BI

WISEflow
Europe/Oslo(CEST)
02 Jul 2023

Handelshøyskolen BI

GRA 19703 Master Thesis

Thesis Master of Science 100% - W

Predefinert informasjon

Startdato:	09-01-2023 09:00 CET	**Termin:**	202310
Sluttdato:	03-07-2023 12:00 CEST	**Vurderingsform:**	Norsk 6-trinns skala (A-F)
Eksamensform:	T		
Flowkode:	202310||11184||IN00||W||T		
Intern sensor:	(Anonymisert)		

Deltaker

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Informasjon fra deltaker

Tittel *:	Return predictability for interest rate swap spreads
Navn på veileder *:	Sven Klingler

Inneholder besvarelsen konfidensielt materiale?:	Nei	**Kan besvarelsen offentliggjøres?:**	Ja

Gruppe

Gruppenavn:	(Anonymisert)
Gruppenummer:	30
Andre medlemmer i gruppen:	

Return predictability for interest rate swap spreads

Master Thesis

by
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MSc in Business with Major in Finance

Oslo, July 2, 2023

ABSTRACT

This study seeks to discover time-series reversals in interest rate swap spread changes. We document significant abnormal returns on strategies exploiting these trends, with persistent returns across holding periods. A regression of hedge fund returns on these strategies shows some evidence of utilisation in the market.

Acknowledgements

We want to thank our supervisor, Associate Professor Sven Klinger, for pointing us in the right direction regarding the topic and for providing guidance and feedback underway. We also want to thank our fellow students for providing a forum for discussion or socialisation when needed.

Contents

Acronyms

AR Autoregressive. 1, 14, 32

BofA Bank of America. 13

CMA Conservative Minus Aggressive. 12, 23

CMS Constant Maturity Swap. 3, 10, 17, 38

CMT Constant Maturity Treasury. 3, 10, 12, 17, 39

DEF Default. 6, 12, 22–24, 26

DV01 Dollar Value of one basis point. 6, 16, 17

FX Foreign Exchange. 12, 18

GC General Collateral. 6, 11

HAC Heteroskedasticity and Autocorrelation. 24–26, 28, 46–49

HF Hedge Fund Index. 27, 28, 32, 49

HML High Minus Low. 6, 12, 22

ICE Intercontinental Exchange. 10, 13

ICR Intermediary Capital Ratio. 23, 24

ICRF Intermediary Capital Ratio Factor. 13, 23, 24, 51

IRS Interest Rate Swap. 2, 8, 10, 11, 29, 32, 36, 50

LAB Liquid Alternative Beta. 27, 28

LIBOR London Interbank Offered Rate. 3, 5, 10, 16

LTCM Long Term Capital Management. 1, 3

MKTRF Market Excess Return. 6

MSCI Morgan Stanley Capital International. 12

OTC Over-the-Counter. 29

REPO Repurchase Agreement. 3, 6, 11, 12, 16, 29, 36

RMW Robust Minus Weak. 12, 23

SARON Swiss Average Rate Overnight. 11, 12

SLR Supplementary Leverage Ratio. 4

SMB Small Minus Big. 6, 12, 22

SOFR Secured Overnight Financing Rate. 10, 11

SONIA Sterling Overnight Interbank Average. 12

SR Sharpe-Ratio. 21, 22, 29–32

SS Swap Spread. 1, 3, 8, 14–16, 18, 19, 27, 32, 50

TERM Term-Structure. 6, 12, 22–26

UMD Up Minus Down. 12, 23

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1 Introduction and Motivation

In this master thesis, we investigate the predictability and return characteristics of interest swap spread changes. We study time-series reversals similar to Moskowitz et al. (2012), who investigated time-series momentum. Using two Autoregressive (AR) models, we aim to discover patterns in daily, weekly and monthly intervals across four different markets. These markets are Japan, Switzerland, the United Kingdom and the United States. From these patterns, we aim to generate abnormal returns above common and some not-so-common risk factors that fit these returns. Our two AR models will aim to capture the difference in predictability from the size of the Swap Spread (SS) change and the sign of the SS change in the hope that this will directly translate to the returns of two weighting strategies.

The interest rate swap market is one of the largest markets in the world, with outstanding swaps of 405 Trillion USD in the latter half of 2022 ("OTC derivatives outstanding", 2023). The swap spread is the difference between the n-year swap rate and the n-year government par-bond yield (Fehle, 2003). Trading on swap spreads is often limited to the swap spread arbitrage strategy. Following the swap spread arbitrage strategy used by Long Term Capital Management (LTCM), who defaulted during the hedge fund crisis in 1998, Duarte et al. (2007) present positive average excess returns with positive skewness using the same strategy with data from 1988 to 2004. We will propose a different strategy to the Swap Spread (SS) arbitrage strategy. This strategy will use the same transactions, but the justification for engaging in the trades will differ. We will use this strategy to answer our research question:

Can interest rate swap spread changes be predicted and generate abnormal returns, and are these returns reflected in hedge fund returns?

We expect to find stronger patterns of predictability in the more frequent time intervals and that these patterns translate directly to returns in our paper portfolio. To our knowledge, no other literature has tried to do the same, making mapping risks present in such a strategy and viability a solid contribution to future research.

We find evidence of reversals across the four markets that the Interest Rate Swap (IRS) spread changes can be predicted in a large sample of maturities. This predictability used in conjuncture with a swap spread trade shows significant alpha across all markets, with the monthly data showing the weakest significance. The hedge fund comparison shows some evidence of utilisation, but further investigations must be conducted to create a clear picture. When considering the sensitivity to transaction costs, the weekly data stands out as the most viable data interval for actual implementation.

The thesis is structured as follows. Section 2 will highlight previous research on the topic. Section 3 presents our hypotheses emphasising predictability, abnormal returns, and a comparison of hedge fund returns. Section 4 describes the data used. Section 5 describes our methodology and present results; finally, section 6 concludes the thesis.

2 Literature Review

About Swap Spreads

Duarte et al. (2007) presented several fixed-income arbitrage strategies utilised by LTCM, which were revealed after the hedge fund crisis of 1998. Out of these strategies, the SS arbitrage strategy shows a way of earning a return on the difference between a Constant Maturity Treasury (CMT) and a Constant Maturity Swap (CMS) of the same maturity. The swap spread strategy has two legs: (I) Enter into a par swap and receive a fixed coupon rate CMS and pay the floating London Interbank Offered Rate (LIBOR) rate L_t. (II) Short a par treasury bond with the same maturity as the swap and invest the proceedings in a margin account earning the Repurchase Agreement (REPO) rate. The cash flows from this leg consist of paying the fixed coupon rate of the CMT and receiving the REPO rate from the margin account r_t. The two legs combined make the arbitrageur receive the fixed annuity (SS) and pay the floating spread (S_t). The strategy bets that the fixed annuity will be larger than the floating spread. The cash flows from the reverse strategy are the opposite of those above. Regarding transaction costs, they took the bid-ask spreads on actively traded Treasuries estimated by Fleming (2003) and made those more conservative. Therefore, they assumed a bid-ask spread for Treasuries of one 32nd (equal to 3.125 basis points), a bid-ask spread for swaps of one basis point and finally assumed a REPO bid-ask spread of 10 basis points.

However, this SS arbitrage strategy is not an actual arbitrage in the textbook sense as the arbitrageur is exposed to indirect default risk. If the liquidity of several major banks were to become uncertain, this would likely increase the LIBOR significantly Duarte et al. (2007). One of the main arguments for exploiting this trade is that the floating spread has historically been relatively stable.

Sun et al. (1993) state that according to swap pricing theory, the arbitrage-free rate for a generic interest rate would equal the yield on a par bond with the same maturity. That is if one would assume no default risk or transaction cost. In their data, they actually observe that this spread generally increases with maturity. They also observe that the bid-ask spread for the swaps are sensitive to the credit rating of the swap dealer, with the A-rated dealer providing a mean bid-ask spread of between 4.65 bp (4Y) and 4.77 bp (10Y) for all maturities 2Y, 3Y, 4Y, 5Y, 7Y and 10Y. The AAA dealers spread were always 10 bp across maturities for their daily data between October 1988 and April 1991.

Fehle (2003) defines swap spread as the difference between the n-year swap rate and the n-year government par-bond yield. Arbitrage arguments show that in the absence of swap default risk and market imperfections, the swap rate for a swap with a default-free reference rate should equal the default-free par-bond yield of maturity equal to the swap, implying a swap spread of zero. They found that the US dollar swap spread average was 27 bp to 44 bp for different maturities and a cross-maturity average of 36 bp between 1992 and 2000. For GBP and JPY, this ranged from 11 bp to 44 bp.

Lekkos and Milas (2004) discuss common risk factors' effect in the US and UK interest rate swap market. Using the risk factors' slope of the term structure of zero-coupon government bonds, estimates of the corporate bond spread, and the interest rate differential between the US and UK government bonds, they aimed to predict interest rate swaps in both markets. They use weekly observations from June 1991 to June 2001 and successfully capture a nonlinear relationship between these risk factors and the US and UK swap spreads. Their data also state that default risk is priced into the swap spreads in the US and the UK markets.

Boyarchenko et al. (2018) also presents the mechanics of the Treasury-swap spread trade. The costs of performing this trade are also a central part of the article, and they assume a haircut on the repo position of 2,5 per cent in their example. Further, the costs associated with the swap spread trades have changed since the enactment of the mandated clearing of interest rate swaps, which broadly went into effect in early 2014. Due to Supplementary Leverage Ratio (SLR) guidelines, the dealer costs have also changed. These costs might be passed on to clients wanting to use dealers as Futures Clearing Merchants to trade swaps. They also shed light on other factors, such as if a dealer finds a spread trade unprofitable, they are also less likely to provide leverage to their clients pursuing the same trades. Also, post-crises regulations may affect unregulated intermediaries' ability to carry out leveraged trades.

Swap Spread Predictability

Lekkos and Milas (2004) also explored the ability of factor models to predict US and UK interest rate swap spreads. The article compares the ability to predict swap spreads between two nonlinear models and two linear models. The two nonlinear models being one smooth transition vector auto-regressive (STVAR) model and one non-parametric nearest-neighbours (NN) model. The two linear models being one autoregressive (AR) model and one vector autoregressive (VAR) model. The time period used in the article is limited to weekly observations from June 1991 to June 2001 in the US and the UK markets. Each estimation uses a rolling window of 90 months, with each new window shifting one week into the future. The models are then used to forecast one week and 26 weeks into the future; the performance of each model is reported using the mean square prediction error (MSPE) value. The article concludes that nonlinear models are superior to linear models, while the data presented in the article suggested that this might not be the correct interpretation given that neither the STVAR model nor the NN model is strictly better than the VAR model or AR model across forecast periods and markets.

Chan et al. (2009) apply the class of mixture autoregressive conditional heteroscedastic (MARCH) model to 3-, 5- and 10-year swap spread series in Australia. The swap spread reflects the risk premium involved in a swap transaction instead of holding risk-free government bonds, primarily composed of the liquidity and credit risk premium. Following their methodology, we see that MARCH models work well when forecasting interest swap rates; we also notice that it might not be necessary to utilise a nonlinear model as the linear model's performance are quite accurate.

Swap Spread Return

Hanson et al. (2022) developed and tested a model where swap spreads are determined by end users' demand for and constrained intermediaries' supply of long-term interest rate swaps. Following Boyarchenko et al. (2020), they have formulated an equation on the return of the swap spread strategy. The equation consists of a carry component and a mark-to-market loss component. The carry represents the LIBOR spread, withdrawing the 3-month LIBOR and adding the

General Collateral (GC) REPO rate, all multiplied by the representative period fraction(here 1/52). Further, the mark-to-market loss consists of the Dollar Value of one basis point (DV01) for the trade, i.e. the sensitivity of the position's mark-to-market value to changes in the swap spread, multiplied with swap spread in period t+1 minus the one in t.

Momentum

The time-series momentum paper by Moskowitz et al. (2012) documents significant time-series momentum across different instrument classes. For their data, they use excess daily returns accumulated to monthly returns. They regress the returns on the lagged returns, scaled down with the instrument's volatility to make it possible to compare the results with other instruments. When testing the strategy's performance, they use multiple combinations of a lookback period and a holding period of 1 to 48 months. In their study, they found a significant time-series momentum effect that is consistent across most of the assets tested. They conclude that the dominant force for cross-sectional and time-series momentum is the security's excess return next month and the 1-year lagged return. Moskowitz et al. (2012) shows that time-series momentum is present in the market and is strictly superior to cross-sectional momentum.

Risk Factors

Fama and French (1993) studied the US market and introduced the three-factor model consisting of Market Excess Return (MKTRF), High Minus Low (HML), and Small Minus Big (SMB). They also present two bond market factors, TERM and DEF. The proxy for TERM is the difference between the monthly long-term government bond return and the one-month treasury bill rate measured at the end of the previous month. As the bill rate is meant to proxy the general level of expected returns on bonds, TERM proxies the deviation of long-term bond returns from expected returns due to shifts in interest rates. Further, for corporate bonds, shifts in economic conditions that change the likelihood of default give rise to the DEF factor. DEF is the difference between the return on a market portfolio of long-term corporate bonds and the long-term government bond return. They found that TERM and DEF resulted in much lower bond residual standard errors.

They also conclude that the five-factor regression provides the best model for returns and average returns on bonds and stocks.

Fama and French (2011) examined whether one must create regional factor models or if using international factors would be good enough. They examine four different markets, North America, Europe, Japan, and the Asia Pacific, and there is no good support for integrated pricing across regions, suggesting that one would have to make regional risk factors.

Carhart (1997) took FF (1993) 3-factor model and added the momentum factor by Jegadeesh and Titman (1993) widely used as UMD (up minus down) to create a 4-factor model. Carhart (1997) construct the momentum factor as an equally-weighted average of firms with the highest 30 per cent eleven-month returns lagged one month minus the equivalent 30 per cent lowest firms. The evidence from his article suggested three important factors for wealth-maximising mutual fund investors; (i) avoiding funds with persistently poor performance, (ii) funds with high last-year returns have higher-than-average expected returns next year (but not in years after that), (iii) and also investment costs of expense ratios, transaction costs, and load fees all have a direct negative impact on performance.

He et al. (2017) argues that financial intermediaries play a critical role in asset pricing that has not been addressed to a great extent in previous research. The paper provides evidence from seven markets, including stocks, US government bonds, foreign sovereign bonds, commodities and foreign exchange. They present a primary dealers' market equity ratio, as these institutions are large and active intermediaries likely to be marginal in almost all financial markets. The primary dealers represent a selected group of financial intermediaries that serve as trading counterparties to the Federal Reserve Bank of New York's implementation of monetary policy (He et al., 2017). Each quarter t, they constructed the aggregated primary dealer capital ratio being $Equity/Assets$. They find that differences in assets' exposure to innovations in the capital ratio of primary dealers explain variation in expected excess return on equities, US bonds, foreign sovereign bonds, options, CDS, commodities and currencies (He et al., 2017). Also, it supports the view that the financial soundness of the intermediaries is vital for understanding wide-ranging asset price behaviour.

3 Hypothesis

Our research question consists of three parts. Therefore, to answer this research question, we have constructed three hypotheses regarding IRS swap spread predictability, abnormal returns and a hedge fund comparison.

Hypothesis 1: *Can lagged Swap Spread (SS) changes predict SS changes?*

$$H_0 : \beta_1 = \beta_2 = \ldots = \beta_{10} = 0, \forall\, i \in \{1, 2, \ldots,\ 10\}$$
$$H_A : \beta_i < 0 \text{ for some } i \in \{1, 2, \ldots,\ 10\}$$

Our null hypothesis is that no evidence suggests any of the $\beta's$ are significantly different from zero. For our alternative hypothesis, we expect at least one of the $\beta's$ to be significantly different from zero in the negative direction, showing a reversal pattern. Figure A shows the SS for the 10Y maturity; the SS does not continue to increase forever but instead seems to revert to a trend, prompting us to test only for a reversal.

Hypothesis 2: *Do strategies utilising this predictability generate abnormal returns?*

$$H_0 : \alpha = 0$$
$$H_A : \alpha \neq 0$$

This hypothesis answers whether our returns generate significant abnormal returns above our chosen risk factors. Here we do a two-sided test to see if the only reason for positive returns is the risk factors present. We expect some loading on our bond-specific and less stock-specific factors, but probably not enough to discard all alpha.

Hypothesis 3: *Are the returns of these strategies present in hedge fund returns?*

$$H_0 : \beta = 0$$
$$H_A : \beta \neq 0$$

In this hypothesis, we want to determine if the strategies' returns might be present in hedge fund returns proxied by a couple of hedge fund indices. We do a two-sided test to check if a short version of the same returns might be present. As we expect our strategies to be relatively unknown as we emphasise changes, we do not expect a large extent of significance.

4 Data

4.1 Strategy Data

The data periods are limited to the earliest data where we could get a continuous daily time series of matched treasury bonds and IRS. We create three data sets; one with daily, one with weekly and one with monthly data. The daily data is the close rate/yield each day; the weekly data is the close rate/yield each Wednesday (leaving us without the ”weekend effect”[1]), and the monthly data is the close rate/yield the last trading day of each month.

We are only using IRSs where the floating component is the London Interbank Offered Rate (LIBOR); other conventions for our swaps are shown in Table 1. The LIBOR has been gradually replaced in favour of rates like the equivalent local version of Secured Overnight Financing Rate (SOFR). This means that our data ends at different dates, at the end of 2021 for Switzerland, Japan and the UK and the end of 2022 for our US data.

We collected the IRSs from the Refinitiv platform. The composite rate benchmarks published by Thomson Reuter should be a good proxy for the Constant Maturity Swap (CMS) used by Duarte et al. (2007). We used the mean of all other providers for missing data from our time series, given that the providers' values do not exceed a limit of 10% of the mean rate for a given maturity at a given date. We do this to remove any outliers resulting from erroneous data that might give us a wrong picture. Full summary statistics for the CMS data are found in Table E.

We use the Constant Maturity Treasury (CMT) benchmarks available on the Refinitiv platform. These benchmarks should be equivalent to the ones referenced by Duarte et al. (2007). Our data set covers the time period displayed in Table 2 and includes the maturities listed in the same table. Additionally, we have provided summary statistics for all markets and maturities in Table F.

Since we are using IRSs that each has the local equivalent of the LIBOR as the floating rate as seen in Table 1, getting the data was relatively straightforward. We fetched the data using the Refinitiv Terminal, using the Intercontinental Exchange

[1] The paper by Keim and Stambaugh (1984) shows a positive correlation between Friday and Monday and consistently negative Monday returns, prompting us to pick Wednesday as this day is furthest from the weekend on both sides.

	Fixed Leg		Floating Leg		
Currency	Frequency	Convention	Frequency	Convention	Underlying
CHF	Annual	30/360	Semi-Annual	Actual/360	LIBOR
GBP	Semi-Annual	Actual/365	Semi-Annual	Actual/365	LIBOR
JPY	Annual	30/360	Semi-Annual	Actual/360	LIBOR
USD	Semi-Annual	30/360	Quarterly	Actual/360	LIBOR

Table 1: Swap Conventions
In this table, we see the description of the swaps we use; this is the same for every maturity for a given currency.

(ICE) provider. We got the Quarterly rate for the US market and the Semi-Annual rate for the Swiss, Japanese and UK markets.

To get a REPO rate to match with the frequency of the floating leg of our IRSs as seen in Table 1, we had to get creative. We got the full quarterly GC REPO rate for the US from Datastream and the pre-2018 data for the semi-annual UK REPO rate. We got the semi-annual Japanese REPO rate from JSDA (2023). We only had access to the overnight rate for the entire time series of the Swiss market and post-2018 rates for the UK market. In both these markets, we needed semi-annual rates. To fix this, we used the methodology from "Information about the Effective Federal Funds Rate and Overnight Bank Funding Rate" (2022), where we compound the overnight SOFR equivalent in the markets. We used a daily sliding window of the compounding period for Equation 1 to calculate these compounded REPO rates. For the Swiss market, this would be the Swiss Average Rate Overnight (SARON), the company responsible for the rate SIX-Group (2020) suggests using the same compounding methodology as "Information about the Effective Federal Funds Rate and Overnight Bank Funding Rate" (2022)

Currency	Start Date	End Date	Days	Maturities
CHF	1999-12-20	2021-12-30	57185	1Y, 2Y, 3Y, 4Y, 5Y, 6Y, 7Y, 8Y, 9Y, 10Y, 15Y, 20Y, 30Y
GBP	1997-07-01	2021-12-31	74667	1Y, 2Y, 3Y, 4Y, 5Y, 6Y, 7Y, 8Y, 9Y, 10Y, 12Y, 15Y, 20Y, 25Y, 30Y, 40Y, 50Y
JPY	1994-09-26	2021-12-30	72893	1Y, 2Y, 3Y, 4Y, 5Y, 6Y, 7Y, 8Y, 9Y, 10Y, 15Y, 20Y, 30Y, 40Y
USD	2000-01-27	2022-12-29	33142	1Y, 2Y, 3Y, 5Y, 7Y, 10Y, 20Y, 30Y

Table 2: Maturities
A Table showing all the maturities used, the start date of the earliest maturity, the end date of the last maturity as well as the amount of days spanning all maturities for each currency.

confirming the viability of our proxy. For the UK market, we compounded the Sterling Overnight Interbank Average (SONIA). We got the SONIA and SARON time series from Refinitiv.

$$REPO_{Comp.} = \left[\prod_{i=1}^{d_b} \left(1 + \frac{REPO_{ON} * n_i}{360} \right) - 1 \right] * \frac{360}{d_c} \tag{1}$$

Where d_b denotes the number of business days in the calculation period, d_c is the number of calendar days in the calculation period (90 or 180 as seen in Table 1) and n_i is the number of calendar days for which the rate is applied.

Since we are assuming the perspective of an American investor, all returns would have to be converted to USD to be relevant. We extracted the daily Foreign Exchange (FX) rate time series for our three foreign markets relative to USD from Refintiv. A summary statistic of the FX data is available in Table D.

4.2 Transaction Cost

To get a picture of the transaction cost, we got a limited sample of the bid/ask spread for the REPO rate for the US and the Japanese markets shown in Table C. We got a larger sample for the government bonds, with daily data for 602 different bonds shown in Table A. We obtained the bid/ask spreads for the IRS from Refinitiv and have presented the summary statistics in Table B.

4.3 Risk Factor Data

We went with the World Gross return index in USD by Morgan Stanley Capital International (MSCI) fetched from Refinitiv for our market proxy. The same market portfolio is used by Moskowitz et al. (2012) when measuring the exposure to market risk across different markets. The risk-free rate we use is the 1-Month CMT treasury bond from Refinitiv.

For the factors Small Minus Big (SMB), High Minus Low (HML) in Fama and French (1993), the Up Minus Down (UMD) included in the model by Carhart (1997), the Robust Minus Weak (RMW) and Conservative Minus Aggressive (CMA) factors used in Fama and French (2015), we extracted the data from French (2023).

To calculate the Term-Structure (TERM) and Default (DEF) factor, we used the 10-year US Treasury index provided by Refinitv for the long-term bond proxy, the 3-month t-bill index provided by ICE Bank of America (BofA) for the short-term bond proxy and ICE BofA BBB US Corporate Index for our corporate bond index, all from Refinitiv.

To calculate the Intermediary Capital Ratio Factor (ICRF) factor by He et al. (2017), we got the Market Equity and Book debt for the NY Fed primary dealers publicly traded holding companies from Datastream. The plotted quarterly values are in Figure B. The period ranges from the end of 1998 to the end of 2022 and depicts the 1998 hedge fund crisis, the 2001 Dotcom bubble burst, the 2008 financial crisis and the Covid-19 pandemic around 2020, with strong fluctuations.

The correlation between risk factors can be seen in Table I.

4.4 Hedge Fund returns

For our hedge fund returns, we used the Credit Suisse hedge fund indices, which we got from Refinitiv. We use the monthly time series since this is the one that matches up with our returns.

5 Methodology & Results

5.1 Time series predictability

Swap Spread (SS) is defined as the between a swap rate (the fixed leg of a swap) and a government par-bond yield of equal maturity and currency. This definition is used by Fehle (2003), Duarte et al. (2007), among others. We want to determine the predictability of the changes in this SS and use it to generate returns. The change is simply the difference between the SS at time t and the SS at time $t-1$, as seen in Equation 2.

$$\Delta SS_t^{(m)} = SS_t^{(m)} - SS_{t-1}^{(m)} \tag{2}$$

We will use an AR model to test the predictability of the SS change and then see if this data holds up in the returns gained from such a prediction. Chan et al. (2009) used several different models to try to predict only the swap spreads, and their data does not show that other models are strictly better than the AR model. Also, they used the models for swap spreads, not changes in swap spreads, so we believe we will reach different results.

We create two AR models. One is called "Size", where we regress the size of the swap spread change on the lagged SS change. The other is "Sign", where we regress the swap spread change on the sign of the lagged SS change. The sign is either 1 or -1, depending on whether the Swap Spread change is positive or negative. Moskowitz et al. (2012) used the same AR models for their calculations. For the sign and size regression, we see the models in Equation 3 and Equation 4, respectively.

$$\text{Sign} : \Delta SS_t = \alpha + \beta_1 sign(\Delta SS_{t-1}) + ... + \beta_l sign(\Delta SS_{t-l}) \tag{3}$$

$$\text{Size} : \Delta SS_t = \alpha + \beta_1 \Delta SS_{t-1} + ... + \beta_l \Delta SS_{t-l} \tag{4}$$

Here we have two auto-regressive models, one to see how the size of the swap spread changes can predict the future swap spread changes (Size), and the second to see how a positive or negative sign of the swap spread change predicts the future swap spread change (Sign).

In Figure 1, we see the t-statistics for both the "Sign" regression from Equation 3 and the "Size" regression from Equation 4 separated by the data intervals

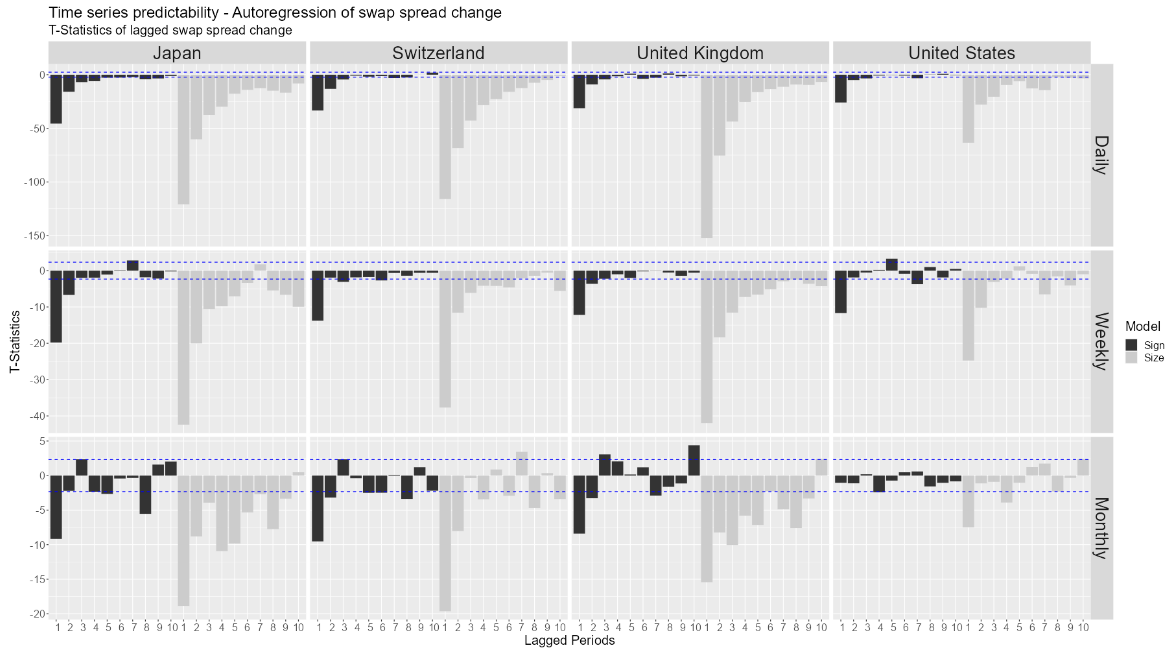

Figure 1: Time series predictability
This graph shows the t-statistics of our autoregressions from Equation 3 and Equation 4 for 10 lagged periods across the three different data intervals: Daily, Weekly and Monthly. The blue dotted line shows the one-sided 1% significance level.

Daily, Weekly and Monthly, signifying the time interval between lagged periods in the graph. The graph shows mostly negative t-statistics at an extraordinary size, with the coefficient being significant at the 1% level for the first lagged period across both regressions and all but the monthly interval for the Sign model in the US market. We can, therefore, without reasonable doubt, reject our null hypothesis in Hypothesis 1 and conclude that there is, without a doubt, some predictability.

The size of the t-statistics shows how likely the coefficient at that lagged period can explain the change in the swap spread. We can see that the "Size" of the SS change has a larger t-statistic than "Sign" across all the markets, showing that it is the size of the SS change that is the best predictor for future SS changes.

In Table H, we see a more detailed representation of Figure 1. Here, the adjusted R^2 varies a lot. The best fit seems to be the size regression across all markets, with the adjusted R^2 as high as 21.32% for the daily interval in the UK market. Switzerland and Japan also seem to have quite a high fit, leaving the US with the weakest fit across data intervals and regression.

5.2 Returns of the strategy

While Duarte et al. (2007) used an arbitrage strategy earning from the carry component of the swap spread trade, we instead focus on the mark-to-market, making the carry just a cost to the trade. The mark-to-market gain or loss we encounter would be the return from holding the position over a given period and stepping out of that position, similar to other asset classes.

We will present daily, weekly and monthly data representing the time between each data point. The daily interval between $t-1$ and t would be one day, and for the weekly interval, the time would be one week. If we were to hold the positions for longer than t until $t+1$ (one holding period), we would utilise overlapping portfolios.

To generate a time series of returns for our strategies, we use the methodology described by Duarte et al. (2007) for the swap spread strategy returns but switch out the mark-to-market calculation with the DV01 calculation from Hanson et al. (2022). First, let us look at the carry component.

There are two legs to the carry. First, we have the swap rate; if we buy the swap rate, we must pay the floating rate, the local LIBOR, and vice versa. Secondly, we have the treasury; if we buy the swap rate, we would like to short an equivalent treasury with the same maturity to get the yield of that treasury. When shorting the treasury, we can invest the proceeds and get the Repurchase Agreement (REPO) rate, and here, we assume that we can borrow at the REPO rate if we were to reverse this trade. The annual return of the carry is therefore equal to $r^{carry} = r^{swap} - r^{LIBOR} - r^{treasury} + r^{REPO}$. In other words, the Swap Spread (SS) minus the LIBOR spread, using the same terminology as Duarte et al. (2007) expressed in Equation 5.

$$r^{carry} = Swap\,Spread - LIBOR\,Spread \tag{5}$$

The carry component of a swap spread arbitrage strategy

The mark-to-market loss of the strategy measures the return lost/gained from holding the position to the next period. To calculate this, we use the DV01; this measures how the value of a swap or bond changes if the yield curve shifts one basis point up or down. Multiplying the DV01 with the rate/yield change from

$t-1$ until time t would give us a proxy for the return from holding the swap/bond over the same period. Hanson et al. (2022) show that a swap's DV01 is equal to that of the modified duration of an n-year par coupon bond. We calculate this using Equation 6.

$$DV01_t^{(m)} = \frac{1}{Y_t^{(m)}} \frac{\left(1 + Y_t^{(m)}/C_y\right)^{C_y * m} - 1}{(1 + Y_t^{(m)}/C_y)^{C_y * m}} \tag{6}$$

Where m corresponds to years until maturity, $Y^{(m)}$ is a swap with maturity m, and C_y is the yearly coupon frequency of the fixed leg of the swap. The frequency for our swaps can be seen in Table 1.

To make sure the estimation of mark-to-market was adequately precise for the data to be valid, we used Equation 6 on a large sample of government bonds found on the Refintiv terminal. We multiplied the DV01 with the change in yield from the last trading day to get an estimate of return from owning the bond overnight. We calculated the actual return using the mid-bond price and compared them in Figure C. The correlation between actual and estimated returns ended up above 99% across all markets, making us confident in the accuracy of our calculations.

The DV01 differs slightly for the treasury and the swap. Hanson et al. (2022) finds that the difference is negligible on their results (Equation 7). We have decided to include this difference and calculate the DV01 for both the swap and the treasury bond.

$$DV01_{t-1}^{Swap} * \Delta SS_t \approx DV01_{t-1}^{Swap} * \Delta \mathrm{SR}_t - DV01_{t-1}^{Bond} * \Delta \mathrm{BY}_t \tag{7}$$

Where SR is the Constant Maturity Swap (CMS) rate, and BY is Constant Maturity Treasury (CMT) yield. The Δ corresponds to the simple change from $t-1$ to t.

The carry component of the strategy compounds every day [2], while the Mark-to-market loss is between trading days. We adjust the carry based on the number of days since the last trading day to match these up. To calculate the return at a specific period t for a given maturity m, we use the equation shown in Equation 8.

Moskowitz et al. (2012) standardised the volatility of their return to 40% using ex-ante data from the last year. They state that the choice of 40% is inconsequential but makes the portfolios easier to compare to others in literature.

[2] The compound convention for the CMS can be seen in Table 1

$$r_t^{s(m)} = \frac{PLT}{PPY} * r_{t-1}^{carry} - \overbrace{DV01_{t-1}^{(n)} \times \Delta SS_t^{(n)}}^{\text{Mark-to-market loss}} \tag{8}$$

The PLT the days since last trading day and PPY the compounding days per year. The mark-to-market loss is between each trading day, while interest compounds every day of the year, using the $\frac{PLT}{PPY}$, we can estimate the carry over the weekend or holidays.

The implication of standardising the volatility would be that our size- and sign-weighted strategies would not only be weighted by "Size" or "Sign" but also by volatility. Since we are doing a self-financing strategy, this might not be a problem for us as it could be for other strategies since we already assume no borrowing constraints.

Moskowitz et al. (2012) reach an annualised volatility of 12% per year over the sample period for their time-series momentum factor after standardising the volatility of all the different securities to 40%. 12 % is the same general annualised volatility as in other common risk factors like the one by Fama and French (1993).

To standardise the volatility of each maturity using ex-ante volatility, we use Equation 9. We calculate the ex-ante volatility using a sliding window of one year. We set the volatility to 10% for all maturities.

$$r_{t,adj} = \frac{r_t}{\sigma_{t-1,t-1-y} * y} * \bar{\sigma}\% \tag{9}$$

Where σ is the annualised one-year ex-ante volatility ending at $t-1$ for each period starting one year and one period from the start of our data and $\bar{\sigma}$ is the volatility we standardise to.

Table G shows the volatility of the equal daily interval strategy in the different markets based on the volatility used to standardise the return of the different maturities. As we can see, the volatility of Japan, Switzerland, and the United Kingdom is somewhat higher than the United States; this is due to the added volatility from converting the returns to USD. The summary statistics of the FX return from investing in these foreign currencies are available in Table D.

As we saw in subsection 5.1, we can reject the null hypothesis in Hypothesis 1 and conclude that a reversal pattern is present in the SS changes. We also noticed that the model using the size of the change from Equation 4 outperformed the sign of the change from Equation 3.

We will denote the strategy based on the Equation 3 regression as the equally-weighted strategy. In this strategy, the returns from all maturities are equally weighted each time t. To calculate the return for each portfolio, we use Equation 10.

$$r_t^p = \frac{1}{n} \sum r_t^{s(m)} * \text{Sign}(\Delta SS_{t-l}^{(m)}) \tag{10}$$

Where r_t^p corresponds to the return of a portfolio of maturities at time t, l is the lookback period, and Sign means that only the sign of the value is used (1/-1)

For the size-weighted portfolios, based on Equation 4, we take the lagged SS change for a given maturity and divide it by the sum of the absolute value of lagged SS changes for all maturities at a given time t. Here we get a scaling factor that would add up to 1 if we take the absolute sum of the factor at a given time t as seen in Equation 11. We will denote this strategy as the size-weighted strategy further in the thesis.

$$r_t^p = \sum r_t^{s(m)} * \overbrace{\frac{\Delta SS_{t-l}^{(m)}}{\sum abs(\Delta SS_{t-l}^{(m)})}}^{\text{Scaling Factor}} \tag{11}$$

Where r_t^p corresponds to the return of a portfolio of maturities at time t, l is the lookback period of the strategy. The scaling factor is the lagged SS change divided by the sum of the absolute value for all lagged SS changes for a given t.

In Table J, we can see the correlation between returns for a single lookback period. Here, the correlations stay the same across data intervals, with the only considerable difference being the GBP/CHF correlation at the monthly interval. Correlation also persists in the different weighting strategies.

In Figure 2, we see the Sharpe ratios for the different markets without transaction costs. The one lookback period dominates the other strategies across the daily and the weekly data intervals. We see no discernible pattern for the monthly interval that persists through the different markets. However, the Sharpe ratio for the combined portfolio is at its highest at the one lookback period, telling us that there still is some predictability across markets for the monthly interval.

Due to the low Sharpe Ratios for other lookback periods than 1, we will focus on the one lookback period for the rest of the thesis, however, with the inclusion of more extended holding periods than the one holding period present in Figure 2.

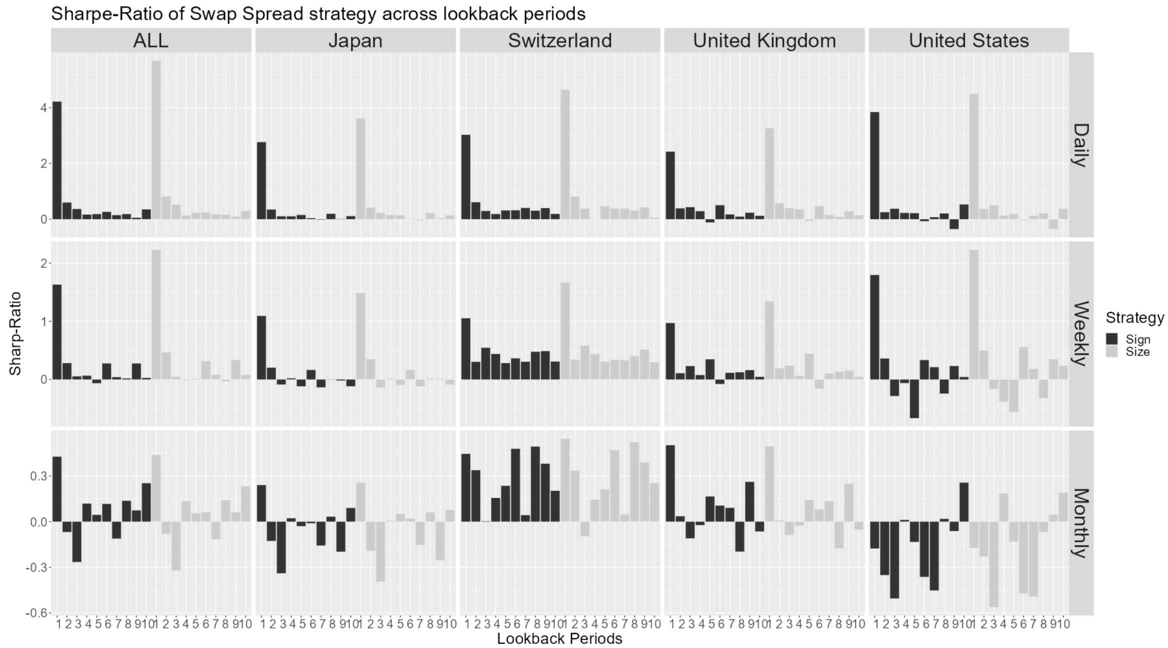

Figure 2: Sharpe-Ratios by lookback period
Sharpe-rations for each data interval for each market and strategy. The volatility for each maturity is standardized to 10% at each time t using ex-ante annualised volatility for the last year.

In table Table M, we can see the kurtosis and skewness of our return and a few chosen hedge fund indices. Kurtosis tells us how likely the strategy is to yields extreme returns since it shows how the distribution deviates from a standard distribution. We can see a high level of kurtosis across all but the monthly data, though it is still high for the combined portfolio. The Swiss market has the highest kurtosis; this is on another level than the others, even beating the Fixed Income Arbitrage Index. The takeaway is that most of our strategies have a high kurtosis risk, with the least for the monthly data. Regarding the skewness of the distribution, we see a positive skewness across all but the monthly Size strategy in the US market (Table M). The skewness shows that we are more likely to get positive returns; we see the opposite for most hedge fund indices.

5.2.1 Holding periods

The holding period defines the number of portfolios. If there is one holding period, only one portfolio is re-balanced each period. With a holding period of two, two portfolios re-balance every two periods, on alternating periods. In their strategies, Moskowitz et al. (2012) utilised portfolios that overlapped with holding periods that ranged from 1 to 48. We will use the same amount of holding periods for all data intervals. To demonstrate the process for a holding period of one week, represented by five days, refer to the visual aid in Figure 3.

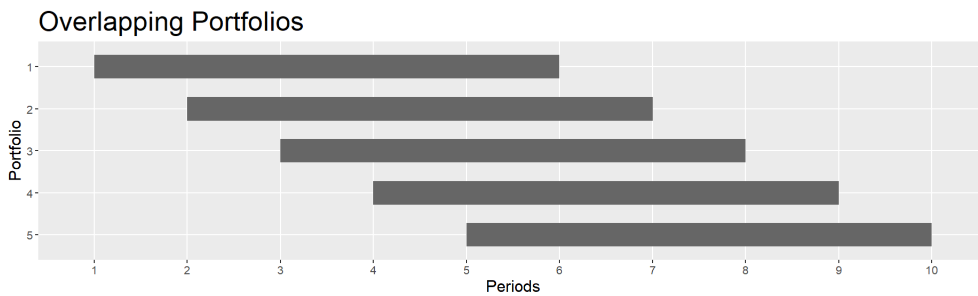

Figure 3: Overlapping Portfolios
An illustration of how the overlapping portfolios work in practice. Each bar represents a portfolio that rebalances every five periods.

The Sharpe Ratio for selected holding periods can be seen in Figure 4, and all holding periods can be seen in Table K. The drop-off is relatively low in the multiple holding periods in difference to the lookback period as seen in Figure 2. Between the data intervals, there is not much to say about daily and weekly intervals, but we see a quick drop in the monthly. We see a negative or very low Sharpe-Ratio (SR) for both strategies at three months in the Japanese market. The US market still gives a negative Sharpe Ratio for multiple holding periods in the monthly data interval.

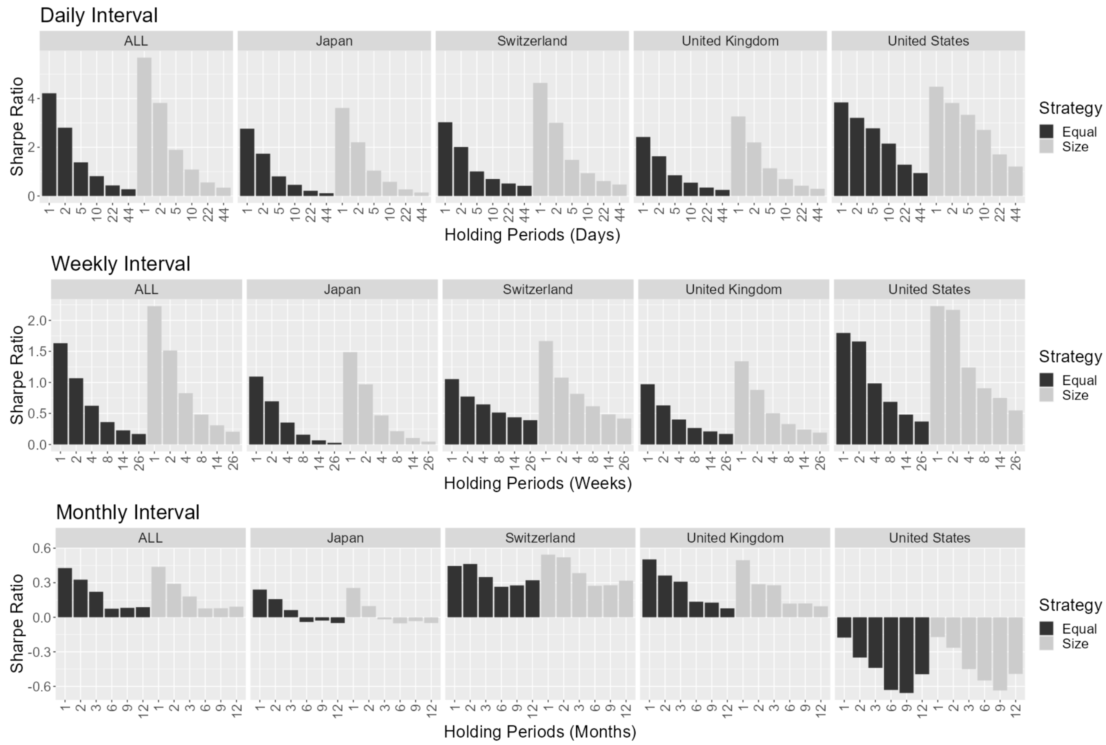

Figure 4: Sharpe-Ratio Holding Periods
This figure shows the SR for the different data intervals with several holding periods utilising overlapping portfolios. The data is divided into two strategies; equally weighted and size weighted. All holding periods between 1 to 48 can be seen in Table K.

5.3 Risk

To easily capture some of the risks associated with the strategies and calculate the abnormal returns, we will use a set of common risk factors and a few less frequently used factors. First, we have the market; here, we could use a local or global market index. Fama and French (2011) argue that there is no good support for integrated pricing across regions suggesting that one would have to make regional risk factors. With this in mind, we still look at the returns from the perspective of a US investor wanting to create a combined portfolio of these markets. We have therefore opted to use the same factors across markets and use a global index, following Moskowitz et al. (2012). Duarte et al. (2007) used the local market portfolio provided by French (2023).

From Fama and French (1993) we will use SMB, HML, as well as TERM and DEF. The idea behind the TERM factor is to capture the yield curve shape's influence on the returns. DEF reflect the default risk, Fama and French (1993) concluded that these factors were advantageous in explaining bond returns. The calculation used by Chen et al. (1986) for TERM and DEF would give us risk factors that would be hard to interpret in combination with risk factors in the form of excess returns. We, therefore, choose to capture the same risk using bond indices.

For the TERM factor, we calculate the spread in return between a 10-year government bond index and a 3-month government bond index. The choice of the 10-year government bond is due to this being the most liquid of the long-term bonds and the last bond before the curve usually flattens (Federal Reserve Bank of New York, 2000).

$$TERM_t = r_t^{10\text{Y}} - r_t^{3\text{M}} \tag{12}$$

The DEF factor is the difference between the return of a corporate bond index made up of corporate bonds with a rating lower and equal to "Baa" based on the rating scale by Moody's (2023) and a long-term government bond (Equation 13).

$$DEF_t = \overbrace{\text{Corp. Bond Index}_t}^{<=Baa} - r_t^{10\text{Y}} \tag{13}$$

We also bring in the UMD factor created as an extension of Fama and French (1993) by Carhart (1997); this factor measures the exposure to cross-sectional momentum. From Fama and French (2015), we bring in the factors CMA and RMW.

The last factor we will include is the Intermediary Capital Ratio Factor (ICRF) by He et al. (2017). Using quarterly data, we calculate the factor from the Intermediary Capital Ratio (ICR) of the NY Fed—primary dealers' publicly traded holding companies. The argument for using the ICRF is that He et al. (2017) found that the assets' exposure to Intermediary Capital Ratio (ICR) shocks are essential in explaining cross-sectional differences in average returns. We first construct the ICR as shown in Equation 14.

$$\eta_t = \frac{\Sigma_i \text{Market Equity}_{i,t}}{\Sigma_i(\text{Market Equity}_{i,t} + \text{Book Debt}_{i,t})} \tag{14}$$

Where i is a NY Fed primary dealer designee during quarter t. Market equity is calculated as outstanding share multiplied by stock price, and book debt as total assets withdrawing common equity.

From there, we create the risk factor using the residuals from a one lag autoregression of the ICR as seen in Equation 15.

$$\eta_t^{\Delta} = u_t/\eta_{t-1} \tag{15}$$

Where η_t^{Δ} is the capital ratio growth rate (ICRF), u_t is the estimated shock to the capital ratio in levels as an innovation in the auto-regression $\eta_t = \rho_0 + \rho\eta_{t-1} + u_t$, and dividing by the lagged capital ratio.

We construct a pairwise correlation table to check for multicollinearity between all factors. We do this to depict and intentionally omit very highly correlated factors. However, the necessity of this check is widely discussed, and both Goldberger (1991) and Wooldridge (2020) even argue against it. The correlations can be seen in Table I; we see quite a high correlation between BANK and WORLD, so we have therefore decided to omit the BANK factor. TERM and DEF seem highly correlated but still on a level of comfort.

We calculate all t-statistics using Heteroskedasticity and Autocorrelation (HAC) robust standard errors from Newey and West (1987). The number of lags will follow the suggestion by Greene (2018) of using this simple rule: $lag = \text{int}(n)^{1/4}$, where n is equal to the number of observations.

To evaluate Hypothesis 2, we use the model specified in Equation 16. A comparison between this model and the models by Fama and French (1993), Carhart (1997) and Fama and French (2015) can be seen in Table N, Table O and Table P for the daily, weekly and monthly data intervals respectively.

$$\begin{aligned} r_t = \alpha_T &+ \beta_T^{RMRF} MKTRF_t + \beta_T^{HML} HML_t + \beta_T^{SMB} SMB_t + \beta_T^{UMD} UMD \\ &+ \beta_T^{RMW} RMW_t + \beta_T^{CMA} CMA_t + \beta_T^{TERM} TERM_t + \beta_T^{DEF} DEF_t \\ &+ \beta_T^{ICRF} ICRF_t + \epsilon_t \end{aligned} \tag{16}$$

All factors, including Default (DEF) and Term-Structure (TERM) from Fama and French (1993), and Intermediary Capital Ratio Factor (ICRF) from He et al. (2017)

Table 3 shows the "All" regression results for the US market and the combined market for the daily interval. The alpha is significant at the 1% level across both markets for the size and equal weighting strategy. If we take a look at Table 4, we see this is true for the weekly data interval as well, prompting us to firmly reject

	All Markets		United States	
Factor	Size	Equal	Size	Equal
WORLD.RF	-0.0256**	-0.0279**	0.0293*	0.0216*
(T-NW)	(-2.0578)	(-2.3387)	(1.8973)	(1.7032)
SMB	-0.0049	0.003	-0.0019	0.0095
(T-NW)	(-0.4136)	(0.2824)	(-0.1552)	(0.9602)
HML	-0.0032	7e-04	0.0059	0.0084
(T-NW)	(-0.244)	(0.0608)	(0.4363)	(0.7675)
CMA	-0.035*	-0.0374**	-0.0359	-0.0346*
(T-NW)	(-1.8643)	(-2.0919)	(-1.4411)	(-1.8255)
RMW	-0.0024	0.0016	0.0245	0.0249*
(T-NW)	(-0.1565)	(0.121)	(1.3135)	(1.6574)
UMD	0.0053	0.0076	0.0013	0.0026
(T-NW)	(0.6641)	(1.0881)	(0.1237)	(0.3112)
TERM	0.0909***	0.0976***	-0.0344	-0.0174
(T-NW)	(3.1852)	(3.9005)	(-0.9393)	(-0.5862)
DEF	-0.0848	-0.0809	-0.0983*	-0.0551
(T-NW)	(-1.4017)	(-1.4781)	(-1.7695)	(-1.2299)
ICRF	-0.0108	-0.013	0.0764	0.0289
(T-NW)	(-0.0934)	(-0.1328)	(0.5303)	(0.2609)
α	47.5443***	31.7451***	36.7226***	24.6573***
(T-NW)	(31.0937)	(24.4334)	(17.5843)	(15.5151)
Adjusted R^2	0.0321	0.0446	0.0024	0.0023
N	5615	5615	5078	5078

Two-Sided test: $*** < 1\% < ** < 5\% < * < 10\%$

Table 3: Regression Summary - Daily
Regression results for the daily data interval for the US and All market portfolios. The returns come from a strategy of one holding and lookback period. All t-statistics are calculated using HAC robust standard errors with a lag of 8 using the method by Newey and West (1987). All α's are annualised and in per cent

the null hypothesis from Hypothesis 2 for both data intervals.

For the risks present in returns, we can see in the daily interval from Table 3 that the TERM factor is significant, at least at the 1% level for the all markets portfolio. This shows us that the shape of the yield curve has some effect on our returns, the exposure to changes in the yield curve is relatively low for both Size and Equal, but the positive coefficient tells us that a normal yield curve positively affects our return. In contrast, an inverted curve negatively affects our return. Interestingly, we do not see this pattern in return from the US market, even though we constructed TERM from US Treasury indices. We also see some significance for the world market portfolio, with the coefficient being significant

	All Markets		United States	
Factor	Size	Equal	Size	Equal
WORLD.RF	-0.0237	-0.0187	0.0102	0.0285
(T-NW)	(-1.3497)	(-1.1177)	(0.4811)	(1.4567)
SMB	0.0206	0.0173	-0.0144	-0.0067
(T-NW)	(0.9618)	(0.8588)	(-0.6005)	(-0.3226)
HML	-0.0273	-0.0306	6e-04	0.0085
(T-NW)	(-1.2046)	(-1.4462)	(0.028)	(0.4669)
CMA	-0.0521	-0.0483	0.0197	0.0031
(T-NW)	(-1.3723)	(-1.3197)	(0.4675)	(0.0908)
RMW	-0.0069	-0.0033	0.055*	0.0378
(T-NW)	(-0.2399)	(-0.1269)	(1.6739)	(1.3479)
UMD	0.0127	0.0159	-0.0092	0.005
(T-NW)	(0.8977)	(1.2508)	(-0.6764)	(0.4333)
TERM	0.0611	0.0784**	-0.0619*	-0.0372
(T-NW)	(1.5916)	(2.1482)	(-1.7312)	(-1.1297)
DEF	-0.1707**	-0.1619**	-0.1172**	-0.1267**
(T-NW)	(-2.3415)	(-2.4522)	(-2.0234)	(-2.3509)
ICRF	0.254	0.3807	0.4256	0.415
(T-NW)	(0.5787)	(0.9671)	(0.718)	(0.9192)
α	18.0535***	12.6347***	15.9553***	11.2967***
(T-NW)	(14.5362)	(10.9508)	(9.4676)	(8.0559)
Adjusted R^2	0.0593	0.0731	0.0027	0.0024
N	1157	1157	1052	1052

Two-Sided test: $*** < 1\% < ** < 5\% < * < 10\%$

Table 4: Regression Summary - Weekly
Regression results for the weekly data interval for the US and All market portfolios. The returns come from a strategy of one holding and lookback period. All t-statistics are calculated using HAC robust standard errors with a lag of 5 using the method by Newey and West (1987). All α's are annualised and in per cent

at the 5% level for both the combined market and the size strategy for the US market. The exposure to market risk is relatively low across the strategies, though the coefficient is inverted between the two portfolios.

In the weekly data interval, seen in Table 4, we can see that the DEF factor is significant at the 5% level for both markets and strategies. The DEF factor is a proxy for changing market conditions where the risk-premium for low-grade corporate increases in relation to the risk-free rate (Fama & French, 1993). With a negative coefficient, we expect a high risk-premium to affect these returns negatively, showing that the strategy might not be as viable in a market turmoil. We also see that TERM is significant at the 5% level for the equally weighted strategy for the all-markets portfolio. This shows that the yield curve affects the weekly and the daily interval.

Overall, our risk factors do not explain the return all that well, resulting in very high alphas. What we can conclude, though, is that our null hypothesis from Hypothesis 2 can be rejected in favour of our alternative hypothesis across both the combined all market and the US market. It is, therefore, evident that the SS predictability can be used to generate abnormal returns.

5.4 Hedge Fund Returns

To check if hedge funds utilise these strategies, we will use the risk-based approach commonly used by models like Fama and French (1993) and Fama and French (2015). Instead of using those factors, we will try to explain some hedge fund returns using our own set of returns, like Fung and Hsieh (2004). We have picked out two hedge fund indices, both by Credit Suisse. The first is Liquid Alternative Beta (LAB) and comprises a set of different liquid hedge fund strategies; the second is Hedge Fund Index (HF), a composite index of multiple strategies across liquid and non-liquid assets. The model we will use to test this can be seen in Equation 17.

$$r_t^{HF} = \alpha_t + \beta_T r_t^{\text{Strategy}} + \epsilon_t \tag{17}$$

Regression model to see if our strategies are part of hedge fund returns.

Table 5 shows some significant betas, with the only one being significant at the 1% level being the All Markets Daily for the Hedge Fund Index (HF). Still, other factors in our return might be captured by the coefficient. To make sure this is not the case, we regress Hedge Fund Index (HF) on our risk factors present in the model from Equation 16 as well as the returns from our strategy for the US and All markets, with the data intervals daily, weekly and monthly.

		LAB		HF	
Market	Interval	α	β	α	β
All Markets	Daily	5.2985***	-0.0869	6.1054***	-0.1766***
		(3.7776)	(-1.5261)	(3.9953)	(-4.1277)
	Weekly	5.9036***	-0.0282	7.7979***	-0.1667**
		(4.0808)	(-0.3894)	(5.515)	(-2.1628)
	Monthly	5.7995***	-0.0069	7.4105***	-0.0723
		(3.8127)	(-0.1286)	(4.9083)	(-1.5103)
United States	Daily	4.46***	-0.0876*	4.669***	-0.0697
		(3.2695)	(-1.855)	(3.2489)	(-1.3543)
	Weekly	5.7801***	-0.0903	5.9369***	-0.1437**
		(4.5331)	(-1.383)	(4.2063)	(-2.2347)
	Monthly	5.8768***	0.1657*	6.1091***	0.21**
		(4.9336)	(1.688)	(4.7527)	(2.1113)

Two-Sided test: $*** < 1\% < ** < 5\% < * < 10\%$

Table 5: Regression Summary - Hedge Fund indices
Regression results from regressing the hedge fund indices Liquid Alternative Beta (LAB) and HF on our different sets of returns using the equally weighted strategy. The model can be seen in Equation 17 The t-statistics are calculated using HAC robust standard errors with a lag of 4. All α's are in percentage.

The summary of this regression can be seen in Table 6. While we see some significance still, non are at the 1% level making it hard to reject the null hypothesis in Hypothesis 3. What we can say, though, is that we see some evidence of these returns being present in the HF. Further regression results can be seen in Table Q.

	All Markets		United States	
Data Interval	α	β	α	β
Daily	5.1015***	-0.0513*	3.3187***	-1e-04
	(4.2418)	(-1.795)	(3.1861)	(-0.0044)
Weekly	4.311***	-0.066**	3.9547***	-0.0622*
	(4.9939)	(-2.1346)	(4.568)	(-1.8849)
Monthly	3.5897***	-0.0192	3.4886***	0.0636**
	(4.4585)	(-1.031)	(4.7005)	(2.08)

Two-Sided test: $*** < 1\% < ** < 5\% < * < 10\%$

Table 6: Regression Summary - Hedge Fund All Factors
Regression summary showing the α and the coefficient(β) for our strategy denoted by data interval and market. The results come from regressing HF on all factors in Equation 16 along with the return of our strategy. Full regression results can be seen in Table Q.

5.5 Transaction Cost

Finding a reasonable estimate for transaction cost is quite challenging for our strategies, with most of the transactions happening Over-the-Counter (OTC), and different deals may be tailored specifically for a given counterparty.

Duarte et al. (2007) used a spread of 1/32nd[3] for their treasury. This treasury spread came from Fleming (2003), where they report the average daily bid/ask spreads for treasuries between December 1996 and March 2000 in the US. With this limited period and data only for the US, this might not accurately represent the current market. For the swap rate spread, Duarte et al. (2007) used one bp, significantly lower than what Sun et al. (1993) found. They found a spread between 4.65 bp and 4.77 bp for all maturities from dealers with an A rating. This last one might be outdated, but it tells us what to expect. For the REPO rate, Duarte et al. (2007) used a value of 10 bp. They got this value from several discussions with bond traders, making it seem this spread was quite trader specific.

For consistency, we use 15 bp as the transaction costs as a main rule across the four markets. This is slightly more conservative than what Duarte et al. (2007) presented. Less liquid markets, such as Switzerland, will usually have a larger bid-ask spread, which might explain the higher returns from our calculations using mid-price/mid-yield. Further, we assume there is no haircut on financing this strategy that would leave us with added costs related to financing a margin account. This contrasts with (Boyarchenko et al., 2018) that assumes a haircut of 2.8% annualised for the REPO position.

We have found some limited data on spreads in the different markets. What we can deduce for the different markets is that the IRS spread is quite similar in all markets as seen in Table B, but quite a lot higher compared to Duarte et al. (2007). Switzerland has the highest yield spread for the government bonds compared to the others in Table A, and about twice the amount used by Duarte et al. (2007). Lastly, our data is relatively limited regarding the REPO rates, with only data on Japan and US. We see a higher spread for the US than Japan, but it is hard to tell if these spreads are what market participants will get.

In Figure 5, we have plotted the Sharpe-Ratio (SR) for both the equally weighed and size-weighted strategies. In all markets, the SRs becomes nega-

[3]This corresponds to 3.125 basis points according to CME-Group (2023)

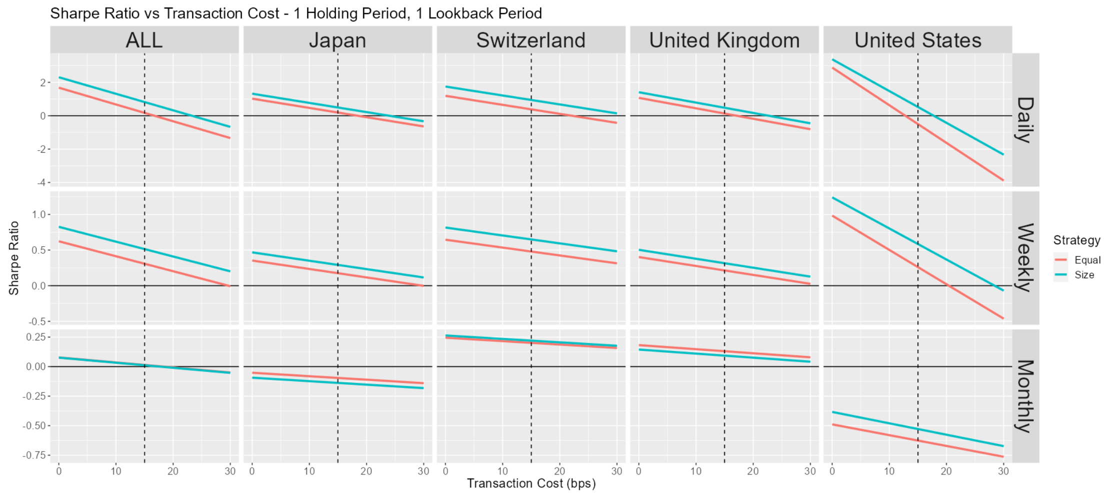

Figure 5: Transaction Cost Sensitivity
This figure shows how the Sharpe-Ratio changes with transaction cost across markets and strategies, all for the 1 lookback and 1 holding period. The dotted line corresponds to a transaction cost of 15 bp, a slightly more conservative cost than Duarte et al. (2007).

tive for the equally weighted portfolio at or before reaching the transaction cost of 15 bp for the daily data. We see a quite low Sharpe-Ratio (SR) across the board for the monthly data, with the US data having a negative SR even before considering transaction costs. The weekly data seem to have the most persistent returns across transaction costs. The market where our data shows the highest spread is the one with a SR most persistent to an increase in transaction costs; this shows that the lack of reasonable transaction costs might be a source of the returns. The abnormal return with a transaction cost of 15bp can be seen at the bottom of Table N, Table O and Table P for the Daily, Weekly and Monthly interval. The US market only shows significant positive alphas in the weekly data. In contrast, the All market portfolio shows significant positive alphas for all but the daily equally weighted strategy and both strategies in the monthly data, leaving us with the weekly being the most viable again.

Figure 6 shows the SR across holding periods with a transaction cost of 15 bp. For the daily interval, we see that the equal strategy is no longer viable, but the story is different for the weekly one. We see that the SR for the weekly interval is relatively high and holds up for more extended holding periods. A complete table of SR across holding periods can be seen in Table L.

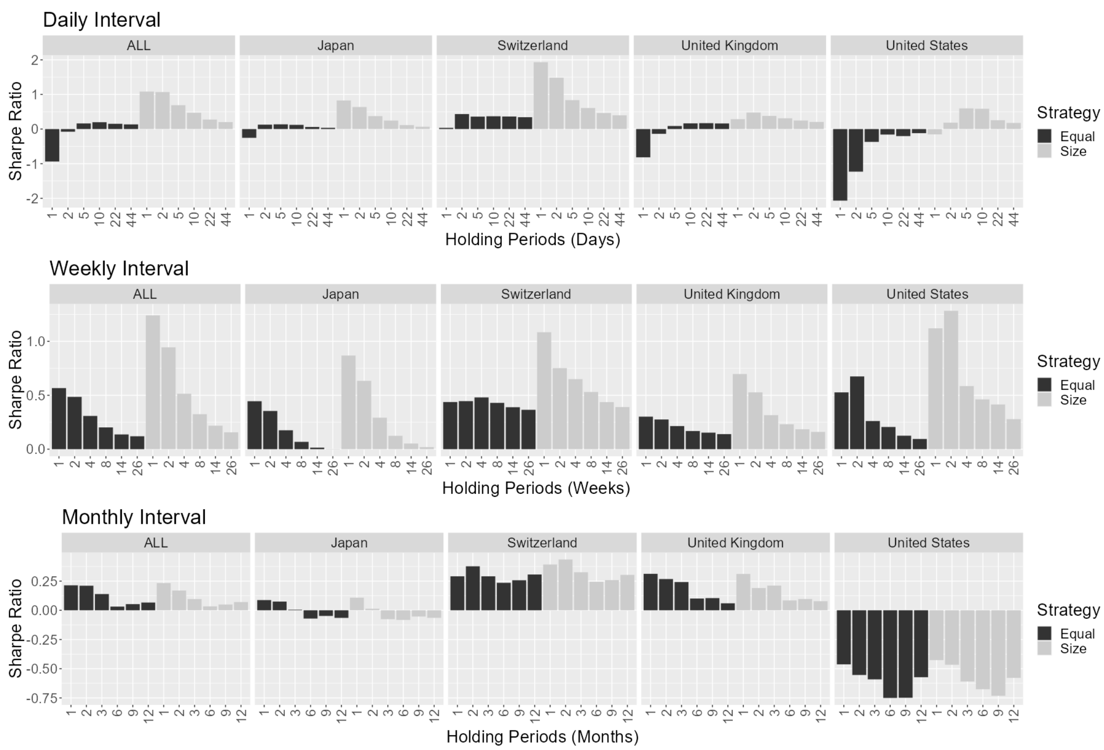

Figure 6: Sharpe-Ratio Holding Periods
This figure shows the SR with a transaction cost of 15 bp for the different data intervals with several holding periods utilising overlapping portfolios. The data is divided into two strategies; equally weighted and size weighted. All holding periods between 1 to 48 can be seen in Table L. This Figure is the same as Figure 4, but with transaction cost.

6 Conclusion

This thesis has examined whether interest rate swap spread changes can be predicted and generate abnormal returns and whether these are reflected in hedge fund returns. We created three hypotheses covering IRS spread change predictability, abnormal returns and a hedge fund comparison to answer this.

We show clear evidence of IRS spread change predictability in Hypothesis 1, and could reject the null hypothesis across all markets for the first lagged period. This predictability was useful when utilised in a SS trade, with the Sharpe-Ratio (SR) also being reflected through the AR regression. Regarding abnormal returns, in Hypothesis 2, we show that the strategy generates significant abnormal returns at the 1% level for both the combined market portfolio and the US market, leading us to reject the null hypothesis. Lastly, for the hedge fund comparison in Hypothesis 3, we found limited evidence of the strategy returns being present in the returns of a Hedge Fund Index (HF), with the highest significance being at the 5% level when controlling for our other risk factors.

We also checked the sensitivity of the returns to changes in transaction costs, as these will vary and would be the make-it-or-break-it when implementing this strategy. The findings lead us towards the weekly data interval, suggesting that weekly changes in swap spreads are the most viable strategy.

For further research, we suggest investigating the presence of this strategy in other hedge fund returns and if similar reversal patterns can be found in overnight index swaps and in other markets.

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Appendix

Table A: Bid / Ask - Government Bonds
This table shows the spread in basis points between the Bid and Ask Yield of Japanese, Swiss, UK and US government bonds accessible through the Refintiv Terminal.

Market	Avg. Spread	Median Spread	n	Bonds	Start Date	End Date
Japan	1.25751 bp	1.20000 bp	619399	223	2004-01-08	2022-12-30
Switzerland	6.58543 bp	5.80000 bp	49364	21	2001-12-04	2022-12-30
United Kingdom	2.84209 bp	0.500000 bp	73577	45	2002-09-09	2022-12-30
United States	1.42967 bp	0.710000 bp	298108	292	2011-01-03	2022-12-30

Table B: Bid / Ask - Interest Rate Swaps
This table shows the spread in basis points between the Bid and Ask rate of IRS with the conventions seen in Table 1 available to us through Refintiv Terminal.

Market	Avg. Spread	Median Spread	Std.	N	Start Date	End Date
Japan	2.7330 bp	2.0000 bp	1.999%	102949	1999-12-23	2021-12-30
Switzerland	3.9335 bp	4.0000 bp	2.3475%	86942	2000-01-03	2021-12-30
United Kingdom	4.0257 bp	3.0000 bp	4.2594%	91952	1999-12-30	2021-12-30
United States	2.6058 bp	4.0000 bp	2.1428%	293462	2002-09-23	2022-12-30

Table C: Summary statistics - REPO rate
Summary statistics of the REPO rates used in calculating the swap spread strategy returns. The spread in basis points is reported for the currencies where that were available to us.

Currency	Average	Std	Max	Min	Spread
CHF	0.3063	1.0757	3.2943	-0.7482	N/A
GBP	2.5988	2.4571	7.5175	0.0482	N/A
JPY	0.1663	0.4293	2.2863	-0.279	0.17bp
USD	1.7797	1.8834	6.6	0.02	6.66bp

Table D: Summary statistics - FX rate
The annualised return and standard deviation from the perspective of an American investor investing in these currencies.

Currency	Annualised Return	Annualised Standard Deviation
CHF	4.18%	12.75%
GBP	2.18%	11.13%
JPY	-0.98%	11.73%

Table E: Summary statistics - Interest Rate Swaps
Summary statistics of all the CMSs used in this thesis. Data gathered from Refinitiv. The First Date and Last Date value corresponds to the first and last date of that given maturity in our data.

	1Y	2Y	3Y	4Y	5Y	6Y	7Y	8Y	9Y	10Y	12Y	15Y	20Y	25Y	30Y	40Y	50Y
Japan																	
First Date	1996-01-08	1994-09-26	1994-09-26	1994-09-26	1994-09-26	1995-05-18	1994-09-26	1995-05-18	1995-05-18	1994-09-26	NA	2003-07-17	2003-05-01	NA	2003-07-17	2010-10-12	NA
Last Date	2021-12-30	2021-12-30	2021-12-30	2021-12-30	2021-12-30	2021-12-30	2021-12-30	2021-12-30	2021-12-30	2021-12-30	NA	2021-12-30	2021-12-30	NA	2021-12-30	2021-12-30	NA
Mean	0.3001	0.448	0.5674	0.6941	0.8175	0.8573	1.0548	1.0762	1.1707	1.336	NA	1.2079	1.4113	NA	1.5806	1.1761	NA
Std.	0.3238	0.5594	0.67	0.7663	0.8415	0.7486	0.9532	0.8399	0.8649	1.007	NA	0.7178	0.7473	NA	0.767	0.6257	NA
Skewness	0.8227	2.4684	2.2176	1.9489	1.7026	0.8725	1.3629	0.7016	0.5955	0.9413	NA	-0.1783	-0.3058	NA	-0.3671	0.0088	NA
Kurtosis	2.6263	11.8435	10.0316	8.2896	6.8959	3.2914	5.3662	3.0294	2.8744	4.1118	NA	1.6281	1.6801	NA	1.7503	1.462	NA
n	5319	5948	5953	5933	5942	5791	5940	5813	5810	5960	NA	4008	4057	NA	4005	2427	NA
Switzerland																	
First Date	2003-03-31	1999-12-20	1999-12-20	1999-12-20	1999-12-20	1999-12-20	1999-12-20	1999-12-20	1999-12-20	1999-12-20	NA	2007-07-31	2005-04-01	NA	2005-04-01	NA	NA
Last Date	2021-12-30	2021-12-30	2021-12-30	2021-12-30	2021-12-30	2021-12-30	2021-12-30	2021-12-30	2021-12-30	2021-12-30	NA	2021-12-30	2021-12-30	NA	2021-12-30	NA	NA
Mean	0.3442	0.7804	0.9307	1.067	1.2081	1.3441	1.4594	1.5669	1.6628	1.7373	NA	0.9956	1.5954	NA	1.6131	NA	NA
Std.	1.3232	1.403	1.4226	1.4307	1.4385	1.4383	1.4354	1.4347	1.4342	1.4315	NA	0.9325	1.2078	NA	1.1784	NA	NA
Skewness	0.8502	0.6552	0.4927	0.372	0.2714	0.1866	0.1306	0.082	0.047	0.0291	NA	0.6309	0.2303	NA	0.1729	NA	NA
Kurtosis	2.2592	2.2355	2.0264	1.8857	1.786	1.728	1.7021	1.683	1.6743	1.6723	NA	2.4006	1.746	NA	1.8425	NA	NA
n	2962	4870	4896	4865	4866	4899	4890	4897	4893	4877	NA	2822	3720	NA	3728	NA	NA
United Kingdom																	
First Date	2016-06-09	1997-07-01	1997-07-01	1997-07-01	1997-07-01	1997-07-01	1997-07-01	1997-07-01	1997-07-01	1997-07-01	2017-03-15	2003-08-20	2003-08-20	2009-06-18	2003-08-20	2006-05-08	2005-05-18
Last Date	2021-12-30	2021-12-30	2021-12-30	2021-12-30	2021-12-30	2021-12-30	2021-12-30	2021-12-30	2021-12-31	2021-12-30	2021-12-30	2021-12-30	2021-12-30	2021-12-30	2021-12-30	2021-12-31	2021-12-30
Mean	0.5734	3.0723	3.1979	3.2903	3.3655	3.4319	3.5066	3.5356	3.546	3.6127	1.1119	3.0273	3.0533	2.2899	3.0064	2.6479	2.6957
Std.	0.3026	2.3506	2.2898	2.2237	2.1623	2.1275	2.0885	2.0093	2.0048	1.9347	0.3994	1.5569	1.5012	1.1488	1.4393	1.3323	1.3338
Skewness	-0.3279	0.3127	0.2436	0.1853	0.1328	0.0803	0.0132	-0.0033	-0.0022	-0.0747	-0.3122	-0.0017	-0.113	0.2192	-0.2126	-0.0551	-0.206
Kurtosis	2.0654	1.4997	1.4858	1.4942	1.5082	1.4977	1.5083	1.5815	1.5618	1.6404	1.922	1.5754	1.5932	1.7768	1.6204	1.6167	1.5769
n	1273	5573	5580	5572	5577	5467	5395	5576	5329	5582	1100	4183	4188	2860	4185	3570	3792
United States																	
First Date	1999-10-07	1999-10-07	1999-10-07	NA	1999-10-07	NA	1999-10-07	NA	NA	1999-10-07	NA	NA	2020-05-21	NA	2000-06-26	NA	NA
Last Date	2022-12-30	2022-12-30	2022-12-30	NA	2022-12-30	NA	2022-12-30	NA	NA	2022-12-30	NA	NA	2022-12-30	NA	2022-12-30	NA	NA
Mean	2.1085	2.3393	2.569	NA	2.9208	NA	3.22	NA	NA	3.4851	NA	NA	2.063	NA	3.7721	NA	NA
Std.	1.9137	1.8663	1.817	NA	1.7457	NA	1.6843	NA	NA	1.6431	NA	NA	0.8809	NA	1.5234	NA	NA
Skewness	0.9917	0.8694	0.7677	NA	0.6681	NA	0.5407	NA	NA	0.4423	NA	NA	0.583	NA	0.1975	NA	NA
Kurtosis	2.9063	2.7992	2.7031	NA	2.5934	NA	2.4645	NA	NA	2.3611	NA	NA	2.2915	NA	1.9906	NA	NA
n	5330	5330	5323	NA	5229	NA	5343	NA	NA	5334	NA	NA	605	NA	5117	NA	NA

Table F: Summary statistics - Government Bonds

Summary statistics of all the CMTs, or the local equivalent of a CMT used in this thesis. Data gathered from Refinitiv. The First Date and Last Date value corresponds to the first and last date of that given maturity in our data.

	1Y	**2Y**	**3Y**	**4Y**	**5Y**	**6Y**	**7Y**	**8Y**	**9Y**	**10Y**	**12Y**	**15Y**	**20Y**	**25Y**	**30Y**	**40Y**	**50Y**
Japan																	
First Date	1996-01-08	1994-09-26	1994-09-26	1994-09-26	1994-09-26	1995-05-18	1994-09-26	1995-05-18	1995-05-18	1994-09-26	NA	2003-07-17	2003-05-01	NA	2003-07-17	2010-10-12	NA
Last Date	2021-12-30	2021-12-30	2021-12-30	2021-12-30	2021-12-30	2021-12-30	2021-12-30	2021-12-30	2021-12-30	2021-12-30	NA	2021-12-30	2021-12-30	NA	2021-12-30	2021-12-30	NA
Mean	0.1407	0.2894	0.4018	0.5333	0.6478	0.695	0.8976	0.9407	1.0442	1.2065	NA	1.118	1.395	NA	1.6102	1.2677	NA
Std.	0.2767	0.5068	0.6022	0.6965	0.7669	0.6853	0.9041	0.7996	0.8153	0.9684	NA	0.7069	0.7175	NA	0.7422	0.6388	NA
Skewness	0.7399	2.604	2.4324	2.0951	1.7748	0.7053	1.3366	0.57	0.4077	0.9184	NA	-0.1904	-0.4039	NA	-0.4164	0.1318	NA
Kurtosis	2.8138	12.8155	11.8241	9.6453	7.8184	3.0856	5.5725	3.0617	2.7823	4.3927	NA	1.4694	1.5629	NA	1.678	1.5997	NA
n	5319	5948	5953	5933	5942	5791	5940	5813	5810	5960	NA	4008	4057	NA	4005	2427	NA
Switzerland																	
First Date	2003-03-31	1999-12-20	1999-12-20	1999-12-20	1999-12-20	1999-12-20	1999-12-20	1999-12-20	1999-12-20	1999-12-20	NA	2007-07-31	2005-04-01	NA	2005-04-01	NA	NA
Last Date	2021-12-30	2021-12-30	2021-12-30	2021-12-30	2021-12-30	2021-12-30	2021-12-30	2021-12-30	2021-12-30	2021-12-30	NA	2021-12-30	2021-12-30	NA	2021-12-30	NA	NA
Mean	0.3313	0.5846	0.7812	0.8979	1.0198	1.1149	1.2151	1.3075	1.3518	1.4164	NA	0.6805	1.289	NA	1.3401	NA	NA
Std.	1.3391	1.3517	1.4154	1.4361	1.4504	1.4368	1.4373	1.4405	1.4135	1.4095	NA	0.9156	1.2058	NA	1.1639	NA	NA
Skewness	0.9219	0.6618	0.3853	0.2999	0.2141	0.1476	0.0902	0.055	0.04	0.0424	NA	0.7802	0.2932	NA	0.2561	NA	NA
Kurtosis	2.4848	2.3369	1.8928	1.7499	1.6511	1.6022	1.5786	1.558	1.5949	1.6097	NA	2.695	1.7514	NA	1.7642	NA	NA
n	2962	4870	4896	4865	4866	4899	4890	4897	4893	4877	NA	2822	3720	NA	3728	NA	NA
United Kingdom																	
First Date	2016-06-09	1997-07-01	1997-07-01	1997-07-01	1997-07-01	1997-07-01	1997-07-01	1997-07-01	1997-07-01	1997-07-01	2017-03-15	2003-08-20	2003-08-20	2009-06-18	2003-08-20	2006-05-08	2005-05-18
Last Date	2021-12-30	2021-12-30	2021-12-30	2021-12-30	2021-12-30	2021-12-30	2021-12-30	2021-12-30	2021-12-31	2021-12-30	2021-12-30	2021-12-30	2021-12-30	2021-12-30	2021-12-30	2021-12-31	2021-12-30
Mean	0.3492	2.6254	2.7554	2.8758	2.9617	3.052	3.1411	3.2093	3.209	3.3072	1.0342	2.9844	3.1056	2.5089	3.1415	2.8471	2.8759
Std.	0.2917	2.3338	2.2553	2.1638	2.0606	2.0301	1.9738	1.8736	1.8494	1.7549	0.4508	1.4705	1.379	1.1326	1.3021	1.2931	1.2835
Skewness	0.1801	0.3275	0.2536	0.1772	0.1184	0.0517	-0.0156	-0.0571	-0.025	-0.1745	-0.163	-0.0929	-0.2242	0.213	-0.3894	-0.2091	-0.3521
Kurtosis	1.5158	1.4548	1.4587	1.4747	1.5051	1.5117	1.5331	1.6405	1.6282	1.7343	1.7206	1.6035	1.6273	1.939	1.7211	1.5802	1.6639
n	1273	5573	5580	5572	5577	5467	5395	5576	5329	5582	1100	4183	4188	2860	4185	3570	3792
United States																	
First Date	1999-10-07	1999-10-07	1999-10-07	NA	1999-10-07	NA	1999-10-07	NA	NA	1999-10-07	NA	NA	2020-05-21	NA	2000-06-26	NA	NA
Last Date	2022-12-30	2022-12-30	2022-12-30	NA	2022-12-30	NA	2022-12-30	NA	NA	2022-12-30	NA	NA	2022-12-30	NA	2022-12-30	NA	NA
Mean	1.7809	2.0136	2.0291	NA	2.5981	NA	2.9391	NA	NA	3.2133	NA	NA	2.32	NA	3.746	NA	NA
Std.	1.7906	1.733	1.3881	NA	1.5249	NA	1.4125	NA	NA	1.3465	NA	NA	0.9409	NA	1.1576	NA	NA
Skewness	0.9728	0.9048	0.5584	NA	0.6439	NA	0.4197	NA	NA	0.2769	NA	NA	0.6751	NA	-0.0582	NA	NA
Kurtosis	2.8091	2.8236	2.1361	NA	2.6202	NA	2.4038	NA	NA	2.2926	NA	NA	2.3692	NA	1.9735	NA	NA
n	5330	5330	5323	NA	5229	NA	5343	NA	NA	5334	NA	NA	605	NA	5117	NA	NA

Table G: Volatility - Equally Weighted Strategy

This table shows the volatility of the equally weighted strategy across markets when standardising the volatility of each maturity to the different levels. The 10% highlighted in bold is the used in our results.

Market	**5%**	**10%**	**15%**	**20%**	**25%**	**30%**	**35%**	**40%**
ALL	6.42%	**7.33%**	8.64%	10.2%	11.92%	13.72%	15.59%	17.49%
Japan	11.47%	**12.53%**	14.16%	16.19%	18.48%	20.96%	23.55%	26.24%
Switzerland	11.78%	**12.63%**	13.95%	15.61%	17.53%	19.61%	21.83%	24.13%
United Kingdom	10.3%	**11.67%**	13.64%	15.99%	18.57%	21.3%	24.13%	27.03%
United States	3.2%	**6.4%**	9.59%	12.79%	15.99%	19.19%	22.39%	25.58%

Table H: Time series predictability

This is the full table for Figure 1, and therefore the full regression results from Equation 3 and Equation 4 for every market and data interval.

			Lookback Periods											
Market	**Regression**	**Intercept**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**n**	**Adj. R^2**
Daily Data														
Japan	Sign	0.0000	-1e-04***	0***	0***	0***	0***	0***	0**	0***	0***	0.0000	80993	0.0260
		(0.7682)	(-45.5989)	(-15.9068)	(-6.8976)	(-6.0642)	(-2.7786)	(-2.6779)	(-2.2038)	(-4.2871)	(-3.4926)	(-1.1347)	80993	0.0260
	Size	0.0000	-0.4246***	-0.2293***	-0.1458***	-0.1169***	-0.0696***	-0.0552***	-0.0491***	-0.0579***	-0.0636***	-0.0287***	80993	0.1571
		(-0.7066)	(-120.7813)	(-60.1728)	(-37.5048)	(-29.854)	(-17.7091)	(-14.0502)	(-12.5475)	(-14.9137)	(-16.7393)	(-8.2013)	80993	0.1571
Switzerland	Sign	0.0000	-1e-04***	0***	0***	0.0000	0*	0.0000	0***	0***	0.0000	0*	69435	0.0166
		(0.7003)	(-33.3863)	(-13.1897)	(-4.4754)	(-0.8938)	(-1.7882)	(-1.2285)	(-3.0508)	(-2.5943)	(0.0538)	(1.922)	69435	0.0166
	Size	0.0000	-0.4404***	-0.2839***	-0.1832***	-0.123***	-0.0988***	-0.0694***	-0.0539***	-0.032***	-0.0204***	-0.0040	69435	0.1686
		(-1.1449)	(-115.9201)	(-68.4079)	(-42.7354)	(-28.3777)	(-22.721)	(-15.9647)	(-12.4577)	(-7.4865)	(-4.9223)	(-1.0492)	69435	0.1686
United Kingdom	Sign	0.0000	-1e-04***	0***	0***	0.0000	0.0000	0***	0***	0.0000	0.0000	0.0000	86218	0.0116
		(0.5525)	(-31.2234)	(-9.0345)	(-4.3848)	(-1.4099)	(0.9486)	(-3.8834)	(-2.7961)	(1.1876)	(-1.4734)	(-0.767)	86218	0.0116
	Size	0.0000	-0.5195***	-0.2893***	-0.173***	-0.1017***	-0.0653***	-0.0538***	-0.0451***	-0.0362***	-0.0366***	-0.023***	86218	0.2132
		(0.2554)	(-152.4007)	(-75.353)	(-43.6647)	(-25.3997)	(-16.2604)	(-13.4036)	(-11.2795)	(-9.1315)	(-9.5443)	(-6.748)	86218	0.2132
United States	Sign	0.0000	-1e-04***	0***	0***	0.0000	0.0000	0.0000	0***	0.0000	0.0000	0.0000	39552	0.0170
		(-0.1899)	(-25.9086)	(-4.9886)	(-3.4472)	(-0.7767)	(-0.2873)	(-0.8121)	(-3.2682)	(0.1787)	(0.7601)	(-0.4109)	39552	0.0170
	Size	0.0000	-0.3191***	-0.1471***	-0.1095***	-0.0513***	-0.0329***	-0.0682***	-0.0767***	-0.0125**	-0.0151***	-0.0171***	39552	0.0999
		(-1.3926)	(-63.3898)	(-27.8535)	(-20.5291)	(-9.5932)	(-6.158)	(-12.7803)	(-14.3925)	(-2.3626)	(-2.8735)	(-3.413)	39552	0.0999
Weekly Data														
Japan	Sign	0.0000	-1e-04***	0***	0**	0*	0.0000	0.0000	0***	0*	0**	0.0000	16117	0.0252
		(-0.0942)	(-19.778)	(-6.6862)	(-1.9661)	(-1.9268)	(-1.0797)	(0.1197)	(2.7985)	(-1.8334)	(-2.1828)	(-0.2098)	16117	0.0252
	Size	0.0000	-0.3336***	-0.1658***	-0.0882***	-0.0823***	-0.0592***	-0.0283***	0.0146*	-0.0452***	-0.0545***	-0.0772***	16117	0.1113
		(-1.0945)	(-42.4182)	(-20.0339)	(-10.5463)	(-9.817)	(-7.0522)	(-3.3753)	(1.7449)	(-5.4421)	(-6.6398)	(-9.933)	16117	0.1113
Switzerland	Sign	0.0000	-1e-04***	0*	0***	0*	0*	0***	0.0000	0.0000	0.0000	0.0000	13662	0.0143
		(-0.3234)	(-13.783)	(-1.9181)	(-3.0846)	(-1.8561)	(-1.7585)	(-2.6948)	(-0.6382)	(-1.3961)	(-0.5983)	(-0.5986)	13662	0.0143
	Size	0.0000	-0.3234***	-0.1042***	-0.0553***	-0.0377***	-0.0381***	-0.0418***	-0.0189**	-0.0127	-0.0049	-0.0472***	13662	0.0980
		(-1.2961)	(-37.6873)	(-11.5559)	(-6.1094)	(-4.1588)	(-4.2108)	(-4.6239)	(-2.0951)	(-1.4138)	(-0.546)	(-5.5507)	13662	0.0980
United Kingdom	Sign	0.0000	-1e-04***	0***	0**	0.0000	0**	0.0000	0.0000	0.0000	0.0000	0.0000	16970	0.0090
		(0.7414)	(-12.1671)	(-3.6284)	(-2.2351)	(-1.0004)	(-1.9959)	(-0.1975)	(0.0541)	(-0.5189)	(-1.4194)	(-0.5651)	16970	0.0090
	Size	0.0000	-0.3238***	-0.1488***	-0.0945***	-0.0595***	-0.0536***	-0.0416***	-0.0237***	-0.0199**	-0.029***	-0.0327***	16970	0.0982
		(0.1729)	(-41.966)	(-18.3576)	(-11.5473)	(-7.2518)	(-6.5841)	(-5.1118)	(-2.9182)	(-2.4606)	(-3.6135)	(-4.276)	16970	0.0982
United States	Sign	0.0000	-1e-04***	0*	0.0000	0.0000	0***	0.0000	0***	0.0000	0*	0.0000	8165	0.0194
		(-0.8904)	(-11.659)	(-1.878)	(-0.5188)	(0.2048)	(3.2789)	(-0.8449)	(-3.7301)	(0.9842)	(-1.8775)	(0.471)	8165	0.0194
	Size	0.0000	-0.2751***	-0.1178***	-0.0361***	-0.0252**	0.0138	-0.0099	-0.0749***	-0.0185	-0.0466***	-0.0108	8165	0.0783
		(-1.6035)	(-24.7405)	(-10.2261)	(-3.1138)	(-2.18)	(1.1913)	(-0.8625)	(-6.5178)	(-1.6062)	(-4.0771)	(-0.9884)	8165	0.0783
Monthly Data														
Japan	Sign	0.0000	-1e-04***	0**	0**	0**	0***	0.0000	0.0000	-1e-04***	0.0000	0**	4374	0.0326
		(-0.8884)	(-9.1685)	(-2.2135)	(2.3533)	(-2.3349)	(-2.6517)	(-0.4232)	(-0.343)	(-5.5357)	(1.5927)	(2.0259)	4374	0.0326
	Size	0.0000	-0.2833***	-0.1364***	-0.0605***	-0.1678***	-0.1509***	-0.0815***	-0.0403***	-0.1147***	-0.049***	0.0067	4374	0.1085
		(-1.5076)	(-18.8615)	(-8.8043)	(-3.9173)	(-10.918)	(-9.8256)	(-5.3286)	(-2.6891)	(-7.7519)	(-3.34)	(0.4789)	4374	0.1085
Switzerland	Sign	0.0000	-2e-04***	-1e-04***	0**	0.0000	0**	0**	0.0000	-1e-04***	0.0000	0**	3725	0.0338
		(0.6749)	(-9.5239)	(-3.1762)	(2.3498)	(-0.3855)	(-2.498)	(-2.4851)	(0.1065)	(-3.3775)	(1.2069)	(-2.1906)	3725	0.0338
	Size	0.0000	-0.3204***	-0.1085***	-0.0049	-0.0456***	0.0117	-0.0387***	0.0454***	-0.0618***	0.0047	-0.0432***	3725	0.1239
		(-0.7513)	(-19.6382)	(-8.0333)	(-0.3613)	(-3.4222)	(0.8808)	(-2.912)	(3.4336)	(-4.6776)	(0.3539)	(-3.3882)	3725	0.1239
United Kingdom	Sign	0.0000	-1e-04***	-1e-04***	1e-04***	0**	0.0000	0.0000	-1e-04***	0.0000	0.0000	1e-04***	4556	0.0254
		(0.6018)	(-8.4)	(-3.2818)	(3.0707)	(2.0477)	(0.1576)	(1.1946)	(-2.8923)	(-1.6276)	(-1.141)	(4.3871)	4556	0.0254
	Size	0.0000	-0.2313***	-0.1236***	-0.1514***	-0.0879***	-0.1084***	-0.0343**	-0.0739***	-0.1136***	-0.0489***	0.0348**	4556	0.0806
		(0.1973)	(-15.4299)	(-8.2254)	(-10.0522)	(-5.7957)	(-7.1414)	(-2.2587)	(-4.8872)	(-7.5955)	(-3.3181)	(2.4433)	4556	0.0806
United States	Sign	0**	0.0000	0.0000	0.0000	-1e-04**	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	2049	0.0016
		(-2.2574)	(-1.0431)	(-1.1193)	(0.186)	(-2.4145)	(-0.7245)	(0.4768)	(0.5943)	(-1.5699)	(-1.0455)	(-0.8385)	2049	0.0016
	Size	-1e-04**	-0.1691***	-0.0258	-0.0203	-0.0863***	-0.0227	0.0271	0.038*	-0.0502**	-0.0073	0.0521**	2049	0.0383
		(-2.3569)	(-7.4821)	(-1.1269)	(-0.9038)	(-3.8996)	(-1.0282)	(1.227)	(1.7386)	(-2.2987)	(-0.3336)	(2.4183)	2049	0.0383

Table I: Correlation: Risk Factors
Pairwise correlation between risk factors from section 5.3

	WORLD	BANK	MKTRF	SMB	HML	RMW	CMA	UMD	TERM	DEF	ICRF
WORLD	1										
BANK	0.8324	1									
MKTRF	0.8105	0.6916	1								
SMB	0.0804	0.0978	0.0402	1							
HML	0.0511	0.3262	-0.0537	0.1248	1						
RMW	-0.276	-0.2001	-0.3138	-0.2768	0.1548	1					
CMA	-0.2074	-0.0935	-0.3356	0.036	0.5316	0.2596	1				
UMD	-0.2334	-0.3664	-0.2026	-0.0707	-0.3336	0.0815	0.0547	1			
TERM	-0.2819	-0.3288	-0.2838	-0.0771	-0.1445	0.1304	-0.0016	0.1366	1		
DEF	0.4397	0.4595	0.3666	0.0754	0.1475	-0.1436	-0.0123	-0.1675	-0.7271	1	
ICRF	-0.0078	-0.0068	-0.0082	-0.0057	0.0253	-0.0015	0.0158	0.0235	-0.0077	-0.0429	1

Table J: Correlation - Strategy Returns
Correlation between the return for each market for one equally weighted and one size weighted strategy for 1 holding period and 1 lookback period.

	Daily Data				Weekly Data				Monthly Data			
	ALL	**CHF**	**GBP**	**JPY**	**ALL**	**CHF**	**GBP**	**JPY**	**ALL**	**CHF**	**GBP**	**JPY**
Equally Weighted												
CHF	0.5966				0.5682				0.5758			
GBP	0.2790	-0.3583			0.3161	-0.3589			0.1699	-0.5003		
JPY	0.7082	0.3251	-0.0970		0.6999	0.2900	-0.0629		0.6921	0.2761	-0.0902	
USD	0.3221	0.0550	-0.0082	0.0120	0.3079	0.0182	-0.0122	0.0326	0.4733	0.1860	0.0101	0.0136
Size Weighted												
CHF	0.5997				0.5874				0.5706			
GBP	0.3050	-0.3014			0.3390	-0.2991			0.1855	-0.4768		
JPY	0.6669	0.2718	-0.0784		0.6630	0.2663	-0.0674		0.6888	0.2821	-0.0986	
USD	0.3930	0.0779	0.0063	0.0244	0.3458	0.0306	0.0091	0.0254	0.5298	0.2015	0.0284	0.0621

Table K: Sharpe Ratio - Holding Periods

Sharpe ratios for the different strategies across holding periods for the one lookback period with no transaction cost.

		Holding Periods																
Strategy	Data Interval	1	2	3	4	5	6	8	10	12	14	16	18	20	22	26	36	48
All Markets																		
Size	Daily	5.6817	3.8201	2.8638	2.3036	1.8944	1.6314	1.2750	1.0852	0.9163	0.8183	0.7345	0.6613	0.5972	0.5568	0.4883	0.3929	0.3262
	Weekly	2.2282	1.5140	1.0969	0.8264	0.6756	0.6212	0.4823	0.4460	0.3446	0.3087	0.2793	0.2745	0.2471	0.2354	0.2053	0.1712	0.1527
	Monthly	0.4382	0.2906	0.1809	0.0761	0.0919	0.0766	0.0607	0.0789	0.0921	0.0878	0.1015	0.1033	0.1077	0.1094	0.1127	0.1263	0.1221
Equal	Daily	4.2184	2.8031	2.0671	1.6782	1.3799	1.1961	0.9409	0.8132	0.6855	0.6146	0.5538	0.5080	0.4579	0.4333	0.3838	0.3115	0.2623
	Weekly	1.6318	1.0675	0.8054	0.6236	0.4997	0.4568	0.3604	0.3394	0.2593	0.2274	0.2145	0.2158	0.1970	0.1881	0.1690	0.1481	0.1398
	Monthly	0.4273	0.3267	0.2214	0.0777	0.0733	0.0745	0.0632	0.0785	0.0879	0.0884	0.1049	0.1055	0.1076	0.1059	0.1105	0.1163	0.1176
Japan																		
Size	Daily	3.6153	2.2053	1.5981	1.3179	1.0401	0.8995	0.6973	0.5816	0.4727	0.4142	0.3686	0.3304	0.3007	0.2695	0.2285	0.1730	0.1332
	Weekly	1.4867	0.9684	0.6350	0.4680	0.3568	0.3084	0.2134	0.1893	0.1173	0.1040	0.0795	0.0787	0.0719	0.0614	0.0468	0.0191	-0.0003
	Monthly	0.2550	0.0970	-0.0179	-0.0938	-0.0385	-0.0525	-0.0460	-0.0491	-0.0495	-0.0508	-0.0520	-0.0548	-0.0464	-0.0476	-0.0521	-0.0550	-0.0591
Equal	Daily	2.7641	1.7360	1.2458	1.0217	0.8052	0.7055	0.5494	0.4580	0.3655	0.3205	0.2833	0.2567	0.2346	0.2134	0.1805	0.1363	0.1062
	Weekly	1.0934	0.6957	0.5016	0.3534	0.2534	0.2287	0.1576	0.1426	0.0782	0.0659	0.0524	0.0543	0.0481	0.0387	0.0271	0.0075	-0.0076
	Monthly	0.2405	0.1579	0.0626	-0.0519	-0.0119	-0.0410	-0.0405	-0.0437	-0.0499	-0.0521	-0.0467	-0.0555	-0.0446	-0.0494	-0.0551	-0.0574	-0.0601
Switzerland																		
Size	Daily	4.6436	3.0070	2.2174	1.7472	1.4809	1.2979	1.0576	0.9350	0.8314	0.7765	0.7179	0.6722	0.6433	0.6123	0.5693	0.5052	0.4602
	Weekly	1.6661	1.0776	0.9229	0.8162	0.7442	0.6873	0.6161	0.5795	0.5202	0.4857	0.4745	0.4408	0.4323	0.4305	0.4173	0.4021	0.3771
	Monthly	0.5443	0.5207	0.3839	0.2636	0.2555	0.2736	0.2795	0.3040	0.3181	0.3033	0.3036	0.2916	0.3043	0.2911	0.3110	0.3138	0.3192
Equal	Daily	3.0273	2.0122	1.4773	1.1910	1.0084	0.9015	0.7587	0.6964	0.6454	0.6069	0.5791	0.5518	0.5297	0.5112	0.4854	0.4386	0.4121
	Weekly	1.0530	0.7720	0.6956	0.6457	0.6060	0.5716	0.5145	0.5099	0.4719	0.4380	0.4301	0.4054	0.4017	0.4018	0.3915	0.3782	0.3600
	Monthly	0.4457	0.4632	0.3494	0.2449	0.2402	0.2650	0.2739	0.3003	0.3218	0.3091	0.3112	0.3000	0.3044	0.2921	0.3153	0.3124	0.3151
United Kingdom																		
Size	Daily	3.2649	2.2002	1.6672	1.4072	1.1372	1.0125	0.8138	0.6939	0.6093	0.5685	0.5213	0.4804	0.4283	0.4217	0.3816	0.3238	0.2835
	Weekly	1.3406	0.8785	0.6813	0.5037	0.5090	0.4367	0.3287	0.3144	0.2927	0.2410	0.2214	0.2318	0.2166	0.2056	0.1906	0.1707	0.1628
	Monthly	0.4957	0.2874	0.2782	0.1444	0.1123	0.1185	0.0996	0.1068	0.0956	0.1048	0.1120	0.1207	0.1236	0.1405	0.1413	0.1552	0.1484
Equal	Daily	2.4233	1.6305	1.2781	1.0687	0.8506	0.7661	0.6348	0.5475	0.4843	0.4552	0.4125	0.3852	0.3417	0.3458	0.3189	0.2772	0.2409
	Weekly	0.9705	0.6291	0.5245	0.4021	0.4171	0.3562	0.2656	0.2602	0.2473	0.2101	0.1944	0.2083	0.1902	0.1792	0.1701	0.1514	0.1529
	Monthly	0.5027	0.3627	0.3092	0.1819	0.1039	0.1353	0.1033	0.0947	0.0774	0.0940	0.1007	0.1061	0.1085	0.1263	0.1306	0.1453	0.1484
United States																		
Size	Daily	4.4875	3.8188	3.6074	3.3791	3.3332	3.1406	2.8762	2.7116	2.4960	2.2725	2.2231	1.9945	1.8005	1.7050	1.5284	1.2823	1.2321
	Weekly	2.2289	2.1688	1.7576	1.2400	0.9273	1.0243	0.9057	0.8936	0.8057	0.7506	0.7422	0.7752	0.6382	0.7245	0.5481	0.4291	0.4299
	Monthly	-0.1718	-0.2649	-0.4503	-0.3835	-0.4236	-0.5492	-0.6709	-0.5643	-0.4917	-0.4482	-0.3772	-0.3072	-0.3118	-0.4061	-0.3875	-0.0724	-0.0436
Equal	Daily	3.8429	3.2089	2.8585	2.8826	2.7794	2.5057	2.2526	2.1502	1.9473	1.7384	1.6703	1.5167	1.4003	1.2843	1.1523	0.9609	0.9333
	Weekly	1.7964	1.6590	1.2747	0.9844	0.6710	0.6504	0.6868	0.6193	0.5348	0.4818	0.5256	0.5320	0.4517	0.4767	0.3693	0.3300	0.3736
	Monthly	-0.1764	-0.3494	-0.4397	-0.4890	-0.5676	-0.6313	-0.7185	-0.6037	-0.4947	-0.4796	-0.3666	-0.2688	-0.2597	-0.3554	-0.3274	-0.1436	-0.1094

Table L: Sharpe Ratio - Holding Periods With Transaction Cost

Sharpe ratios for the different strategies across holding periods for one lookback period with transaction costs of 15bp.

		Holding Periods																
Strategy	Data Interval	1	2	3	4	5	6	8	10	12	14	16	18	20	22	26	36	48
All Markets																		
Size	Daily	1.0830	1.0691	0.9223	0.8172	0.6893	0.6221	0.5113	0.4710	0.4034	0.3772	0.3482	0.3176	0.2875	0.2750	0.2498	0.2207	0.1968
	Weekly	1.2405	0.9446	0.6967	0.5139	0.4260	0.4121	0.3246	0.3196	0.2388	0.2178	0.1996	0.2035	0.1832	0.1774	0.1561	0.1356	0.1259
	Monthly	0.2327	0.1691	0.0961	0.0116	0.0409	0.0338	0.0284	0.0527	0.0703	0.0691	0.0851	0.0887	0.0945	0.0975	0.1026	0.1190	0.1167
Equal	Daily	-0.9378	-0.0762	0.0815	0.1693	0.1625	0.1781	0.1737	0.1979	0.1719	0.1737	0.1679	0.1649	0.1489	0.1521	0.1457	0.1395	0.1333
	Weekly	0.5663	0.4847	0.4019	0.3081	0.2476	0.2456	0.2021	0.2126	0.1532	0.1365	0.1347	0.1449	0.1332	0.1301	0.1198	0.1126	0.1130
	Monthly	0.2140	0.2104	0.1391	0.0140	0.0224	0.0318	0.0310	0.0524	0.0663	0.0698	0.0886	0.0909	0.0944	0.0940	0.1004	0.1091	0.1122
Japan																		
Size	Daily	0.8250	0.6369	0.5136	0.4915	0.3741	0.3433	0.2781	0.2454	0.1920	0.1733	0.1575	0.1427	0.1317	0.1158	0.0983	0.0791	0.0627
	Weekly	0.8685	0.6332	0.4048	0.2918	0.2149	0.1898	0.1241	0.1180	0.0576	0.0527	0.0346	0.0387	0.0359	0.0287	0.0190	-0.0010	-0.0154
	Monthly	0.1078	0.0132	-0.0757	-0.1379	-0.0739	-0.0823	-0.0685	-0.0672	-0.0645	-0.0637	-0.0632	-0.0648	-0.0555	-0.0558	-0.0590	-0.0601	-0.0629
Equal	Daily	-0.2530	0.1271	0.1479	0.1897	0.1360	0.1475	0.1294	0.1216	0.0847	0.0795	0.0723	0.0692	0.0657	0.0598	0.0504	0.0424	0.0356
	Weekly	0.4448	0.3542	0.2688	0.1755	0.1104	0.1093	0.0679	0.0709	0.0182	0.0143	0.0073	0.0141	0.0120	0.0059	-0.0008	-0.0127	-0.0227
	Monthly	0.0871	0.0747	0.0049	-0.0960	-0.0473	-0.0708	-0.0629	-0.0618	-0.0648	-0.0650	-0.0579	-0.0655	-0.0537	-0.0576	-0.0620	-0.0624	-0.0638
Switzerland																		
Size	Daily	1.9324	1.4839	1.1623	0.9425	0.8346	0.7555	0.6493	0.6078	0.5591	0.5426	0.5130	0.4898	0.4792	0.4631	0.4429	0.4140	0.3917
	Weekly	1.0843	0.7521	0.7029	0.6496	0.6094	0.5737	0.5304	0.5108	0.4628	0.4363	0.4313	0.4026	0.3978	0.3991	0.3907	0.3828	0.3627
	Monthly	0.3922	0.4348	0.3257	0.2200	0.2206	0.2441	0.2572	0.2860	0.3030	0.2904	0.2923	0.2816	0.2952	0.2829	0.3039	0.3087	0.3154
Equal	Daily	0.0353	0.4334	0.4062	0.3810	0.3592	0.3577	0.3497	0.3690	0.3730	0.3730	0.3744	0.3694	0.3656	0.3620	0.3590	0.3473	0.3437
	Weekly	0.4370	0.4456	0.4754	0.4798	0.4721	0.4589	0.4293	0.4416	0.4147	0.3889	0.3871	0.3674	0.3673	0.3706	0.3650	0.3590	0.3456
	Monthly	0.2907	0.3768	0.2907	0.2013	0.2055	0.2355	0.2517	0.2823	0.3067	0.2962	0.2998	0.2899	0.2953	0.2839	0.3083	0.3073	0.3113
United Kingdom																		
Size	Daily	0.2854	0.4784	0.4552	0.4763	0.3790	0.3788	0.3361	0.3111	0.2895	0.2937	0.2809	0.2664	0.2356	0.2467	0.2332	0.2166	0.2031
	Weekly	0.6969	0.5268	0.4362	0.3154	0.3553	0.3071	0.2311	0.2357	0.2265	0.1843	0.1715	0.1873	0.1765	0.1692	0.1598	0.1484	0.1460
	Monthly	0.3110	0.1908	0.2116	0.0930	0.0708	0.0841	0.0735	0.0860	0.0782	0.0896	0.0987	0.1089	0.1129	0.1308	0.1330	0.1493	0.1439
Equal	Daily	-0.8156	-0.1372	0.0510	0.1296	0.0884	0.1301	0.1558	0.1646	0.1646	0.1808	0.1723	0.1714	0.1493	0.1710	0.1708	0.1702	0.1606
	Weekly	0.3018	0.2756	0.2795	0.2141	0.2638	0.2270	0.1683	0.1816	0.1811	0.1534	0.1445	0.1639	0.1501	0.1428	0.1394	0.1291	0.1361
	Monthly	0.3122	0.2675	0.2419	0.1303	0.0622	0.1008	0.0772	0.0740	0.0599	0.0789	0.0874	0.0943	0.0978	0.1165	0.1223	0.1394	0.1439
United States																		
Size	Daily	-0.1535	0.1852	0.4183	0.5230	0.5971	0.5463	0.5793	0.5861	0.5748	0.4997	0.5626	0.4031	0.2691	0.2556	0.2262	0.1715	0.2240
	Weekly	1.1207	1.2828	1.0231	0.5851	0.3643	0.4974	0.4616	0.4962	0.4464	0.4147	0.4147	0.4652	0.3392	0.4360	0.2785	0.1964	0.2233
	Monthly	-0.4262	-0.4662	-0.6091	-0.5283	-0.5611	-0.6753	-0.7697	-0.6614	-0.5786	-0.5260	-0.4560	-0.3843	-0.3870	-0.4784	-0.4541	-0.1344	-0.1006
Equal	Daily	-2.0668	-1.2301	-0.8749	-0.5015	-0.3703	-0.4274	-0.2899	-0.1588	-0.1556	-0.1619	-0.0862	-0.1452	-0.1809	-0.2022	-0.1992	-0.1859	-0.0913
	Weekly	0.5268	0.6747	0.4557	0.2607	0.0478	0.0746	0.2058	0.1952	0.1519	0.1251	0.1728	0.1988	0.1323	0.1743	0.0947	0.0890	0.1601
	Monthly	-0.4628	-0.5539	-0.5912	-0.6260	-0.6955	-0.7502	-0.8138	-0.6937	-0.5729	-0.5501	-0.4389	-0.3392	-0.3268	-0.4181	-0.3829	-0.1883	-0.1456

Table M: Kurtosis & Skewness

Annualised Standard deviation, Skewness and Kurtosis for the different markets with 1 holding period and 1 lookback period

Market	Stategy	Standard Deviation	Skewness	Kurtosis	N
Daily Data					
All Markets	Size	0.0822	2.4284	34.0694	6466
	Equal	0.0733	1.7745	26.6203	6466
Japan	Size	0.1355	0.7503	9.2597	5675
	Equal	0.1253	0.4631	7.6504	5675
Switzerland	Size	0.1394	2.5014	63.3738	4641
	Equal	0.1263	2.6378	83.6367	4641
United Kingdom	Size	0.1269	1.2375	17.9599	5261
	Equal	0.1167	0.6508	12.3488	5261
United States	Size	0.0814	1.9083	19.1580	5103
	Equal	0.0640	1.0316	12.7830	5103
Weekly Data					
All Markets	Size	0.0790	2.1685	23.3278	1328
	Equal	0.0732	1.8458	21.0734	1328
Japan	Size	0.1262	0.6856	7.0150	1142
	Equal	0.1203	0.5335	6.5219	1142
Switzerland	Size	0.1341	1.1478	14.7483	921
	Equal	0.1266	1.1327	17.0402	921
United Kingdom	Size	0.1212	1.0941	11.3701	1026
	Equal	0.1166	1.2561	14.0134	1026
United States	Size	0.0704	0.8384	6.7617	1077
	Equal	0.0614	0.7781	8.3746	1077
Monthly Data					
All Markets	Size	0.0876	1.7346	16.6802	393
	Equal	0.0844	2.0398	19.9271	393
Japan	Size	0.1222	0.4024	6.5893	330
	Equal	0.1174	0.6157	7.5037	330
Switzerland	Size	0.1184	0.2610	4.8579	265
	Equal	0.1161	0.2691	5.4578	265
United Kingdom	Size	0.0975	0.2065	3.4692	285
	Equal	0.0945	0.3064	3.7443	285
United States	Size	0.0708	-0.0967	6.2530	267
	Equal	0.0629	0.0760	6.9579	267

Table N: Regression Results - Daily

Regression results for the Daily data interval for the US and All market portfolios. The returns come from a strategy of one holding and lookback period. All t-statistics are calculated using HAC robust standard errors with a lag of 8 using the method by Newey and West (1987). All α's are annualised and presented as a percentage.

	All Markets								United States							
	Size Weighted				Equally Weighted				Size Weighted				Equally Weighted			
Factor	FF3	C4	FF5	ALL	FF3	C4	FF5	ALL	FF3	C4	FF5	ALL	FF3	C4	FF5	ALL
WORLD RF	-0.0437***	-0.043***	-0.0468***	-0.0256**	-0.0474***	-0.0461***	-0.0499***	-0.0279**	0.022*	0.0218*	0.0218	0.0293**	0.0166	0.0168	0.0169	0.0216*
	(-4.2816)	(-4.3801)	(-4.4957)	(-2.1621)	(-5.0342)	(-5.0059)	(-5.196)	(-2.4997)	(1.7581)	(1.7262)	(1.5966)	(1.9891)	(1.5356)	(1.4913)	(1.4715)	(1.8201)
SMB	-0.0071	-0.0071	-0.0056	-0.0049	-3e-04	-3e-04	0.0023	0.003	-0.0062	-0.0063	-0.0017	-0.0019	0.0049	0.0049	0.0097	0.0095
	(-0.6696)	(-0.6691)	(-0.5011)	(-0.4296)	(-0.034)	(-0.0335)	(0.2259)	(0.2932)	(-0.4968)	(-0.502)	(-0.1309)	(-0.1537)	(0.4869)	(0.4923)	(0.9414)	(0.9303)
HML	-0.0276***	-0.0262**	-0.0175	-0.0032	-0.025***	-0.0227**	-0.0155	7e-04	-0.0028	-0.0031	0.0045	0.0059	-1e-04	1e-04	0.0062	0.0084
	(-2.7506)	(-2.2755)	(-1.5625)	(-0.2525)	(-2.7629)	(-2.2443)	(-1.4198)	(0.063)	(-0.2729)	(-0.2583)	(0.4084)	(0.4292)	(-0.015)	(0.0112)	(0.6873)	(0.7606)
CMA			-0.0365*	-0.035*			-0.0376**	-0.0374**			-0.0367	-0.0359			-0.0334*	-0.0346*
			(-1.9279)	(-1.8773)			(-2.1177)	(-2.1061)			(-1.5081)	(-1.4121)			(-1.7511)	(-1.8003)
RMW			0.0063	-0.0024			0.0109	0.0016			0.0247	0.0245			0.0258*	0.0249
			(0.427)	(-0.1621)			(0.8362)	(0.1256)			(1.3646)	(1.2942)			(1.6874)	(1.6154)
UMD		0.0029		0.0053		0.0052		0.0076		-8e-04		0.0013		7e-04		0.0026
		(0.344)		(0.6588)		(0.6946)		(1.0853)		(-0.0816)		(0.1255)		(0.085)		(0.3222)
TERM				0.0909***				0.0976***				-0.0344				-0.0174
				(3.2449)				(4.0267)				(-0.9729)				(-0.5957)
DEF				-0.0848				-0.0809				-0.0983*				-0.0551
				(-1.4856)				(-1.5904)				(-1.7007)				(-1.0778)
ICRF				-0.0108				-0.013				0.0764				0.0289
				(-0.0971)				(-0.1359)				(0.5746)				(0.2773)
α	47.7362***	47.7188***	47.8191***	47.5443***	31.9863***	31.9557***	32.0454***	31.7451***	36.6881***	36.6907***	36.6503***	36.7226***	24.6615***	24.6591***	24.6073***	24.6573***
	(32.4366)	(32.1696)	(32.464)	(32.1503)	(25.1489)	(24.9303)	(25.1639)	(25.0231)	(18.6397)	(18.6367)	(18.5603)	(18.3668)	(16.1692)	(16.1355)	(16.0971)	(16.0446)
α TC 15bp	9.9362***	9.9188***	10.0191***	9.7443***	-5.8137***	-5.8443***	-5.7546***	-6.0549***	-1.1119	-1.1093	-1.1497	-1.0774	-13.1385***	-13.1409***	-13.1927***	-13.1427***
	(6.7516)	(6.6868)	(6.8019)	(6.5893)	(-4.571)	(-4.5595)	(-4.5189)	(-4.7728)	(-0.5649)	(-0.5634)	(-0.5822)	(-0.5389)	(-8.6142)	(-8.5986)	(-8.6302)	(-8.5521)
Adjusted R^2	0.0149319	0.0149758	0.0159165	0.0336157	0.0203911	0.0205633	0.0217635	0.0461684	0.00196994	0.00197201	0.00295967	0.00413749	0.00195113	0.00195369	0.00345328	0.00407241
N	5615	5615	5615	5615	5615	5615	5615	5615	5078	5078	5078	5078	5078	5078	5078	5078

Two-Sided test: $*** < 1\% < ** < 5\% < * < 10\%$

Table O: Regression Results - Weekly

Regression results for the Daily data interval for the US and All market portfolios. The returns come from a strategy of one holding and lookback period. All t-statistics are calculated using HAC robust standard errors with a lag of 5 using the method by Newey and West (1987).

	All Markets								United States							
	Size Weighted				Equally Weighted				Size Weighted				Equally Weighted			
Factor	FF3	C4	FF5	ALL	FF3	C4	FF5	ALL	FF3	C4	FF5	ALL	FF3	C4	FF5	ALL
WORLD RF	-0.0494***	-0.0463***	-0.0557***	-0.0237	-0.0469***	-0.0422***	-0.0514***	-0.0187	-0.0115	-0.0113	-0.0016	0.0102	0.0026	0.0068	0.0102	0.0285
	(-3.6689)	(-2.969)	(-3.6854)	(-1.312)	(-3.5924)	(-2.7763)	(-3.4801)	(-1.0926)	(-0.6935)	(-0.6535)	(-0.0886)	(0.4802)	(0.1836)	(0.4378)	(0.6402)	(1.4745)
SMB	0.0143	0.0136	0.0156	0.0206	0.0103	0.0092	0.013	0.0173	-0.029	-0.029	-0.0202	-0.0144	-0.0182	-0.0186	-0.0107	-0.0067
	(0.7239)	(0.6964)	(0.6827)	(0.9692)	(0.5473)	(0.4949)	(0.6068)	(0.8628)	(-1.3197)	(-1.3174)	(-0.8108)	(-0.5983)	(-0.9475)	(-0.9686)	(-0.5067)	(-0.3233)
HML	-0.0623***	-0.0586***	-0.0467**	-0.0273	-0.0657***	-0.0603***	-0.0533***	-0.0306	0.0212	0.0213	0.0095	6e-04	0.0144	0.0176	0.0061	0.0085
	(-3.9342)	(-3.5099)	(-2.24)	(-1.1907)	(-4.1874)	(-3.706)	(-2.6319)	(-1.4197)	(1.1971)	(1.2011)	(0.4459)	(0.028)	(0.9327)	(1.1367)	(0.3316)	(0.4681)
CMA			-0.0511	-0.0521			-0.0457	-0.0483			0.012	0.0197			0.0051	0.0031
			(-1.4139)	(-1.3785)			(-1.2978)	(-1.3199)			(0.2865)	(0.47)			(0.1486)	(0.0911)
RMW			0.0032	-0.0069			0.0087	-0.0033			0.0464	0.055*			0.0384	0.0378
			(0.1109)	(-0.2407)			(0.3247)	(-0.1268)			(1.4237)	(1.6545)			(1.4025)	(1.3495)
UMD		0.0085		0.0127		0.0126		0.0159		4e-04		-0.0092		0.0103		0.005
		(0.6052)		(0.8868)		(0.9906)		(1.2407)		(0.0335)		(-0.6567)		(0.9026)		(0.4219)
TERM				0.0611				0.0784**				-0.0619*				-0.0372
				(1.5603)				(2.1151)				(-1.7244)				(-1.1352)
DEF				-0.1707**				-0.1619**				-0.1172**				-0.1267**
				(-2.2466)				(-2.3799)				(-1.962)				(-2.3559)
ICRF				0.254				0.3807				0.4256				0.415
				(0.5576)				(0.9184)				(0.7408)				(0.9406)
α	18.0164***	17.9541***	18.2092***	18.0535***	12.7442***	12.6522***	12.8869***	12.6347***	16.1365***	16.1336***	15.8317***	15.9553***	11.4745***	11.4075***	11.2411***	11.2967***
	(14.4965)	(14.2505)	(14.3205)	(14.2566)	(10.7803)	(10.6057)	(10.7245)	(10.7525)	(9.6713)	(9.6508)	(9.4386)	(9.4963)	(8.2421)	(8.1701)	(7.947)	(8.047)
α TC 15bp	10.2164***	10.1541***	10.4092***	10.2535***	4.9442***	4.8522***	5.0869***	4.8347***	8.3365***	8.3336***	8.0317***	8.1553***	3.6745***	3.6075***	3.4411**	3.4967**
	(8.2204)	(8.0595)	(8.1863)	(8.0971)	(4.1823)	(4.0673)	(4.2333)	(4.1145)	(4.9964)	(4.985)	(4.7884)	(4.8539)	(2.6394)	(2.5837)	(2.4327)	(2.4908)
Adjusted R^2	0.0341	0.0346	0.0363	0.0666	0.0390	0.0401	0.0409	0.0803	0.0032	0.0032	0.0058	0.0112	0.0013	0.0019	0.0036	0.0109
N	1156	1156	1156	1156	1156	1156	1156	1156	1052	1052	1052	1052	1052	1052	1052	1052

Two-Sided test: $*** < 1\% < ** < 5\% < * < 10\%$

Table P: Regression Results - Monthly

Regression results for the monthly data interval for the US and All market portfolios. The returns come from a strategy of one holding and lookback period. All t-statistics are calculated using HAC robust standard errors with a lag of 4 using the method by Newey and West (1987).

	All Markets								United States							
	Size Weighted				Equally Weighted				Size Weighted				Equally Weighted			
Factor	FF3	C4	FF5	ALL	FF3	C4	FF5	ALL	FF3	C4	FF5	ALL	FF3	C4	FF5	ALL
WORLD RF	0.0548**	0.0561*	0.0537*	0.0765*	0.049**	0.0489*	0.0464*	0.0728**	0.0453	0.0579	0.0384	-0.0073	0.0498	0.0524	0.038	-0.0116
	(1.9875)	(1.7564)	(1.7775)	(1.9225)	(2.0386)	(1.6877)	(1.7704)	(2.02)	(0.8975)	(1.0526)	(0.678)	(-0.1271)	(1.0979)	(1.0436)	(0.7427)	(-0.2467)
SMB	-0.0493	-0.0497	-0.0295	-0.0188	-0.039	-0.039	-0.0285	-0.0145	0.0144	0.0175	0.0221	-0.0035	0.0376	0.0383	0.0351	0.0106
	(-1.4508)	(-1.421)	(-0.8488)	(-0.5345)	(-1.3934)	(-1.352)	(-0.92)	(-0.4629)	(0.2871)	(0.3544)	(0.4569)	(-0.0761)	(0.9449)	(0.9556)	(0.8774)	(0.2859)
HML	-0.0362	-0.0356	-0.0207	-0.0044	-0.0356	-0.0356	-0.0197	-0.0042	0.1028**	0.1044***	0.1797***	0.199***	0.092**	0.0924**	0.165***	0.1754***
	(-1.0477)	(-1.054)	(-0.482)	(-0.1014)	(-1.1129)	(-1.142)	(-0.4573)	(-0.0973)	(2.5402)	(2.6501)	(4.1124)	(5.5671)	(2.4945)	(2.527)	(3.7129)	(5.2362)
CMA			-0.0812	-0.0828			-0.0614	-0.0637			-0.2317***	-0.2445***			-0.1939***	-0.1989***
			(-1.2363)	(-1.2336)			(-0.9822)	(-0.9944)			(-3.5104)	(-3.8963)			(-3.2352)	(-3.6436)
RMW			0.0491	0.0368			0.0254	0.0162			0.0741	0.0144			0.0244	-0.0205
			(1.1661)	(0.8565)			(0.659)	(0.4071)			(1.0398)	(0.2014)			(0.3879)	(-0.3328)
UMD		0.0025		-6e-04		-2e-04		-0.003		0.0233		0.0528*		0.0047		0.0351
		(0.1172)		(-0.0298)		(-0.0084)		(-0.1459)		(0.8827)		(1.7283)		(0.181)		(1.2214)
TERM				0.0532				0.037				0.1321*				0.1106
				(0.8772)				(0.6708)				(1.6454)				(1.5231)
DEF				-0.0732				-0.0954				0.2579**				0.2419**
				(-0.8146)				(-1.1132)				(2.449)				(2.455)
ICRF				-0.5151				-0.9647				-0.558				-0.6545
				(-0.2814)				(-0.6104)				(-0.2647)				(-0.3474)
Alpha	3.527***	3.5111***	3.5573**	3.521**	3.3355***	3.3366***	3.4207***	3.475**	-1.281	-1.4199	-0.9523	-1.1712	-1.253	-1.281	-0.7839	-0.9234
	(2.6651)	(2.7567)	(2.5743)	(2.5412)	(2.6509)	(2.75)	(2.6008)	(2.5681)	(-0.8378)	(-0.9509)	(-0.5828)	(-0.7254)	(-0.9369)	(-0.9654)	(-0.5362)	(-0.6151)
Alpha 15bp	1.727	1.7111	1.7573	1.721	1.5355	1.5366	1.6207	1.675	-3.081**	-3.2199**	-2.7523*	-2.9712*	-3.053**	-3.081**	-2.5839*	-2.7234*
	(1.3049)	(1.3435)	(1.2717)	(1.2421)	(1.2203)	(1.2664)	(1.2322)	(1.2378)	(-2.015)	(-2.1563)	(-1.6844)	(-1.8403)	(-2.2828)	(-2.3218)	(-1.7675)	(-1.814)
Adjusted R^2	0.0187	0.0187	0.0255	0.0339	0.0161	0.0161	0.0194	0.0291	0.0421	0.0444	0.0797	0.1101	0.0559	0.0560	0.0852	0.1155
N	276	276	276	276	276	276	276	276	248	248	248	248	248	248	248	248

Two-Sided test: $*** < 1\% < ** < 5\% < * < 10\%$

Table Q: Regression Results - Hedge Fund Indices

Regression results from regressing Hedge Fund Index (HF) on all the risk factors from Equation 16 and the return of our strategy denoted as STRATEGY in the table. The only thing that changes between rows is the makeup of this STRATEGY factor; the market and the Data Interval denote this. All α's are in percentage and the t-statistics are HAC robust using a lag of 4.

Data Interval	α	WORLD.RF	SMB	HML	RMW	CMA	UMD	TERM	DEF	ICRF	STRATEGY	Adj. R^2
All Markets												
Daily	5.1015***	0.1879***	0.0744***	0.0169	-0.0781***	-0.0408	0.1201***	0.1543***	0.3608***	2.4359*	-0.0513*	0.6807
	(4.2418)	(9.4278)	(3.3362)	(0.7509)	(-3.1877)	(-1.104)	(6.9728)	(3.3865)	(7.4552)	(1.8116)	(-1.795)	
Weekly	4.311***	0.1906***	0.0766***	0.015	-0.0762***	-0.0458	0.1206***	0.1473***	0.3516***	2.5463*	-0.066**	0.6815
	(4.9939)	(9.3805)	(3.5011)	(0.6563)	(-3.0446)	(-1.2183)	(7.0457)	(3.2343)	(7.5179)	(1.8878)	(-2.1346)	
Monthly	3.5897***	0.1848***	0.0791***	0.0171	-0.0773***	-0.0405	0.1204***	0.1526***	0.3737***	2.5548*	-0.0192	0.6778
	(4.4585)	(8.9732)	(3.5384)	(0.7426)	(-3.0286)	(-1.1021)	(7.1105)	(3.4192)	(7.9668)	(1.8977)	(-1.031)	
United States												
Daily	3.3187***	0.1892***	0.0366*	0.0188	-0.0374	-0.0268	0.0949***	0.1275***	0.35***	1.5879	-1e-04	0.6877
	(3.1861)	(8.7237)	(1.8969)	(0.7366)	(-1.4567)	(-0.6562)	(7.1412)	(2.8996)	(6.8357)	(1.2113)	(-0.0044)	
Weekly	3.9547***	0.1909***	0.0359*	0.0178	-0.0329	-0.026	0.0951***	0.1199***	0.3389***	1.6851	-0.0622*	0.6928
	(4.568)	(8.5487)	(1.8308)	(0.7003)	(-1.2889)	(-0.6348)	(7.2897)	(2.6842)	(6.6535)	(1.3058)	(-1.8849)	
Monthly	3.4886***	0.1885***	0.0312	0.005	-0.0413*	-0.0169	0.0929***	0.1196***	0.3389***	1.6394	0.0636**	0.6920
	(4.7005)	(9.1879)	(1.6192)	(0.1925)	(-1.7004)	(-0.4242)	(7.308)	(2.6775)	(7.0595)	(1.2396)	(2.08)	

Figure A: Plotted Swap Spread

This Figure shows the Interest Rate Swap (IRS) rate and the government bond yield across markets for the 10Y maturity. On the bottom par of the Figure we see the Swap Spread (SS) between these two in green.

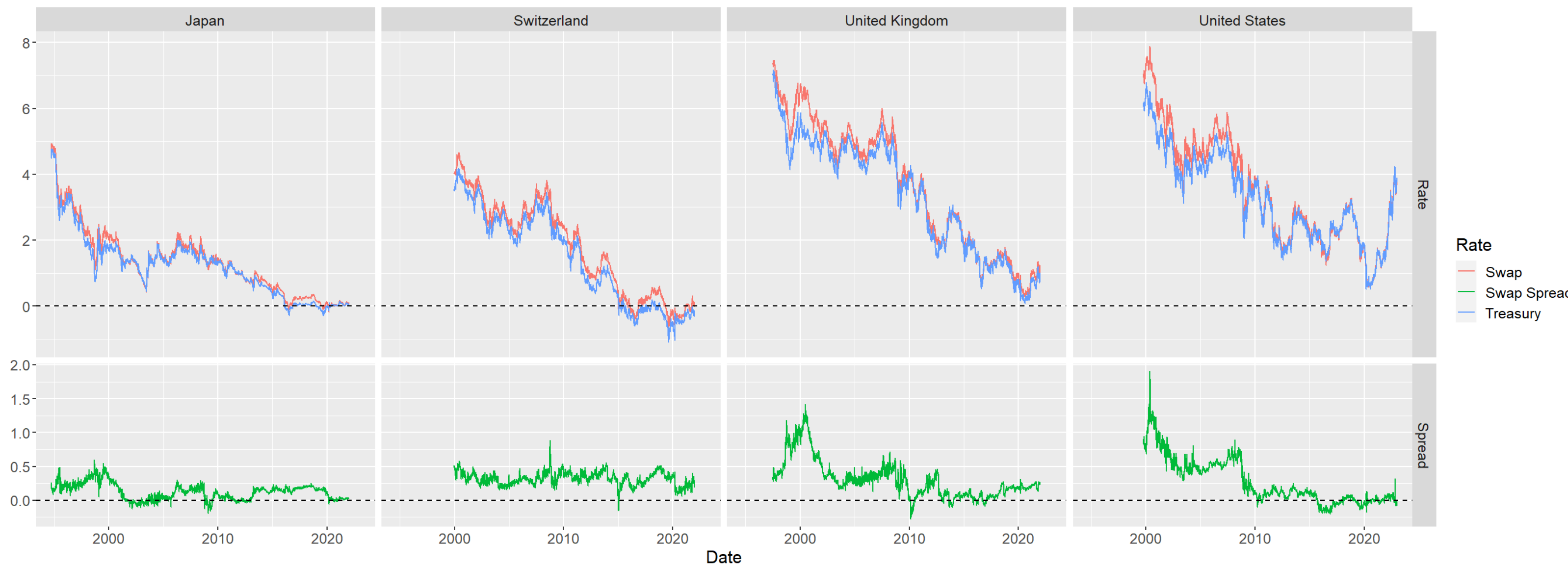

Figure B: ICR-Factor
The quarterly Intermediary Capital Ratio Factor (ICRF)-factor by He et al. (2017) created using Equation 15.

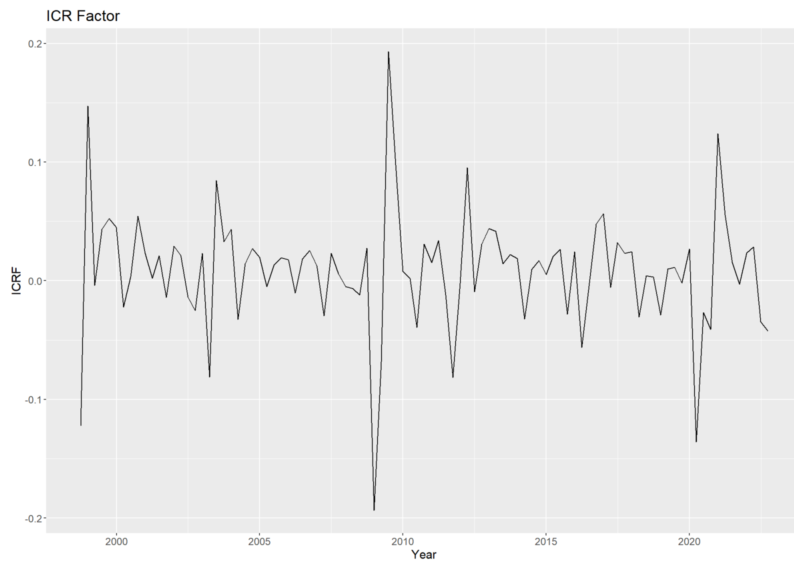

Figure C: Precision of the DV01 Calculations
A scatter plot between the actual mark-to-market return of Government bonds found on the Refinitiv Terminal and the ones calculated using Equation 6