Amount + \beta_3 \times Rating + \beta_4 \times Call + \beta_5 \times Sen + \beta_6 \times Guar + \beta_7 \times Infra + \beta_8 \times RBAS + u_t \quad (2)$$

The goal of this step is to analyze whether bond independent illiquidity (market microstructure illiquidity) as well as infrastructure-specific illiquidity (asset-specific illiquidity) are priced into the bonds.

Regressions of both steps are run separately for each group. The regressions are implemented in R Studio statistic software. The analysis is based on Fama-MacBeth regression, which estimates regression coefficients for each month separately and finally takes an average of monthly coefficients. Calculation of t-statistics is based on Fama-MacBeth standard errors with adjustment to serial correlation using Newey-West standard errors. Regression tests (such as assessing residuals' normality, evaluation of collinearity and homoscedasticity) were run using built-in functions of the R Studio software packages.

III. Results and discussion

Step 1: Whether illiquidity costs are higher for infrastructure bonds

For AAA-A rating:

This group includes bonds with Moody's ratings from "Aaa" to" A3". As shown in **Table 2**, all estimated coefficients are significant. As expected, illiquidity costs increase with increasing duration and decrease with amount issued, and illiquidity is higher for callable bonds without any type of guarantees. Unexpectedly, illiquidity costs decrease as the rating becomes worse. This could be explained through investors' higher interest for A rather than for AA rated bonds (respectively for AA rather than for AAA rated bonds), since they offer higher returns and are still relatively safe. It also seems that investors do not consider seniority as an important feature for bonds with AAA-A ratings, since bonds with this feature tend to be less liquid. Bonds from the infrastructure sector show, in fact, significantly higher illiquidity costs than non-infrastructure bonds. The infrastructure sector dummy variable has almost same effect on illiquidity as adding four years to duration. Time-dependent illiquidity is assumed to be measured by the regression's intercept and show the highest contribution to total illiquidity costs of all variables.

For BBB rating:

This group includes bonds with Moody's ratings from "Baa1" to" Baa3".

Table 3 shows that for the BBB-rated bonds, only duration, amount issued and seniority dummy are significant and show relations to illiquidity costs as expected. The effect of duration on illiquidity is very similar to bonds from AAA-A group. Additionally, seniority matters for BBB bonds. There is no apparent difference in illiquidity between infrastructure and non-infrastructure bonds. But BBB rated bonds show twice lower time-dependent illiquidity (regression's intercept) than AAA-A-rated bonds.

Table 2: Determinants of illiquidity costs for AAA-A rated bonds

Independent variables	Regression coefficients	Std. Error	t value	Pr(>|t|)	
Intercept	0.1169	0.0278	4.2103	0.0001	***
D	0.0007	0.0001	7.7733	0.0000	***
Amount	-0.0129	0.0030	-4.2902	0.0001	***
Infra	0.0027	0.0006	4.5392	0.0000	***
Rating	-0.0009	0.0003	-2.9565	0.0044	*
Call	0.0009	0.0003	2.8078	0.0067	…
Sen	0.0022	0.0006	3.5857	0.0007	**
Guar	-0.0049	0.0014	-3.6021	0.0006	***

Average adjusted R squared = 18.23 %; N=199; ***- significance at < 0.05% level; ** - significance at 0.1% level;
* - significance at 0.5% level; … - significance at 1% level; .. - significance at 5% level

Table 3: Determinants of illiquidity costs for BBB rated bonds

Independent variables	Regression coefficients	Std. Error	t value	Pr(>|t|)	
Intercept	0.0477	0.0147	3.2501	0.0019	**
D	0.0010	0.0002	5.2337	0.0000	***
Amount	-0.0053	0.0023	-2.3322	0.0231	..
Infra	0.0001	0.0009	0.0616	0.9511	
Rating	0.0007	0.0005	1.4722	0.1462	
Call	0.0047	0.0025	1.8559	0.0684	
Sen	-0.0049	0.0014	-3.5386	0.0008	**
Guar	-0.0002	0.0014	-0.1666	0.8682	

Average adjusted R squared = 11.45%; N=203

Step 2: Whether infrastructure bonds have higher yields and their illiquidity is priced

For AAA-A rating:

As shown in **Table 4**, all variables show significant impact on bond's yield with exception of the call dummy variable. Market risk-free rate yield is assumed to be about 1.7 percent (intercept). Illiquidity due to market microstructure frictions (RBAS coefficient) is priced into the bond's yield and has significantly high impact on the bond's yield.[4] Illiquidity due to infrastructure sector nature is significant, but only on 5.0 percent level. Infrastructure-specific illiquidity has an effect on yield comparable to four additional years of duration. That is similar to the effect that the infrastructure sector has on total illiquidity costs. Thus, it could be said, that infrastructure-specific illiquidity is properly priced in AAA-A rated bonds.

For BBB rating:

Table 5 shows that for BBB-rated bonds only rating, amount issued and a call feature have significant impact on bond's yield. Illiquidity due to market microstructure show a contribution similar to bond yield, but is not significant. Infrastructure microstructure show a contribution similar to bond yield, but is not significant.

IV. Conclusion and discussion

The empirical analysis has shown that Eurozone infrastructure corporate bonds with Moody's ratings from "Aaa" to "A3" did in fact have higher illiquidity costs and that these illiquidity costs are appropriately priced in their yields. This is positive for institutional investors'

[4] Coefficient for RBAS (of residual bid ask spread) shows impact on yield by 1% change in RBAS. However, RBAS is usually very small, less than 0.01%

Table 4: Determinants of bond's yield for AAA-A rated bonds

Independent variable	Regression coefficients	Std. Error	t value	Pr(>|t|)	
Intercept	1.6876	0.3569	4.7284	0.0000	***
RBAS	12.8424	2.1802	5.8904	0.0000	***
D	0.0305	0.0105	2.9047	0.0051	*
Infra	0.1344	0.0647	2.0766	0.0421	..
Amount	-0.2058	0.0321	-6.4051	0.0000	***
Rating	0.0947	0.0157	6.0399	0.0000	***
Call	0.0688	0.0823	0.8360	0.4065	
Sen	0.0198	0.0218	0.9096	0.3667	***
Guar	0.2600	0.0590	4.4097	0.0000	***

Average adjusted R squared = 40.55%; N=199

Table 5: Determinants of bond's yield for BBB rated bonds

Independent variable	Regression coefficients	Std. Error	t value	Pr(>|t|)	
Intercept	2.1270	2.4120	0.8819	0.3814	
RBAS	18.8239	11.8587	1.5874	0.1177	
D	0.0433	0.0515	0.8398	0.4044	
Infra	0.0468	0.0957	0.4894	0.6263	
Amount	-0.3681	0.1825	-2.0167	0.0482	..
Rating	0.3775	0.0802	4.7092	0.0000	***
Call	0.6735	0.1730	3.8938	0.0003	***
Sen	-0.5038	0.4129	-1.2201	0.2272	
Guar	-0.1528	0.2342	-0.6525	0.5166	

Average adj. R squared = 39.16%; N=203

perspective, since they mainly invest in the best-rated bonds in the range of "Aaa" to "A3 ". Bonds with ratings from "Baa1" to "Baa3" show no infrastructure-specific illiquidity.

A further step for investors to improve their ability to "deal with illiquidity" could be regression analysis for project-bond investment. The form of regression used in this thesis could be used, with the addition of some further variables, for such analysis.

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Summary of "Market Maturity and Mispricing" Journal of Financial Economics, 122, 270-287, 2016

von Dr. Heiko Jacobs

In their marketing materials, mutual fund companies often claim that emerging markets yield better opportunities for stock picking than developed markets. However, the evidence is mixed. Some studies indeed find that active management outperforms passive management in emerging markets or is at least successful enough to cover its expenses. In contrast, other authors report that mutual funds tend to underperform traditional benchmarks, and find little to no evidence for stock picking skill, superior performance, or performance persistence in emerging markets.

With respect to more specific measures of potential mispricing, particularly studies with early sample periods tend to conclude that there could be larger inefficiencies in emerging markets. More recent results in Griffin, Kelly, and Nardari (2010) point to higher transaction costs and information costs in emerging markets, but also show that proxies for the violation of the weak form of market efficiency as well as the post-earnings-announcement drift are similar in developed and emerging markets. Other studies find that specific return phenomena even tend to be stronger in markets deemed to be more developed.

In essence, the contrasting views can be illustrated with two quotes from recent interviews: "Emerging markets are less efficient than developed markets" (Richard Thaler). There is "nothing convincing we know of" to support such an assertion (Eugene Fama). In sum, the empirical evidence is far from conclusive. In this paper, I aim to revisit this controversial debate. My findings pose a challenge to the widespread perception of necessarily stronger cross-sectional mispricing in emerging markets.

Based on the MSCI market classification, I first construct a comprehensive international stock market data set, which covers 115 million firm days between January 1994 and December 2013. I then implement the cross-sectional composite mispricing metric proposed in Stambaugh, Yu, and Yuan (2015). Their methodological innovation is to condense the information contained in 11 well-established or recently proposed anomalies in an aggregate mispricing score for each stock month. Stambaugh, Yu, and Yuan (2015) show that both the alpha and the associated t-statistic are much higher in their U.S. sample when sorting on the mispricing score as opposed to averaging the estimates for the individual anomalies. In other words, the approach appears to capture inefficiencies particularly well.

I find strong evidence for mispricing around the globe, with point estimates exceeding U.S. estimates for about a third of the 45 developed and emerging markets considered in the baseline analysis. For the average country and based on long/short mispricing quintiles, the equally weighted (value weighted) alpha in local currency relative to a country-specific Fama and French (1993) three-factor model is about 107 (84) bp per month over the 1994 to 2013 period. Notably, mispricing associated with the 11 Stambaugh, Yu, and Yuan (2015) anomalies appears to be at least as prevalent in developed markets as in emerging markets. In fact, the alpha difference between developed and emerging markets tends to be positive, and it is often statistically significant and economically meaningful. This key finding is robust.

All anomalies underlying the mispricing score as well as the return predictive power of the score itself were originally documented in the U.S. stock market. In this context, my key finding could be driven by two different aspects of data mining, broadly defined. First, statistical biases could have inflated the historical magnitude of seemingly anomalous returns in the U.S. stock market. However, many countries produce larger long/short spreads, and my results also hold after the exclusion of the U.S. as well as in post-publication years of anomalies. These findings suggest that data snooping is not a major issue. Second, and more relevant for my purpose, the academic effort of identifying variables that reliably predict differences in cross-sectional average returns has been mainly concentrated on developed markets so far. For instance, Harvey, Liu, and Zhu (2016, p.5) document that there are "hundreds of papers and factors" focusing solely on the U.S. market. In contrast, emerging markets appear to be "comparatively under-researched" (Fidelity (2014, p. 7)). This asymmetric attention likely has led to a better understanding of which factors truly have predictive power for returns in more mature stock markets, and the Stambaugh, Yu, and Yuan (2015) mispricing score could be partly based on such variables. It is thus important to stress that my results are subject to the caveat that

mispricing in emerging markets could be associated with other anomalies, perhaps yet undiscovered.

Furthermore, comparing the relative degree of Stambaugh, Yu, and Yuan (2015) mispricing across markets is challenging as the level and the cost of information production are hard to measure (e.g., Griffin, Kelly, and Nardari (2010)). While by no means conclusive, my attempts to better understand and interpret the findings continue to support the insights from the baseline analysis.

Most notably, I explore the predictability of the market reaction around earnings announcements as well as of sell-side analysts' forecast errors. Engelberg, McLean, and Pontiff (2015) perform a similar analysis for a broad range of cross-sectional return phenomena in the U.S. market. They conclude that the return predictability is the result of mispricing caused by biased beliefs, which are partly corrected upon news arrival. My findings extent these insights to an international level. In line with the idea of biased cash flow expectations, Stambaugh, Yu, and Yuan (2015) spreads around the globe are particularly large surrounding earnings announcements. Differences between developed and emerging markets are consistent with the hypothesis that the cross-country differences in average long/short spreads are driven by different degrees of mispricing associated with the underlying anomalies.

In addition, I exploit within-country variation in market development in two distinct settings. First, I analyze the consequences of MSCI market reclassification. If anything, the findings suggest that relative mispricing increases in countries that have been upgraded to developed markets. Second, I analyze sudden changes in the information environment caused by mandatory International Financial Reporting Standards (IFRS) adoption. Difference-in-differences estimates provide only weak evidence that this shock systematically affects mispricing. Finally, panel regressions indicate that mispricing is positively related to firm specific return variation, to trading activity, and, to a lesser extent, to analyst forecast dispersion. These results appear to be consistent with noise trader-based interpretations of these variables.

My findings add to several streams of the literature. First, they provide novel insights into the price discovery process in emerging markets. Even though these countries are still widely neglected in the literature, they are economically highly important. For instance, based on the 2014 World Economic Outlook of the International Monetary Fund, MSCI emerging markets account for about 1/3 of the world's GDP measured in current USD. Firms in emerging markets also account for more than 14% of the 2014 Financial Times Global 500, which is a snapshot of the world's largest companies by market capitalization. Finally, based on the most recent data available from the World Bank (as of 2012), emerging markets represent ten of the 25 countries with the largest stock market capitalization.

Second, I am the first to study the Stambaugh, Yu, and Yuan (2015) mispricing measure outside the U.S. stock market. I thereby extend the growing literature which tests for the existence and potential drivers of individual cross-sectional return phenomena (but not of a composite measure of mispricing) in an international setting. A comprehensive international analysis can enrich or challenge our understanding of price formation. For instance, out-of-sample tests help to assess to what extent seemingly abnormal returns are robust and whether they are driven by the same factors as in the original sample.

Third, my analysis may offer industry professionals insights into ways to optimize their investment process. For instance, my findings, coupled with the assumption of higher transaction costs in emerging markets, suggest that popular trading strategies tend to be more profitable in developed markets. These results also provide a partial explanation for why the mutual fund literature surprisingly often finds that active management in emerging markets is not more successful than in developed markets.
Fourth, my work contributes to the emerging literature that aims at understanding the "big picture" of anomalies. This work explores, among others, the role of publication effects, statistical dependencies, investor sentiment, or limits to arbitrage for the magnitude of anomalies in the cross-section or the time-series of (exclusively) U.S. stocks. I add to this literature by investigating the role of financial market development by exploiting cross-country and within-country variation in a large international sample.

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Empirical Studies on Asset Management: Multi Asset Portfolio Optimization, Return Prediction Models and Fixed Income Hedging Strategies

von Dr. Dominik Wolff

Die kumulative Dissertation befasst sich theoretisch und empirisch mit den folgenden verschiedenen Bereichen des Asset Managements: Portfoliooptimierung, Prognosemodelle von Aktienrenditen, Anlage in Alternative Investments, insbesondere in Commodities, sowie mit dem Management von Bondportfolios während der Finanzkrise, insbesondere dem Hedging mit Derivaten. Vier der Beiträge wurden bereits in führenden internationalen Journals publiziert (Journal of Banking and Finance, European Journal of Finance, Journal of International Financial Markets, Institutions and Money, International Review of Financial Analysis). Ein weiterer Beitrag befindet sich noch in Vorbereitung zur Publikation in einem internationalen Journal. Ein zusammenfassender Beitrag mit besonderer Praxisorientierung wurde im Absolut Report veröffentlicht.

Im Folgenden werden die Inhalte und Forschungsbeiträge der einzelnen Artikel kurz zusammengefasst.

1. Multi-Asset Portfolio Optimization and Out-of-Sample Performance: An Evaluation of Black-Litterman, Mean-Variance and Naïve Diversification Approaches, Koautoren: Wolfgang Bessler, Heiko Opfer; European Journal of Finance, 2016 (im Druck).

Diese Studie untersucht die Vorteilhaftigkeit verschiedener Asset-Allokationsmodelle und analysiert empirisch deren Performance in einer umfangreichen Studie die mehrere Assetklassen beinhaltet. Berücksichtigt werden naiv-diversifizierte Portfolios (1/N und strategische Gewichtungen), die klassische Markowitz Portfoliooptimierung, Minimum-Varianz-Strategien, Shrinkage Verfahren (Bayes-Stein), sowie das Black-Litterman Verfahren. Die Verfahren werden auf ein Multi-Asset Portfolio angewendet, das die folgenden Assetklassen beinhaltet: weltweite Aktien und Anleihen sowie Rohstoffe. Der Untersuchungszeitraum umfasst die Periode von Januar 1993 bis Dezember 2011. Die empirischen Ergebnisse zeigen, dass die "out-of-sample" Performance des Black-Litterman Ansatzes den anderen untersuchten Verfahren überlegen ist. Verglichen mit den anderen Asset Allokationsmodellen ergeben sich signifikant höhere risikoadjustierte Renditen, gemessen anhand der Sharpe Ratio oder des Omega Maßes. Weiterhin weisen die mit dem Black-Litterman Ansatz optimierten Portfolios ein geringeres Risiko (Volatilität und Tail-Risiken) sowie weniger extreme Asset Allokationen und Umschichtungen auf. Außerdem sind die Black-Litterman optimierten Portfolios breiter über die verschiedenen Asset-Klassen gestreut und haben somit einen höheren Diversifikationsgrad als Markowitz (Mean-Variance) optimierte Portfolios. Der Beitrag wurde im "European Journal of Finance" veröffentlicht.

2. Do Commodities add Value in Multi-Asset Portfolios? An Out-of-Sample Analysis for different Investment Strategies, Koautor: Wolfgang Bessler, Journal of Banking and Finance, 2015, 60, 1-20.

Der zweite Beitrag erweitert die erste Studie indem er untersucht, inwieweit die Portfolio-Allokationen durch die zusätzliche Berücksichtigung alternativer Investments wie Rohstoffe verbessert werden können. Insbesondere werden zwei Forschungsfragen genauer untersucht: Kann die zusätzliche Anlage in Rohstoffen das Rendite-Risiko-Verhältnis von Portfolios bestehend aus Aktien und Anleihen signifikant verbessern und ist diese Verbesserung auch dann möglich, wenn man aus ethischen Gründen auf die Anlage in Lebensmittel (Vieh- und Agrarprodukte) verzichtet. Es werden "in-sample“ und „out-of-sample" Portfolio-Effekte untersucht. Dazu werden verschiedene Asset Allokations- und Optimierungsverfahren verglichen. Diese beinhalten: gleichgewichtete und strategisch gewichtete Portfolios, Risiko-paritätisch gewichtete Portfolios, die klassische Markowitz Portfoliooptimierung (Mean-Variance), Minimum-Varianz-Portfolios, Reward-to-Risk Timing, sowie das Black-Litterman Verfahren.

Die empirischen Analysen deuten eindeutig darauf hin, dass eine Anlage in Lebensmitteln (Vieh- und Agrarprodukte) nicht erforderlich ist, um effiziente Portfolios zu konstruieren. Andere Rohstoffe sind dagegen sehr hilfreich, um das Rendite-Risiko-Profil klassischer Aktien-Anleihen Portfolios zu verbessern. Die Ergebnisse sind für verschiedene Portfolio-Konstruktionsverfahren und für verschiedene Sub-Perioden robust. Der Artikel wurde inzwischen im "Journal of Banking and Finance" veröffentlicht. Ein Artikel mit besonderer Fokus auf die Anwendung in der Praxis, der an die ersten beiden Studien angelehnt ist, erschien im Absolut Report.

Darin werden die Kernergebnisse der ersten beiden Studien anhand eines anderen Datensatzes bestätigt.

3. Portfolio Optimization with Return Prediction Models: Evidence for Industry Portfolios, Koautor: Wolfgang Bessler, 2016

In dieser Studie werden Modelle für die Renditeprognose von US-Industrieindizes entwickelt und deren Prognosegüte sowie deren ökonomischer Nutzen für Anleger untersucht. Die Prognosemodelle berücksichtigen fundamentale, makroökonomische und technische Indikatoren. Zunächst wird die Prognosegüte der Indikatoren individuell und nach den drei Gruppen „fundamental", „makroökonomisch" und „technisch", "in-sample" und "out-of-sample" analysiert. Es zeigt sich, dass für Industrieprognosen die Gruppe der makroökonomischen Kennzahlen die wichtigsten Indikatoren für Renditeprognosen darstellen. Im zweiten Teil werden alle Indikatoren in multivariaten Modellen aggregiert untersucht. Hierfür werden eine Reihe etablierter und neuerer statistischer Verfahren verwendet: Darunter gewöhnliche multivariate Regressionen (OLS), ein Verfahren zur Variablenselektion und Modellschrumpfung (LASSO), ein Modell zur Informationsverdichtung (Principal Component Regression), ein dreistufiger Regressionsfilter („target relevant latent factor approach"), und kombinierte Prognosemodelle („forecast combinations"). Der ökonomische Nutzen dieser Renditeprognosen für Investoren wird "out-of-sample" in Portfolio-Allokationsentscheidungen untersucht. Die Ergebnisse deuten eindeutig darauf hin, dass eine Asset Allokation, die auf statistischen Prognosemodellen basiert, zu einer signifikanten Outperformance im Vergleich zu passiven Strategien (ETF) führt und zudem ein besseres Rendite-Risiko Profil aufweist als ein optimiertes Portfolio, das lediglich historische mittlere Renditen als Renditeschätzer verwendet. Des Weiteren zeigt sich, dass unter den untersuchten Verfahren der dreistufige Regressionsfilter die höchsten risikoadjustierten Renditen erzielt.

4. Hedging European Government Bond Portfolios during the Recent Debt Crisis, Koautor: Wolfgang Bessler, Journal of International Financial Markets, Institutions & Money, 2014, 33, 379-399.

Der zweite große aktuelle Themenbereich, mit der sich die Dissertation befasst, ist das Risikomanagement von Bond-Portfolios während der Staatsschuldenkrise in Europa und insbesondere die Absicherung der damit verbundenen Risiken mit Derivaten. Die Finanzkrise führte dazu, dass die Spreads der Staatsanleihen entsprechend dem Ausfallrisiko der Länder sich ausweiteten und somit eine Risikoreduzierung durch Futures-Kontrakten auf deutsche Staatsanleihen (Bund, Bobl, Schatz) kaum noch möglich war. Bemerkenswert ist, dass sich nach der Euro-Einführung die Spreads zwischen den Renditen der Staatsanleihen verschiedener Länder fast auf null reduzierten, sodass sich der Handel in Derivaten auf deutsche Staatsanleihen konzentrierte und der Handel anderer Kontrakte in Europa eingestellt wurde. In der Krise führte die Deutsche Terminbörse "Eurex" dann neue Futures-Kontrakte auf Staatsanleihen von Italien (BTP), Frankreich (OAT) und schließlich im Oktober 2015 auf Staatsanleihen von Spanien wieder ein.

Diese Studie untersucht, inwieweit und mit welchem Ansatz zur Bestimmung der optimalen Hedge Ratio eine effiziente Absicherung (Hedging-Effizienz) möglich ist. In dieser Studie werden der Portfolio-Ansatz sowie das Duration-Verfahren in einfacher und erweiterter Form angewendet. Die Ergebnisse zeigen zunächst sehr deutlich, dass vor der Finanzkrise eine Absicherung mit Futures-Kontrakten auf deutsche Staatsanleihen mit allen drei Verfahren zur Ermittlung der optimalen Hedge Ratio sehr gut möglich war, dass aber während der Finanzkrise die historischen Zusammenhänge nicht mehr Bestand hatten. Die Hedging-Effizienz ging gegen null. Nur durch die Einführung des BTP (Italien) und später des OAT (Frankreich), konnten die Investoren die Risiken wieder einigermaßen managen. Eine interessante Fragestellung, die untersucht wird, ist, ob man das Bondportfolio in 3 Laufzeit- und 2 Bonitätsrisikogruppen aufteilen sollte, um dann jedes der 6 Teil-Portfolios mit dem entsprechenden der 6 verfügbaren Futures-Kontrakte absichern sollte. Die Ergebnisse deuten darauf hin, dass diese Strategie vorteilhaft gegenüber dem aggregierten Hedging des Gesamtportfolios gewesen wäre. Der Artikel wurde inzwischen im "Journal of International Financial Markets, Institutions & Money" publiziert.

5. Analyzing Hedging Strategies for Fixed Income Portfolios: A Bayesian Approach for Model Selection, Koautoren: Wolfgang Bessler, Alexander Leonhardt, International Review of Financial Analysis, 2016, 46, 239-256.

In Erweiterung der vorigen Studie wird untersucht, inwieweit eine Verbesserung der Hedging Effizienz während der Finanzkrise dadurch zu erzielen gewesen wäre, dass man entweder erheblich anspruchsvollere und komplexere mathematische Hedging-Verfahren verwendet hätte oder dadurch, dass zeitnäher neue Kontrakte eingeführt worden wären. Diese Frage ist von allgemeiner Bedeutung nicht nur für die Finanzkrise, sondern auch für andere Situationen mit Schock-Charakter. In diesem Umfeld mit stark erhöhter Unsicherheit mögen bedingte Volatilitätsmodelle wie GARCH Modelle besser für das Hedging geeignet sein als einfachere Modelle wie der Minimum-Varianz Ansatz oder der Duration Ansatz. In der Studie werden simple und komplexere Heging-Stratgien für das Hedging von EMU-Bond-Portfolios mit dem Bund und den italienischen BTP Futures sowohl in der Vorkrisen- als auch in der Krisenperiode untersucht. Wie in den anderen Studien erfolgt die Analyse "out-of-sample". Die berücksichtigten Verfahren beinhalten OLS und multivariate GARCH Modelle (Constant Conditional Correlation und Dynamic Conditional Correlation). Zudem wird eine Bayesianische Hedging Strategie entwickelt, die das Ziel hat, die Vorteile von OLS und multivariaten GARCH Modellen zu kombinieren. Hierdurch soll das Dilemma, im Zeitablauf immer wieder das beste Modell selbst auswählen zu müssen, endogenisiert. Die empirischen Ergebnisse deuten darauf hin, dass mit dem Bayesianischen Ansatz die höchste Hedging Effizienz erzielt werden kann. Das gilt aber nur dann, wenn auch die Transaktionskosten eine bestimmte Höhe nicht übersteigen und die Terminmärkte effizient organisiert sind. Von daher deutet die Studie auch darauf hin, dass eine Transaktionssteuer dazu führen kann, dass hierdurch weniger anspruchsvolle aber kostengünstigere Verfahren zum Hedging eingesetzt werden würden, was wiederum zu einer geringeren Risikoreduzierung führt.

Damit eröffnet diese Studie weitere interessante Erkenntnisse und neue Einsichten, die weit über die der vorherigen Studie hinausgehen. Der Beitrag wurde mittlerweile im "International Review of Financial Analysis" publiziert.

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Introduction

The term "infrastructure" refers to the backbone of each economy, which provides the basic goods and services to society, in order to promote economic and social welfare and development. Accordingly, infrastructure is typically defined in terms of the respective industrial sectors involved in the provision of these key essential services for the community. Specifically, infrastructure can be divided into economic and social. Whereas economic infrastructure includes the transportation, utilities and telecommunications sectors, social infrastructure typically comprises the health and educational sectors (Weber and Alfen, 2010). Due to factors such as climate change, growth, technological process and urbanization, the worldwide demand for new infrastructure is expected to expand significantly over the next few decades. Additionally, the existing infrastructure in countries of the Organization for Economic Co-operation and Development (OECD) is aging rapidly and therefore needs to be renewed, upgraded or maintained. Numerous studies attempt to quantify these future investment needs on a global basis. For instance, the OECD estimates approximately $71.1 trillion infrastructure investment demands by 2030 (OECD, 2006; OECD, 2007). More recently, the OECD even raised the number to $82.2 trillion (OECD, 2012), which corresponds to annual investment needs of nearly $3 trillion.

The mismatch between investment needs and financial resources is widely known as the "infrastructure gap" (Inderst, 2013). A study from the World Economic Forum (WEF) comes to the conclusion that the yearly global investment gap will amount to about $1 trillion (WEF, 2012). Needless to say, such large-scale investments cannot be financed solely by the public sector in times of constrained governmental budgets. Therefore, private capital may play a major role in addressing this issue, either in the form of corporate finance (operating infrastructure companies) or project finance (contractual financing arrangements) (Weber and Alfen, 2010). As a result, a new asset class labeled "infrastructure" has emerged in the financial markets and found its way into the portfolios of institutional investors in recent years, above all in those of insurance companies and pension funds. From a regional perspective, especially Australian and Canadian pension funds play a pioneering role in this field, with some of them allocating almost 10% of their assets to infrastructure (Croce, 2011).

Yet, there is a remarkable lack of academic research on infrastructure investments. However, more research would enhance the general understanding of this new asset class and thereby catalyze investment activity. To date, investors have to rely on almost only qualitative information concerning the attributes of infrastructure investments. The literature typically associates infrastructure investments with certain characteristics, such as an attractive risk/return profile, low correlation with the broader economy and other asset classes, diversification benefits, stable and predictable long-term cash flows with a good inflation hedge and low default rates (Inderst, 2013; Dechant et al., 2010). However, very few of these alleged features have yet been quantified and empirically examined. Accordingly, this dissertation aims at partially filling this very relevant research gap, thereby contributing to the emerging research stream on infrastructure investments. The dissertation consists of three papers and examines the inflation hedge characteristics, portfolio diversification benefits, as well as risk and return profile of listed infrastructure investments.

PAPER 1: INFLATION HEDGING AND PROTECTION CHARACTERISTICS OF INFRASTRUCTURE AND REAL ESTATE ASSETS

The first paper investigates the short-term and long-term inflation-hedging characteristics of direct and listed infrastructure investments. In addition, common direct and listed real estate indices are included in the study, so as to allow for a comparison between the two supposedly closely related asset classes. There is a common belief that both, infrastructure and real estate investments offer attractive inflation-hedging characteristics for investors, which stems from the fact that both assets are seen as real assets, and the corresponding cash flows are mostly contractually linked to inflation.

While most other studies make only general comments on the influence of inflation on infrastructure assets, this paper highlights the significance of a detailed

sector-specific analysis. In general, the inflation- hedging capacity is dependent on the revenue-scheme (regulation by contract or agency), the pass-through mechanism of operating costs, the replacement value of existing assets and specific capital structure that might erode inflation-hedging. It is evident that only few studies to date focus on (direct) infrastructure and inflation, thus emphasizing the significance of the given study.

To empirically analyze the short-term and long-term relationship with inflation, the paper investigates the US market, based on quarterly total-return data spanning the period from Q1 1991 to Q1 2013. With help of a unique direct infrastructure performance index, provided by the Center of Private Equity Research (CEPRES), this is the first paper to answer this research question. The traditional Fama and Schwert (1977) methodology is used to assess the short-term inflation hedge, and Engle and Granger (1987) co-integration tests are conducted to analyze the relationship in the long-run. Furthermore, Granger causality tests allow for insights into the short-run dynamics. Ultimately, different shortfall risk measures are calculated to analyze the inflation protection characteristics in terms of a positive real return for different given investment holding periods.

The results suggest that direct infrastructure is the only asset exhibiting a (partial) short-term inflation hedge. In the long-run, all assets included in the study reveal a relationship with inflation. However, the causality tests indicate that inflation Granger-causes real estate, whereas infrastructure seems to Granger-cause inflation. Regarding the inflation protection, direct infrastructure investments offer the best inflation protection among all assets in the sample period (see Table 1). The practical implications are straightforward. Investors seeking assets that are sensitive to inflation and mitigate inflation risk should consider direct infrastructure investments in their asset allocation strategy. This result extends the empirical findings that direct infrastructure investments should be included in investor's portfolios in order to enhance diversification. Moreover, both real estate and

Table 1: Shortfall Risk Measures

Investment Period in Years		*1*	*2*	*3*	*4*	*5*	*10*	*15*	*22*
Direct Infrastructure	Return	-1.84%	3.84%	9.77%	15.71%	21.64%	50.13%	79.85%	117.04%
	SP	77.27%	14.29%	5.00%	-	-	-	-	-
	MEL	2.61%	2.70%	0.67%	-	-	-	-	-
	SE	2.02%	0.39%	0.03%	-	-	-	-	-
Listed Infrastructure	Return	5.75%	10.93%	15.61%	19.93%	24.79%	47.37%	77.00%	126.51%
	SP	22.73%	28.57%	35.00%	26.32%	16.67%	7.69%		-
	MEL	26.05%	22.26%	15.97%	14.45%	18.57%	0.97%	-	-
	SE	5.92%	6.36%	5.59%	3.80%	3.09%	0.07%	-	-
Direct Real Estate	Return	-0.29%	6.11%	13.43%	20.48%	28.92%	70.76%	110.60%	119.57%
	SP	45.45%	23.81%	20.00%	21.05%	16.67%	-	-	-
	MEL	8.78%	20.28%	20.78%	14.83%	8.93%	-	-	-
	SE	3.99%	4.83%	4.16%	3.12%	1.49%	-	-	-
Listed Real Estate	Return	10.99%	20.44%	29.61%	37.65%	44.34%	96.09%	138.37%	241.80%
	SP	22.73%	19.05%	25.00%	15.79%	16.67%	-	-	-
	MEL	22.42%	34.47%	23.54%	30.52%	17.79%	-	-	-
	SE	5.10%	6.57%	5.88%	4.82%	2.97%	-	-	-

Notes: Return = Average cumulative Return, SP = Shortfall Probability, MEL = Mean Expected Loss, SE = Shortfall Expectation.

infrastructure assets are able to hedge inflation in the long-run, which is particularly of interest for investors with a long-term investment horizon. As the causality tests reveal, a viable strategy might be to invest in infrastructure assets in order to assess inflation risk, as they are a factor producing inflation. Ultimately, direct infrastructure and real estate investments deliver stable (real) returns that ensure purchasing power after only a few years of investment. Moreover, the extent of loss is the lowest for direct infrastructure returns over the whole sample period. This holds despite several market downturns in the last twenty years of observation, emphasizing its potential role as a portfolio stabilizer for investors.

PAPER 2: SOLVENCY II AND PORTFOLIO EFFICIENCY - THE CASE OF INFRASTRUCTURE AND REAL ESTATE INVESTMENTS

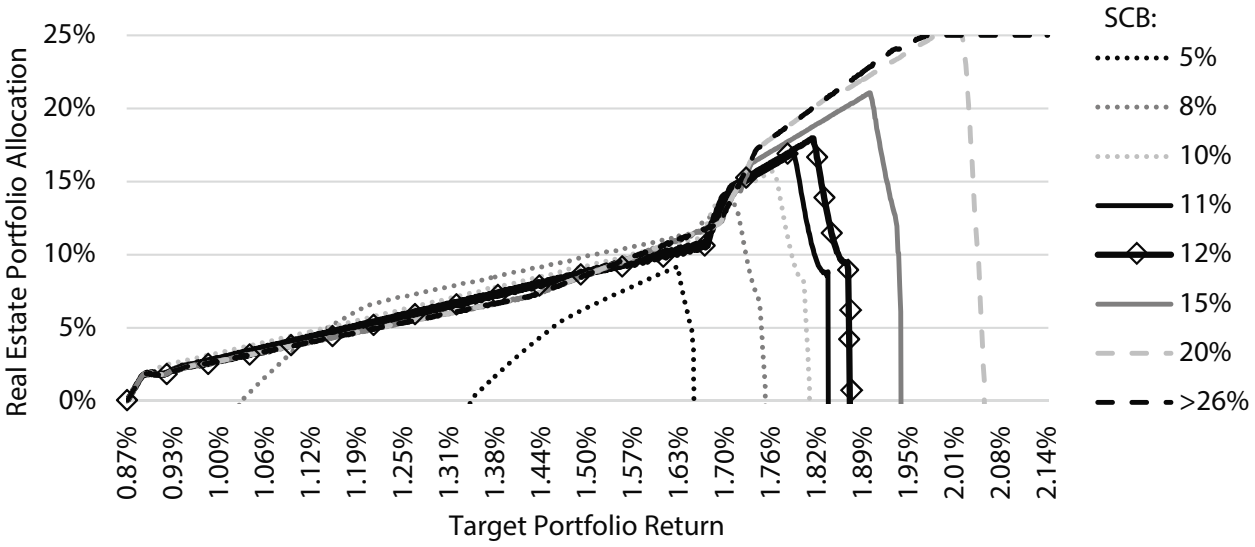
The second paper of the dissertation investigates the potential effects of the Solvency II Directive on the portfolio efficiency and asset allocation of institutional investors. Specifically, the focus lies on the potential shift of real estate and infrastructure allocation within the mixed asset portfolio of a representative European insurance company. These alternative assets have been attracting more and more interest in the past few years, as investors seek high risk-adjusted returns in the current structural low interest rate environment. However, Solvency II introduces a new risk-based model for deriving the capital requirements of an insurer in dependency on the specific portfolio structure. As real estate and infrastructure assets are heavily penalized by the standard formula of the Solvency II Directive, the abovementioned development might well be hampered, as insurance companies may be forced to minimize the capital requirements by means of their asset allocation.

The empirical study covers the period from Q1 1993 to Q4 2014, using European total return data retrieved from Thomson Reuters Datastream and conducts different portfolio optimizations with the following set of assets: direct real estate, direct infrastructure, government bonds, corporate bonds, stocks and money market instruments. The special feature of the study is the first use of a performance index for direct infrastructure investments in Europe, which is again provided by CEPRES. Firstly, Markotwitz (1952) portfolio optimizations are used to derive the efficient portfolio with respect to portfolio risk. Next, the empirical covariance matrix is replaced with the regulatory correlation matrix imposed by Solvency II, in order to calculate efficient portfolios with regard to capital requirements (SCR). Thirdly, both optimizations are blended, in order to derive optimal portfolios with respect to portfolio risk, given certain capital constraints (SCB).

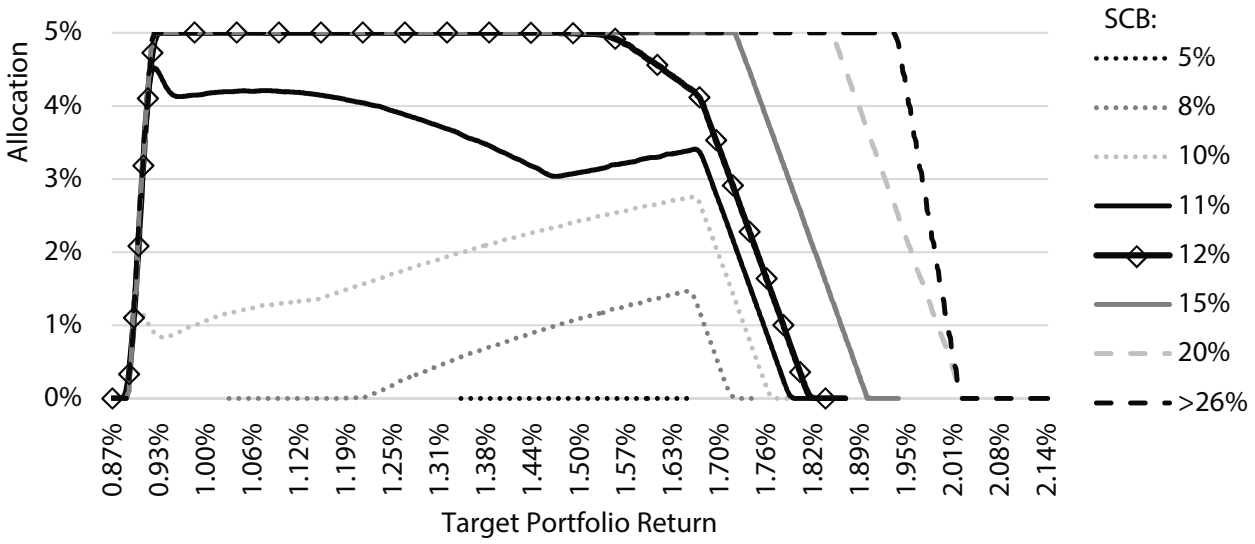
The results confirm the current investment trends; real estate and infrastructure investments should play a significant role in the mixed asset portfolio of a representative European insurance company, when the aim of the optimization is to minimize portfolio standard deviation. By contrast, in capital-efficient optimizations, for which the aim of the optimization is to minimize the overall SCR, infrastructure is completely removed from the portfolios over the whole spectrum of target returns and real estate weights are reduced substantially. However, accounting for the actual (not minimum) capitalization of European insurers again yields a different picture. As shown in Figure 1, although the calibration of the capital requirements for alternative assets are obviously inadequate in terms of the risk and SCR relationship, real estate as well as infrastructure investments are still allocated in the risk optimal portfolios, even if realistic capital budgets (SCB) are considered. In the case of well-capitalized insurance companies, the derived optimal portfolio weights even exceed the observable allocations in practice, which indicates that Solvency II is not likely to affect the investment policy with respect to real estate and infrastructure assets. As a consequence, if at all, only small and undercapitalized insurers may be forced to reduce their exposure to alternative investments. Hence, this paper hopefully helps to evaluate the potential effects of Solvency II on a more meaningful basis than in the current and ongoing debates prevailing both in academia and practice. In addition, the paper offers further explanations of the disparity between theoretical optimal and actual alternative asset allocation in practice.

Figure 1: Optimal Real Estate and Infrastructure Po rtfolio Allocation for Different Levels of Solvency Capital Budget (SCB)

(a) Real Estate:



(b) Infrastructure:



Notes: Figure 1 illustrates the STD optimal portfol io weights for real estate and infrastructure asset s for different given levels of Solvency Capital Budget. The marked line thus represents the average capitalization of European insurers (12%).

PAPER 3: CAN COMMON RISK FACTORS EXPLAIN INFRASTRUCTURE EQUITY RETURNS? EVIDENCE FROM EUROPEAN CAPITAL MARKETS

The third and final paper of this dissertation tests the ability of conventional asset pricing models to explain shared variation in the returns of listed infrastructure companies. While there is already a modest number of studies with a focus on the pricing of US and Australian infrastructure stocks (e.g. Bird et al., 2014; Ammar and Eling, 2015), no study has yet examined the European market. This is surprising, given the fact that the European infrastructure market is by far the largest by volume and most active by number of deals.

Generally, the literature on infrastructure asset pricing can be divided into two separate research streams. Whereas the one focuses on infrastructure sub-sectors, such as oil and gas companies, the second and more recent research stream focuses on infrastructure companies in general. These studies adopt the definition of economic infrastructure and subsume utilities, telecommunications and transportation firms. In line with this definition, the present paper builds on an individually created infrastructure equity data set, using an intensive screening process. In the course of this process, only those infrastructure companies that truly own and/or operate physical infrastructure remain in the final sample. In total, the data sample consists of 285 infrastructure companies located in 16 European countries.

The empirical analysis covers the period from June 1992 to July 2014, thus yielding 264 monthly observations. The paper employs the widely-used Fama and French (1993) three-factor model, including the stock market risk factors related to market, size and BE/ME. The three-factor model is augmented by two additional bond market risk factors, namely term and default risk, since infrastructure companies might be strongly related to bond markets, given the relatively high leverage ratios. The results reveal that the three-factor model fails to sufficiently explain the excess returns, although all risk factors show significant factor loadings. However, the additional bond market factors enhance the model quality and prove to be further factors in pricing European infrastructure firms, even after taking the stock market risk factors into account. Hence, infrastructure stocks seem to be sensitive to changes in interest rates (see Table 2).

However, even the augmented asset pricing model is not sufficient to explain the excess returns of infrastructure firms. This might be mainly due to specific infrastructure investment characteristics. Firstly, infrastructure returns are typically regulatorily capped, so that the return distribution is somehow different from general stocks, which might hinder the application of traditional pricing models. Secondly, infrastructure companies are particularly exposed to a high level of idiosyncratic risk, hence leaving a substantial part of the variance unexplained. The results should be very helpful for investors and portfolio managers, whose aim is to construct a diversified portfolio, as the factor loadings help to evaluate the exposure to stock market risk factors. More importantly, the results show that bond risk factors need to be accounted for in asset pricing models, in order to derive the cost of capital more precisely. Nevertheless, investors need to be aware that not all variance can be explained by the risk factors, so that part of the raw returns cannot be attributed to specific risk factors. Hence, outperformance of infrastructure stocks might be only a compensation for taking unknown risks. Besides investors, the results are also of great interest for policy makers, especially in the light of increasing privatizations and PPPs. The asset pricing models can help to evaluate PPPs in a more meaningful manner. The Australian government, for instance, employs the concepts of the Capital Asset Pricing Model (CAPM) in order to financially evaluate PPPs.

FINAL REMARKS AND FURTHER RESEARCH

In summary, the three articles within the dissertation provide valuable empirical evidence on infrastructure-specific issues, thereby contributing to the emerging research stream on infrastructure investments within the general finance literature. It is shown that direct infrastructure indeed represents a good inflation-hedging asset and should therefore be acknowledged by institutional investors. Moreover, the thesis reveals that the common concerns of the infrastructure and real estate industry with regard to Solvency II have become irrelevant. The results of the second paper underline that a significant shift or change

Table 2: Time-series regression results on six infrastructure test portfolios for stock market and bond market risk factors

	Infrastructure Portfolios					
	S/H	S/M	S/L	B/H	B/M	B/L
Stock Market and Bond Market Risk Factors						
Intercept	0.002	0.000	-0.003	0.003	0.004**	0.003*
	(1.50)	(0.28)	(-1.57)	(1.51)	(2.37)	(1.86)
$R_M - R_f$	0.394***	0.476***	0.469***	0.572***	0.581***	0.609***
	(14.48)	(12.57)	(10.62)	(14.65)	(15.12)	(16.14)
SMB	0.390***	0.394***	0.316***	-0.11	-0.058	-0.079
	(6.84)	(5.97)	(4.68)	(-1.35)	(-0.73)	(-0.92)
HML	0.232***	0.113*	0.062	0.182**	-0.122*	-0.392***
	(4.49)	(1.93)	(0.94)	(2.46)	(-1.67)	(-4.31)
TERM	0.050	0.096	0.084	0.197**	0.258***	0.202**
	(0.72)	(1.08)	(0.91)	(1.97)	(2.62)	(2.18)
DEF	-0.320***	-0.189	-0.093	-0.528***	-0.380***	-0.462***
	(-3.13)	(-1.27)	(-0.58)	(-3.60)	(-2.63)	(-3.24)
Observations	264	264	264	264	264	264
F-Statistic	54.84	32.97	27.56	54.42	51.61	58.79
Adjusted R^2	0.51	0.54	0.51	0.50	0.49	0.56
GRS	2.62					
p(GRS)	0.018					

Notes: *, ** and *** denote coefficients with statistical significance at 10, 5 and 1 percent levels; this table reports the time-series regression results for the Fama and French three-factor model augmented by two bond risk factors for the six infrastructure test portfolios; the regression is run for the period July 1992 (m=1) to June 2014 (m=264); t-statistics are in parentheses and, if necessary, adjusted for heteroskedasticity and serial correlation using White (1980) HC3 or Newey-West (1987) standard errors; GRS is the F-statistic of Gibbons et al. (1989); p(GRS) is the p-value of GRS and is reported in the last row of the table.

in the investment patterns of institutional investors concerning real asset allocation should not be expected. Ultimately, this thesis also provides evidence on the listed infrastructure market and presents some first insights into the pricing of European listed infrastructure firms, illustrating a unique risk and return profile.

Nevertheless, the findings also raise further questions which could be accounted for in future research. First of all, the inflation-hedging attributes of infrastructure investments could be analyzed within a macro-economic framework, in order to analyze the relationship between infrastructure returns and the general economy. Moreover, recent studies link the inflation-hedging analysis to traditional asset allocation analysis, thus evaluating the relationship to inflation within the mixed asset portfolio of an investor. With regard to the second paper, there are also comparable regulatory models for US insurance companies or pension plans, according to which the individual capital requirements have to be determined. The suggested methodology could easily be adapted as to extend the significance of the results to other types institutional investors or regions. Ultimately, the third paper also opens up many avenues for further research. Most importantly, one could identify further risk factors that are infrastructure-specific and may therefore be able

to explain most of the variation in returns. In addition, with help of the large infrastructure dataset, many other research questions could be handled. For instance, using the dividend payments of all European infrastructure firms as a proxy, one could examine whether infrastructure investments indeed deliver stable cash flows.

All in all, it is noticeable that the development of infrastructure research closely resembles the development of real estate research. Likewise, for real estate, no generally accepted benchmark for direct investments was available in the early years of real estate research. This dissertation was (in part) only accomplished, thanks to a novel dataset from the Center of Private Equity Research (CEPRES), which was the first to establish a performance index for direct infrastructure. However, this index is not freely available, thus limiting extensive academic use. In real estate research, among other reasons, the data quality has started to significantly improve with the establishment of acknowledged organizations and data providers, such as the National Council of Real Estate Investment Fiduciaries (NCREIF) or the Investment Property Databank (IPD), thus catalyzing independent real estate research. Interestingly, it is IPD (now part of MSCI) that has recently launched a global quarterly infrastructure index tracking the investment performance of direct infrastructure. Hence, this new index could represent a new starting point for academics and thereby a driving force for infrastructure research. Also, the empirical studies available to date could now be validated using an alternative data source. Nevertheless, given the heterogeneous nature of infrastructure, a crucial requirement for future infrastructure research is still the availability of sector-specific data, in order identify differences between the various infrastructure sectors. Concerning the research on listed infrastructure, it would be very helpful to establish organizations similar to the real estate industry, such as the National Association of Real Estate Investments Trusts (NAREIT) or the European Public Real Estate Association (EPRA), in order to bundle data and knowledge. Given the many different industry sectors involved in the infrastructure business, this is likely to take some time. However, ongoing research might expedite this development, and it is hoped that this dissertation makes its own contribution.

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