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Macroeconomic Momentum in the Foreign Exchange Market

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ABSTRACT:
For decades, academics and investors have searched for profitable portfolio management strategies while some fundamental theories in the field deny the possibility for gaining such excess returns. As a counter argument against these theories, momentum anomalies have received attention in academic literature. One of these anomalies is the momentum anomaly, which indicates that historical price or performance development of an asset can be used to predict future prices and performance. Several studies have shown the effectiveness of the respective strategies across several markets, but the source of excess returns is still a mystery. After momentum anomaly gained a permanent foothold in equity market research, the phenomenon has been studied widely in other markets. Although excess returns have been linked to the respective strategy on multiple occasions, the inherent source for such returns remains unknown. This master's thesis examines macroeconomic momentum investment strategy expanding the existing momentum research. As macroeconomic data is strongly linked to the pricing of currencies, we look for momentum trends from macroeconomic data variables. With these trends, currencies in the investment universe are set to a ranking which is used to create monthly balanced long short portfolios.

Macroeconomic momentum portfolios show that the investment strategy produces unique excess returns that well-known foreign exchange strategies cannot explain. Overall, the cumulative returns match almost the returns of benchmark strategies carry and momentum. However, compared to previous reports, the returns of macroeconomic momentum portfolios are relatively volatile. The background of the findings is influenced by possible differences in portfolio construction, differences in research samples and the lack of comparable research. The findings support the importance of further research. In addition to examining the currency market, the investment strategy could also be replaced in other markets for example fixed income products. Additionally, the results provide interesting findings on the most optimal lookback period for observing momentum trends. This study encompasses lookback periods from 1 to 60 months when typically, momentum research considers only lookback periods up to 12 months. The results support the favorability of these short lookback periods. As a new discovery also exceptionally long lookback periods from 37 to 60 months seem favorable.

The findings highlight the importance of further research. Due to the lack of comparable research making large generalizations is still fairly early. Results of this study also provide contradicting evidence to previous studies finding which find relatively low volatility in the return distribution of macroeconomic momentum portfolios. Through this there is an incentive for future research if momentum crashes found with other momentum strategies apply to these portfolios as well. In addition, the strategy could be applied to other markets like the fixed income market.

KEY WORDS: momentum, anomaly, foreign exchange, market efficiency, portfolio strategy

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TIIVISTELMÄ:
Tutkijat sekä sijoittajat ovat vuosikymmenten ajan etsineet sijoitusstrategioita, joilla hallita sijoitussalkua tehokkaasti saavuttaen ylituottoja. Useampi alan tunnetuimpiin teoksiin lukeutuvista teorioista kieltää ylituottojen mahdollisuuden markkinoiden perustavanlaatuisten piirteiden johdosta. Tämän myötä jo pitkän aikaa vasta-argumenttina näille teorioille ovat markkina-anomalioita hyödyntävät sijoitusstrategiat saaneet runsaasti huomiota myös akateemisen tutkimuksen saralla. Yksi näistä anomalioista on momentum anomalia, jonka mukaan sijoituskohteen historiallisen arvonkehityksen perusteella voidaan ennustaa tulevia liikkeitä. Momentum tutkimuksen löytäessä ensin jalansijansa osakemarkkinoilla, on tutkimus laajentunut kattamaan myös muut markkinat. Vaikka useat tutkimukset ovat osoittaneet kyseisten strategioiden toimivuuden useilla eri markkinoilla, on ylituottojen varsinainen lähde edelleen mysteeri. Tämä maisterintutkielma tutkii makroekonomista momentum -sijoitusstrategiaa laajentaen olemassa olevaa momentum -tutkimusta. Talousdatan linkittyessä vahvasti valuuttojen hinnoitteluun, etsitään momentum -trendejä talousalueiden datajulkaisujen kehityksestä. Havaittujen momentum trendien avulla sijoitusuniversumin valuutat laitetaan paremmuusjärjestykseen, jonka avulla luodaan kuukausittain tasapainotettavia long short portfolioita.

Makroekonomiset momentum -portfoliot osoittavat sijoitusstrategian tuottavan uniikkeja ylituottoja, joita esimerkiksi muut tunnetut valuuttamarkkinastrategiat eivät pysty selittämään. Kokonaisuudessaan kumulatiiviset tuotot yltävät lähes yhtä hyviin tuottoihin kuin valuuttamarkkinoiden strategiat carry sekä momentum. Verraten aikaisempiin tutkimuksiin makroekonomisen momentumin portofolioiden tuotot osoittautuvat kuitenkin suhteellisen volatiileiksi. Löydösten taustalla vaikuttaa mahdolliset eriävyydet portfolioiden muodostusmetodeissa, erilaiset tutkimusotokset sekä toisaalta verrokkitutkimusten vähäisyys. Lisäksi tutkimustulokset tuottavat mielenkiintoisia tuloksia optimaalisesta momentumin havainnointiperiodista. Tutkimus kattaa periodit 1-60 kuukautta, kun taas tyypillisesti momentumia on tutkittu lyhyemmillä maksimissaan 12 kuukauden periodeissa. Näiden lyhyiden periodien käyttö saa tukea myös tästä tutkimuksesta. Uutena löydöksenä kuitenkin myös erityisen pitkät 37-60 kuukauden havainnointiperiodit näyttäytyvät tuottavina vaihtoehtoina.

Löydökset tukevatkin jatkotutkimusten tärkeyttä. Aikaisemman tutkimuksen vähäisyyden vuoksi on vielä aikaista sanoa, kuinka laajasti tulokset ovat yleistettävissä. Tutkimuksen tulokset strategian tuottavuudesta eivät ole täysin linjassa aikaisemman tutkimuksen kanssa, jonka mukaan tuottokehityksen volatiliteetti on suhteellisen vähäistä. Tämän myötä tulevissa tutkimuksissa olisi mielekästä esimerkiksi tarkastella, liittyvätkö momentum strategioille tyypilliset momentum crash ominaisuudet myös tämän strategian kautta muodostettuihin portfolioihin. Valuuttamarkkinoita tutkivien tutkimusten lisäksi sijoitusstrategia voitaisiin toisintaa myös muilla markkinoilla esimerkiksi korkotuotteilla, joissa makrotalouden muuttujilla on myös suuri rooli tuotteiden hinnoittelussa.

AVAINSANAT: momentum, anomaly, foreign exchange, market efficiency, portfolio strategy

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Abbreviations

CPI	Consumer price index
ECB	European Central Bank
EMH	Efficient market hypothesis
FX	Foreign exchange
GBP	British pound
G10	Group of Ten
LIBOR	London Interbank Offered Rate
PPP	Purchasing power parity
RER	Real exchange rate
T-BILL	Treasury Bills
USD	The United States Dollar
VIX	CBOE Volatility Index

1 Introduction

Over the years, investors and academics have searched for the most efficient ways for portfolio construction in order to gain the most financial benefit. As a result, financial market anomalies have gained a permanent foothold as an object of academic interest and research. One of these anomalies is the momentum anomaly, that suggests that past performance of investment assets have the tendency to persist making future predictions possible from historical data (Jegadeesh and Titman, 1993). After first signs of momentum were found in the equity market, the phenomenon has been studied in various other asset classes (Asness et al., 2013; Hutchison & O'Brien, 2020; Menkhoff et al., 2012). Although signs of excess returns have been in these studies, the source for these returns remain ambiguous.

This study extends the research on momentum anomaly in the foreign exchange market by finding momentum trends in selected macroeconomic datapoints representing economic activity and inflation. Detected momentum trends are used in the creation of investment signals utilized in building cross currency long short portfolios. Closely following the research of Dahlquist and Hasseltoft (2020) on economic momentum, this study aims to solidify results of the researchers with a newer sample while providing extended evidence on comparability to selected benchmark strategies and creating an investment regime that can be translated into the real environment.

Previous literature has a void in linking macroeconomic factors and momentum returns, however there are several academic revelations supporting this approach. For instance, present-value models have seen to indicate exchange rates as products of current and expected fundamentals supporting momentum in foreign exchange market (Dahlquist & Hasseltoft, 2020). In addition, studies focusing on currency momentum and carry trade strategies have long been known to yield significant excess returns, owing to exploitable disparities in macroeconomic conditions (Orlov, 2016). The main premise is that macroeconomic indicators are strongly linked to exchange rates and thus macroeconomic

momentum should be utilizable in the foreign exchange market (Dahlquist and Hasseltoft, 2020). Previous literature indicate that exchange rates contain information about future fundamentals and more specifically inflation and economic activity fundamentals have been linked to currency rates (Sarno et al., 2014; Engel et al., 2005). Additionally, currency returns have been linked to macroeconomic uncertainty and countries' external imbalances (Berg et al., 2018; Corte et al., 2016). Moreover, it seems that currency rates are affected by macroeconomic fundamentals that essentially can be exploited if specific return drivers are observed.

The unique features and market participants of the currency market make it a desirable research platform for momentum strategies. According to Menkhoff et al. (2012), the foreign exchange markets propose liquidity, low transaction costs, high transaction volumes and investors not being constrained with short selling limits. Studies opposing momentum strategy's ability to create financial benefit to investors often lean on the proposition that the strategy is not profitable after taking for instance transaction costs into consideration (Korajczyk and Sadka, 2005; Lesmond et al., 2004). Taking information about the market structure into account with the research results in previous momentum studies, it is likely that a profitable momentum strategy can be built in the foreign exchange market.

1.1 Hypotheses and research questions

Due to the scarcity of existing literature on macroeconomic momentum, there are still many open questions present and the need for further research remains. This chapter presents a selected set of hypotheses to guide this research. In the last chapter of this paper these hypotheses and questions will be revisited to provide conclusionary statements.

H1: The foreign exchange market is not fully efficient.

For the researched investment strategy to be functionable, it needs to undermine the concept of efficient market hypothesis which suggest that historical movements cannot be utilized to predict future movements (Fama, 1970). Moreover, if macroeconomic momentum investment strategy based on an anomaly relying on essentially technical analysis proves profitable the existence of efficiency in the FX market can be debated (Okunev et al., 2003). Previous research has already uncovered momentum strategies to produce excess returns in the FX market questioning strong market efficiency (Zhang, 2022; Burnside et al., 2011; Menkhoff et al., 2012).

H2: Inflation fundamentals work better in generating excess returns over economic activity fundamentals.

Regardless of whether macroeconomic momentum strategy proves profitable or not, it is hypothesized that inflation data provides superior performance over economic activity data. The only previous study that combines macroeconomic indicators in a momentum strategy suggests that not all macroeconomic indicators produce equal returns. Dahlquist and Hasseltoft (2020) find inflation data to perform better than economic activity. Due to there not being any contradicting findings present, it is assumed that a similar result is obtained in this study. If contradicting evidence is found it enforces the importance on focusing more research on these topics in the future. This said, this study is based on a different dataset while also considering a different time period which may alter the results to deviate.

H3: Macroeconomic momentum generates the best results when momentum is observed from a short lookback period.

Previous momentum anomaly research has focused on strategies utilizing a lookback period from three to twelve months casting it as the most favorable range of lookback period (Weist, 2022). In addition, even shorter than three-month lookback periods have

received compelling evidence in previous literature. Zaremba et al. (2019) suggests one month-lookback period to be the most favorable for long-short momentum portfolios. Similarly, Medhat and Schmeling (2021) support the finding by stating that momentum patterns are typically the strongest in short lookback periods. Because of this, it is assumed that the best result for macroeconomic momentum portfolios will also be obtained from these lookback periods. This study includes much longer lookback periods to complement previous studies, but it is assumed that the best results are found from the shorter lookback periods stated as shorter or equal to 12 months.

1.2 Structure of the Study

The study is constructed in the following manner. The second chapter details the research gap of this study. The third chapter provides an overview of the study's theory and research framework. The third chapter introduces momentum anomaly in more detail as well as previous research conducted on macroeconomic momentum. The rest of the thesis focuses on the empirical implementation of the study. Chapter five explains the data choices made and the retrieval of the relevant datapoints. Chapter six goes over the methodology applied while the preceding chapter focuses on the results. Chapter eight goes back to the research questions and hypotheses at the start of the study to verify if the answers have been found. Chapter nine recognizes the limitations of the study and presents suggestions for previous research based on the research and results. The last chapter delivers the conclusions of the study.

2 Research gap

Although momentum has been researched on the foreign exchange market on multiple occasions, macroeconomic momentum in the FX market specifically has been only touched on once in academic research. In 2020 Dahlquist and Hasseltoft conducted research where momentum portfolios where composed based on macroeconomic datapoints. To date, this is the only academic contribution on the topic published in the top journals. While this thesis generally follows the guidance of Dahlquist and Hasseltoft, there are some conscious differences. This said, there are also other contributions towards the larger concept of momentum research.

In portfolio construction Dahlquist and Hasseltoft (2020) take on many alterations to portfolio construction such as weighting portfolios' underlying sub strategies according to past volatility instead of applying an equally weighted scheme. These alterations are stated to not have an impact on the end results of portfolio performance but the choice for doing such alterations have not been elaborated on leaving them to intuitive choices by the researchers. To challenge the choices, these alterations are not included in portfolio construction in this study. Because portfolio construction on other aspects follows the lead of Dahlquist and Hasseltoft (2020), significant deviations in performance results could entail these alterations to in fact have a notable effect after all.

Another interesting contribution that this study is able to provide is to set macroeconomic momentum portfolios side by side with a traditional price momentum portfolio utilizing a 3-month momentum lookback period. Dahlquist and Hasseltoft (2020) consider only a 12-month momentum while 3-month momentum is still recognized as one of the most used lookback periods to momentum portfolios (Weist, 2022). A set of fresh momentum research also suggest that as short as 1-month lookback periods typically have even the strongest momentum signals (Medhat & Schmeling, 2021; Zaremba 2019). This supports the avenue of also presenting a shorter lookback period momentum side by side with macroeconomic momentum portfolios.

While focusing on a specific investment strategy, this study provides also evidence utilizable on a larger area of momentum research. By adding evidence on utilizing long term momentum signals, the study expands the scope of momentum research study coverage. This is a notable contribution due to the fact that previous research utilizes only short-term momentum signals obtained with a maximum 12-month lookback period (Weist, 2022).

Conversely there is far less evidence of momentum in the cross section of multiple currencies (Menkhoff et al., 2012). This study contributes to the excising literature by investigating currency momentum in a cross-section of currency rates. Through this, a more realistic approach to currency trading strategies is provided as it is believed that investors aim to include a variety of currencies in their portfolios for diversification and thus are rarely focused on solely one exchange rate.

3 Theory and research framework

This chapter constitutes some of the most important theoretical concepts to understand and execute the empirical research presented. The first chapter focuses on currency valuation and provides an understanding on how macroeconomic variables are embedded into currency values. Macroeconomic momentum strategy inherently relies on a connection between the two concepts are the strategy uses macroeconomic variables in predicting currency valuations. Next, the novel theory of efficient market hypothesis is presented as this study challenges the core fundamentals of this theory's existence in the foreign exchange market. The last section of this chapter focuses on portfolio theory and more specifically the method used in this study, the long-short portfolio construction method.

3.1 Currency valuation

Value in the foreign exchange market has similar building blocks as any other asset class – value ultimately stems from the balance of supply and demand as well as expectation on future value movements. Currencies' values are typically expressed using exchange rates, indicating a currency's value compared to another currency. To put simply, an exchange rate of for instance EUR/USD expresses how many of dollars can you obtain in exchange for one euro. Exchange rates change constantly on international exchange rate markets where currencies of all sorts are exchanged.

Menkhoff et al. (2017) define intrinsic value of a currency, or "currency value" in short, to be a combination of purchasing power parity (PPP) and real exchange rate (RER). In addition to this theoretical framework, there are some external factors that affect the value of a currency. To understand currency quotes presented in the foreign exchange market, both of the concepts should be grasped.

The core idea behind purchasing power parity (PPP) is that exchange rates between two currencies are determined by the value of goods that can be obtained with the currency (Taylor & Taylor, 2004; The Economist, 2023). Parity being the "correct" valuation the imbalance of this parity determined the value of a currency. Purchasing power of currencies are typically measured by comparing prices of similar items. For instance, the Big Mac index is a well-known PPP measure that illustrates the idea in a lighthearted way. The index tells how many units of currency is needed to purchase on Big Mac hamburger (The economist, 2023). Let's assume a Big Mac costs 4,19 pounds in Britain and 5,58 dollars in the United States, implying an exchange rate of 0,75. However, often the price difference of the respective products is greater or lower, leading to a situation where there is a discrepancy between the exchange rate and purchasing power, proving that the purchasing power parity in currency valuations rarely holds. This suggests that there are also other factors affecting currency value that should be accounted for.

Real exchange rate (RER) as perhaps the most common measure of intrinsic currency value captures how a currency deviates from PPP (Taylor & Taylor, 2004; Menkhoff et al., 2017). RER contains three main elements: expected excess returns, expected real rate differentials and long-run expected RER (Menkhoff et al., 2017).

Equation 1. RER.

$$Q_t = \frac{P_t}{S_t P_t^*}$$

Where S is the exchange rate, USD per unit of foreign currency. P denotes the US price level and P* denotes the foreign price level.

Although PPP and RER give a comprehensive overview to currency valuation in terms of theoretical approach, it is important to notice that in real life there are also other forces affecting especially currency quotes. Namely these aspects include for instance central bank policies and their operational models for foreign exchange regimes. These models

and regimes determine if a currency is fully the product of natural supply and demand or if the local central bank has approved right to impose actions on the currency market that may affect currency valuation.

The International Monetary Fund (2023), IMF, concludes that foreign exchange regimes can be roughly divided into four baskets. Floating regimes, soft pegs, hard pegs and residuals. As a loose guideline, floating regime are typically the most organically valued currencies while hard pegs are the tightest measure to direct the valuation of a currency. Residuals include currencies which fall somewhere in between a floating regime and pegs.

Table 1. Exchange rate Arrangements.

Type	Categories				
Floating regimes	Free floating	Floating			
Soft pegs	Conventional pegged agreement	Pegged exchange rate with hotizontal bands	Stabilized arrangement	Crawling peg	Crawl-like arrangement
Hard Pegs	Exchange arrangement with no separate legal tender	Currency coard arrangement			
Residual	Other managed arrangement				

Source: International Monetary Fund (2023).

Floating regimes consists of currencies that are considered to be valued freely by the markets supply and demand (International Monetary Fund, 2023). These regimes can include interventions aiming to stabilize currency value while not aiming towards a specific level. Moreover, a floating regime can be classified as Free floating if market interventions by the central bank occur rarely and only in exceptional market conditions. Majority of the World's most exchanged currencies are under a floating regime.

With soft pegs central banks impose actions on the market in response to external events (International Monetary Fund, 2023). The actions aim to stabilize the currency's value against a reserve currency or a basket currency. Hard peg on the other hand refers to currency regimes where a currency's rate is fixed against another currency with a predetermined rate.

In addition to the chosen exchange regimes the Central banks can be viewed to have even more power over the valuation of currencies. Although currency values are largely defined by the overall markets' supply and demand, similar to many other assets, the foreign exchange market has unique features affecting the valuation. Supply in the foreign exchange markets is partly determined by central banks who issue the respective currency (Haile and Pozo, 2006). On the other hand, the role of central banks in the markets does not end here. They also have an influence in the demand side by monitoring the key interest rate at which the central bank offers loans to banks. Central Bank announcements have large impacts on exchange rates especially due to high market concentration, large scale leverage opportunities and particularly active market with the highest daily turnover compared to all other markets (Mueller et al., 2017).

Main driver in central bank decision is macroeconomic stability. Developed countries' central banks are known to closely monitor and utilize macroeconomic indicators as a part of their forecasts determining future decisions (Szyszko & Rutkowska, 2019; Brzoza-Brzezina et al., 2013). This supports the conclusion that macroeconomic fundamentals can provide vital information on currency rates. However, as central banks do not equally consider different fundamentals, there is no clear view which fundamental is the most important (Brzoza-Brzezina et al., 2013). Ayadi et al. (2019) prove that the foreign exchange market exhibits a systematic reaction to macroeconomic conditions by studying how euro, dollar and pound rates fluctuate relative to public information. The study generates evidence that interest rates do in fact show to move from specific scheduled macroeconomic announcements but also to explicit public comments from key people of relevant macroeconomic institutions. The impact and direction seem to be at least partially dependent on the condition of the market cycle. Previous literature has also found supporting features for the notion that macroeconomic fundamentals could affect currency returns. A study focused on macroeconomic fundamentals and the related risk factors in relation to carry returns reveals that macro fundamentals do in fact relate to currency pricing (Berg et al., 2013). The study is able to show global as well as prove that

the evidence is not dependent on outliers. Moreover, the results hold even when a sample of developed countries' currencies are used.

3.2 Efficient market hypothesis

Efficient market hypothesis is one of the core theories referenced in many major academic studies. The hypothesis states return of investment assets are unpredictable due to there not being any temporal or spatial structures that could be exploited (Fama, 1970). This so-called efficiency of the financial markets stems from equally distributed information on the market. This suggests that excess returns are not achievable due to asset prices, reflecting all available information, at all times. Like many other financial theories, EMH is often targeted by scrutiny and through this it has motivated many other preceding theories and research pieces (Wang & Yu, 2004; Baytas & Cakici, 1999).

Although the general conclusion of the efficient market hypothesis is that the markets are overall efficient, the theoretical framework recognizes different levels of efficiency (Fama, 1970). The weak form of efficiency states that prices reflect historical prices making technical analysis impractical. This already objects the use of technical analysis in estimating prices further. In the semi-strong form, prices include also all public information omitting the use of fundamental analysis. The strongest form on the other hand states that prices include all historical, public, and nonpublic information is reflected in prices. Here an investor does not have the opportunity to gain information that could be exploited.

In term of other financial markets, such as the currency markets, undermining EMH is not as clear. Due to markets nature as a liquid and consistent financial market, the suggested inaccuracy of the hypothesis is not as clear (Menkhoff et al., 2012; Namhoon et al., 2021). It has been suggested that the foreign exchange market does exhibit similar inefficiency as other financial markets, but academics have found it hard to generalize

this to the whole market. Previous research suspects that market inefficiency affects only minor currencies leading to the fact that investment strategies exploiting market inefficiency should not take these currencies into account (Menkhoff et al., 2012; Namhoon et al., 2021).

Meese and Rogoff (1983) find currency spot rates to be consistently unpredictable which can be considered as a sign of market efficiency. However, this connection is not as straight forward with currency spot rates. As Barroso and Santa Clara (2015) conclude, currencies do not have the same interest rates, and this can be utilized by borrowing low yielding currencies and invest in high yielding currencies if the rate difference does not forecast a corresponding depreciation. This sequence is the base for a well-known and thoroughly researched currency investment strategy “carry trade”, first introduced by Fama in 1984. The profitability of currency carry trade provides an indicator that there in fact does exist a discrepancy in currency interest rate differences and currency rate depreciation, meaning that currency rates do not price in all appropriate information, making the market not fully efficient.

To sum up the underlying idea of the *efficient market hypothesis* theory is, that the markets always reflect all available information (Fama, 1970), making it impossible for investors to successfully seek abnormal returns. However, as becomes apparent in the preceding chapters, academic research has found solid evidence that this does not always reflect reality. This thesis follows these research findings by leaning on the assumption that there in fact are possible anomalies which can be exploited to gain abnormal returns.

3.3 Portfolio theory

Modern portfolio theory introduced by Harry Markowitz (1952) is one of the most well-known theories in the financial industry and the cornerstone of many investment strategies. The theory is based on balancing risk minimization while optimizing financial

benefits. The core idea is that the risks related to portfolio returns can be minimized by spreading invested capital across multiple assets, whose returns correlate as little as possible with each other. The main assumption is that individual assets do not always perform equally. Essentially losses from poorly performing investments can be offset by financial gains obtained from other assets.

Portfolio theory can be used to find the composition of an optimal portfolio based on selected investment targets (Makin, 1978). According to portfolio theory, several portfolios can be created from investment targets, which are efficient according to the mean-variance analysis (Mao, 1970). From these portfolios, the investor can freely choose the most suitable one, meanwhile considering set return targets and risk-bearing capacity. Choice between these portfolios is completely up to the investor and the ranking of these portfolios is always personal.

The diversification benefit brought by portfolio theory can be maximized by increasing the number of investable assets in the portfolio (Mao, 1978). However, the achieved benefit grows non-linearly in relation to the added assets because expenses accumulated from increasing the assets eventually eat away part of the benefit. With the help of portfolio theory research, it is therefore possible to bracket how many investment objects a portfolio is as efficient as possible. According to Mao (1978), a 50% diversification benefit can be obtained with a portfolio of just three investment objects, and with 17 investment objects one can already achieve about 90% diversification benefit. Of course, Mao's research was carried out using some simplifications, but even after the robustness tests, it is found that a relatively small number of investment targets is sufficient to achieve the maximum diversification benefit.

3.3.1 Long-short portfolios

Long short is a portfolio construction strategy where an investor enters simultaneously long and short positions in different assets with the aim to benefit from both rising and

falling prices of assets. By expanding an investors investment opportunity, the structure provides the opportunity to manage the portfolios return and risk exposure to a desired level (Jacobs et al., 1999). The strategy is often viewed as a more risky and costly portfolio structure to implement, but this is not necessarily the case.

Perhaps one of the most frequently raised benefit of long-short portfolios is the diversification benefit that the structure provides to an investor. In addition to having insights in assets that are gaining in value, the investor might have insight also that are tied to appreciating assets. By conducting a long only strategy, the investor is only able to exclude stocks through negative insights and not able to benefit fully from the latter mentioned (Jacobs et al., 1999). Although the diversification benefit sound plausible, it should be noted that the investors way of constructing the long-short portfolio will depend immensely the improvement that can be obtained compared to long only portfolios.

On some occasions long-short portfolio strategies are conducted by simply joining a long only portfolio with a short only portfolio (Jacobs et al., 1999). This method could moreover be called long plus short instead of a true long-short portfolio. To obtain the benefits of a long-short portfolio, the investor should take into consideration expected returns of individual assets, standard deviation on returns, correlation between those factors as well as risk tolerance. In order to obtain a portfolio reflecting the investors insights, the investor has the opportunity to exclude assets as well as control exposure to certain types of assets by offsetting long and short positions.

Difficulty in applying long-short positions to real environment sometimes stems from investment constrains and costs. In many market areas, a strategy that includes short selling might not as easily be applicable due to constrains on short selling opportunities (Jacobs et al., 1999). Not only this, entering a short position might also endure extra costs in as for example trading costs and management fees in comparison to long positions. In terms of the currency markets, this is not a factor that is often raised as currency

trades always combine a long and short position as a default. This means that entering a short position in a certain currency is fairly easy and not considered more costly than long positions. However, the cost of entering a position with any asset often depends on the interest of the other counterparty in the transaction.

Investors may shy away from long-short portfolio compositions due to concerns with their risk exposures. Theoretically short positions have unlimited potential losses because there is no limit on how much the price of an asset can rise (Jacobs et al., 1999). However, it is unlikely that if the assets under short positions rise suddenly that there is no offsetting effect from some of the assets that are held long.

These portfolio compositions are relatively often used in academic research focused on market anomalies, as these portfolios have seen to prove cross sectional mispricing (Dong et al., 2022). Combining long and short positions can filter idiosyncratic risk factors attached to isolated predictions while also allowing an investor to speculate on not only which assets are going to appreciate over time but also use the opposite view to gain profits. Portfolios combining an equal amount of long and short positions are typically used in order to achieve a zero-cost portfolio structure where short positions are used to offset the costs endured in entering long positions (Beaver et al., 2016). In addition to cost benefits, a wider portfolio diversification can be obtained through utilizing long and short positions simultaneously.

Although academic research gives recognition to the benefits of long-short investing as opposed to only entering long positions, the return generation benefits have also been under close review. Beaver et al. (2016) finds that although long-short positions do not perform especially badly, they don't provide any extra benefits in terms of acquired returns. On the other hand, Leivo & Pätäri (2011) argue that the risk-adjusted performance of an investment portfolio can be enhanced applying a long-short strategy. The research provides compelling results showing that there is a significant outperformance when comparing some of the best long-short portfolios as opposed to their long- only

counterparties. The evidence is obtained by investigating especially momentum portfolios with a 130/30 composition of long-short strategy. While providing higher returns it is suggested that a long- short strategy can also decrease volatility of a portfolio.

4 Momentum anomaly

Momentum anomaly refers to a financial market phenomenon where the performance of an asset seemingly continues in the future. Moreover, it indicates the tendency for an asset to perform well if it has also in the recent past performed well, and vice versa. When first discovered, *momentum* -anomaly raised a lot of interest within the financial market by questioning for instance the two key theories, *random walk* and *efficient market hypothesis*, both of which have served as foundation for a wide array of academic research covering different phenomena and asset classes. Although first discovered and thoroughly researched on the equity markets, the phenomena seem to have an asset class encompassing nature (Asness et al., 2013; Hutchison & O'Brien, 2020; Menkhoff et al., 2012).

4.1 Equity momentum

In 1993, Jegadeesh and Titman found some of the earliest evidence on price momentum in stock prices. The academics found abnormal returns for up to 12,01% from the US stock markets by utilizing momentum as an investment strategy. This study has thereafter been considered as one of the fundamental research projects in momentum history. After the anomaly was discovered in some of the baseline studies, the phenomena received attention in various asset classes motivated by the co-movement probability of markets (Asness et al., 2013).

There are many factors that have been proposed as the sources for momentum returns in the equity market. Momentum strategies' ability to produce excess returns has received interest especially as it remains one of the only if not the only capital asset pricing model left unexplained by the French and Fama three factor model (Fama and French, 1996; Chordia and Shivakumar, 2002). Avramor et al. (2007) connect momentum returns

with firm specific characteristics such as small firm sizes and lower credit ratings. Previous research suggests firm-specific factors to explain majority of momentums excess returns while also the under- or overreaction of investors has been recognized as a notable contributing factor (Hurst et al., 2013; Jegadees and Titman,1993). Besides firm specific factors, for instance Moskowitz and Grinblatt (1999) link momentum returns to industry factors. Another stream of research relies on efficient-market based explanations. Conrad and Kaul (1998) explain momentum returns to be the result of cross-sectional variability in expected returns. This explanation however was later argued against by momentum pioneers Jegadeesh and Titman (2001), stating that the results are due to estimation errors when estimating expected return variance.

Besides firm or industry specific factors, there is compelling evidence that momentum returns are connected to macroeconomic variable. Shivakumar (2022) attest momentum returns to exhibit sensitivity to macroeconomic variables. Other researchers commence this finding by stating that business cycles affect momentum returns (Perez-Quiros and Timmermann, 2000; Chordia and Shivakumar, 2002). Moreover, this effect is seemingly more consistent for small firms over large firms.

Although momentum strategies have proven to be profitable in many cases, negative skewness and pronounce and persistent negative returns have also been identified in the past (Daniel & Moskowitz, 2016). These so-called crash risks are linked to uncertain market conditions where market returns have been consecutively negative and market volatility is high (Daniel & Moskowitz, 2016; Stivers & Sun, 2010). Short term consistency in return continuum could in fact include a compensation for such non-linear risk factors.

Besides proving or opposing the return bearing characters of strategies using momentum, previous studies have aimed at undercovering the optimal portfolio construction settings. An important part in this is the lookback period which indicates the timeframe from which the strength of momentum is observed from. Zaremba et al. (2019) find the lookback period to be a significant factor when assessing equal weighted quantile long-

short portfolios comprised with momentum strategy's profitability on equity momentum but also multiple other asset classes. A momentum timeframe of one month is highlighted as the effective timeframe where momentum patterns seem the strongest. Short-term momentum findings are also supported by Medhat and Schmeling (2021) who find that momentum strategies exceeding on month momentum have the tendency to exhibit reversal effect meaning that for a longer look back period even a contrarian strategy might become compelling.

4.2 Currency momentum

Compared to momentum in other asset classes, researchers have found some notable differences in momentum in the foreign exchange market. Burnside et al. (2011) argue currency momentum to sustain a slight positive skewness and not experience crashes like Daniel and Moskowitz (2016) reported in equity momentum even during the financial crisis. In addition to this, equity markets have shown strong reversal effect when using one month momentum while strong positive results are obtained from the currency markets using this lookback period (Zhang, 2022).

Previous literature has been able to prove currency momentum strategy's ability to capitalize by the assumption that past currency returns have a predictive nature on upcoming returns (Burnside et al., 2011; Menkhoff et al., 2012). These findings challenge risk-based view of asset prices often seen as a standard while also questioning market efficiency by violating even the weakest form of efficiency (Zhang, 2022).

Although previous research has been able to prove the existence of momentum anomaly in the FX market on multiple occasions, there are papers with converse findings. Many of these studies state that the existence of momentum anomaly in the FX market is compromised due to widespread information availability on anomalies (Hutchinson et al., 2022; Ranaldo et al., 2021; McLean & Pontiff, 2016). The studies suggest that the markets

correct mispricing associated with anomalies especially post academic publications, making the anomalies non exploitable. Additionally, some papers highlight similar evidence from the real environment. For instance, Cotaga (2019) finds some currency hedge funds reporting weak performance having pursued momentum strategies in their investments.

Research on market efficiency suggests that the foreign exchange market does in fact exhibit market inefficiency of some level in the short term (Namhoon et al., 2021). However, it seems that the markets correct this deficiency in efficiency in the long term, creating a reversal effect. This could imply that momentum returns can be obtained in the short term but if the observation period is stretched too long, the result could be inexistent momentum returns or a far lower level of returns. Taking this into account, a short observation period for momentum seems to be favorable from the eyes of academic research.

4.3 Macroeconomic momentum

Macroeconomic momentum is a cross sectional investment strategy approach that aims to capitalize on creating investment signals from macroeconomic activity measures. Currently the only study on macroeconomic momentum is by Dahlquist and Hasseltoft published in 2020 in the Journal of Financial Economics. In their study the academics convert observed changes in economic activity and inflation into portfolio allocation that is rebalanced at the end of each month. The study proposes macroeconomic momentum in the foreign exchange market to yield 3,28% annualized excess returns while carry trade accrued returns of 3,09% and price momentum 1,61%.

Regressed with other well-known currency strategies, less than half of the average returns of macroeconomic momentum portfolios are explained by benchmark strategies (Dahlquist and Hasseltoft, 2020). Therefore, the study finds macroeconomic momentum

returns to be independent from other currency strategies casting it as an independent from other currency strategies meaning that the investment strategy includes a unique return source that are other strategies have not been able to capture.

Sensitivity to market conditions has been found in currency strategies before. For instance, Bakshi and Panayotov (2013) state currency volatility and aggregate liquidity to predict returns when entering carry trade. Similar sensitivity is also found to affect macroeconomic momentum portfolios which show to exhibit sensitivity to market conditions by receiving negative coefficients from regressions against volatility and funding risk measures (Dahlquist and Hasseltoft, 2020). This suggests downward trend in portfolio performance when market volatility and funding risk is high in the market.

5 Data

To execute the empirical part, appropriate macroeconomic data, variables and FX market data is collected. Additionally, data guidelines by Dahlquist and Hasseltoft (2020) are considered to cater towards the comparability of the results. This said, the opportunity to utilize even more recent data is taken. The time period from which the data is collected is from January 1999 to December 2022. The study encompasses roughly a 23-year timespan.

The geographical setting of the study covers a total of 25 countries and regions. The selection is based on the member list of OECD at the start of the study's start date, January 1999 (OECDb, 2022). Because the study covers several decades, observing same list as of today might cause distortion of the dataset. Countries and regions included in the sample are Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, Luxembourg, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, UK, US, Eurozone. During the study, OECD has accepted a total of 14 additional members but none of the before listed countries have left the organization (OECD, 2022b). Members that have been added to the OECD after January 1999 are not included in this study.

Table 2. Classification of sample countries economic state.

	G10	Developed	Frontier	Emerging
Australia		Yes		
Canada	Yes	Yes		
Czech republic				Yes
Denmark		Yes		
Hungary				Yes
Iceland			Yes	
Japan	Yes	Yes		
Korea				Yes
Mexico				Yes
New Zealand		Yes		
Norway		Yes		
Poland				Yes
Sweden	Yes	Yes		
Switzerland	Yes	Yes		
Turkey				Yes
United Kingdom	Yes	Yes		
United States	Yes	Yes		

Table classifies the selected countries as either developed, frontier or emerging (MSCI, 2023).

Due to the guidelines of the OECD membership all member countries are classified as high income or developed countries (OECDb, 2022). The sample also includes over 50% of the G10 countries. Above table shows that some of the sample's countries are however described as emerging by MSCI (2023). Only one frontier country is included. Having a large set of developed countries means that selection bias and data gaps can be best avoided (Barroso & Santa-Clara, 2015). Data gap issues typically concern emerging economies, but large scale issues are not expected in this case as all countries are included in the OECD and thus their economic information is widely available from databases maintained by the OECD.

5.1 Macroeconomic data variables

To measure economic activity and inflation, the following macroeconomic data is collected: consumer prices, producer prices, industrial production, retail sales and unemployment figures. Unemployment rate is used to calculate a measure for employment by taking the inverse of the figure. Due to data gap issues in some instances, monthly data may not be available. In these cases, monthly data is replaced with corresponding quarterly data. A similar method of data cleanup is used by Dahlquist and Hasseltoft (2020) in their economic momentum research.

Datapoints are collected from the comprehensive data archive of the OECD. Previously stated geographical selection allows a single source data collection method. By using a single source for macroeconomic data retrieval, the possibility for differences can be avoided. Datapoint provider OECD is an internationally operating organization collaborating to advance democracy and market economy (OECD, 2022a). The organization is one of the trusted providers of comparative socioeconomic data and analyses. The data archive openly distributes figures on the chosen fundamentals and discloses any possible data biases. Thus, it is viewed as a reliable data source.

Availability of macroeconomic datapoints varies between countries included in the sample. Majority of the countries have published monthly data on the variables for the entire study period but because all data is not available for the same tenors, data cleaning is considered. When monthly data is not available quarterly data is used as a replacement. With the aim of keeping the tenors as comparable as possible longer tenor than quarterly are excluded. Dahlquist and Hasseltoft (2019) use a similar method for filling in data gaps in their study.

Table 1 presented below indicates the start date of monthly data of each macroeconomic data variable. Here CPI represents consumer price index and PPI represents producer price index. Dash indicates that monthly data is not available for the study period. Ranges included in the sample indicate instances when monthly data is available only at a certain timeframe in the middle of the study period. Observing the table, Australia as well as

New Zealand appear as clear outliers in terms of data availability. Monthly data is only available for Australia's unemployment rate. All other datapoints are replaced with quarterly datapoints. Besides this, there are only few countries that have gaps in reported monthly figures. Although stated before that emerging markets might have data gaps, this does not seem to realize in this dataset. From the emerging markets only, Turkey has gaps in monthly data for retail sales as well as unemployment.

Table 3. Summary of macroeconomic data variables

	Retail Sales	Industrial Production	CPI	PPI	Unemployment
Australia	-	-	-	-	1/1999
Canada	1/1999	1/1999	1/1999	-	1/1999
Czech republic	1/1999	1/1999	1/1999	1/1999	1/1999
Denmark	1/1999	1/1999	1/1999	1/1999	1/1999
Eurozone	1/1999	1/1999	1/1999	1/1999	1/1999
Hungary	1/1999	1/1999	1/1999	1/1999	1/1999
Iceland	1/1999	1/1999	1/1999	1/2006	1/2003
Japan	1/1999	1/1999	1/1999-6/2021	1/1999	1/1999
Korea	1/1999	1/1999	1/1999	1/1999	1/1999
Mexico	1/1999	1/1999	1/1999	1/1999	1/1999
New Zealand	-	-	-	-	-
Norway	1/1999	1/1999	1/1999	1/1999	1/1999
Poland	1/1999	1/1999	1/1999	1/1999	1/1999
Sweden	1/1999	1/1999	1/1999	1/1999	1/1999
Switzerland	1/1999	10/2010-9/2022	1/1999	6/2002	-
Turkey	1/2010	1/1999	1/1999	1/1999	1/2005
United Kingdo	1/1999	1/1999	1/1999	1/1999	1/1999
United States	1/1999	1/1999	1/1999	-	1/1999

Table 3 presents start dates for monthly datapoints. Dashes represent non availability. Other discrepancies are highlighted in red. Data ranges are stated for instances where monthly data is only available for that certain period.

Data gaps for monthly data does not propose insurmountable difficulties to the portfolio construction. In accordance with Dahlquist and Hasseltoft's (2019) approach, indices on the macroeconomic indicators can be formed for a country even if some of the indicators are unavailable. For instance, if Turkey had no reported figures for retail sales before January 2010 while all other data is available, the index for macroeconomic activity can be formed regardless by only utilizing figures for industrial production and unemployment. Retail sales would in this case be taken into consideration once the datapoint becomes available.

From the data, country-level indices are constructed using an equal-weighted average of growth rates. The economic activity index considers growth rates in industrial production, retail sales and the inverse of unemployment. Similarly, the inflation index considers growth rates of consumer and producer prices. Macroeconomic conditions are considered to improve if there are increases in the indices.

5.2 FX market data

Data collection for FX market data is simultaneously collected following the approach of Dahlquist and Hasseltoft (2020). Month end closing rates on spot and one-month forward rates are retrieved from Refinitiv Datastream. Daily closing rates for spot prices is used based on the findings that suggest that using a more specific intraday data is not beneficial for an investment strategy essentially based on technical analysis (Okunev et al., 2003; Neely et al., 2003; Raj, 2000).

All currencies are expressed in USD per unit of foreign currency. The base currency choice is based on the long history of reported exchange rates which simplifies the currency conversion. Dahlquist and Hasseltoft (2020) use base currencies both GBP and USD in their data retrieval due to data gaps. For this study this is not necessary, as the retrieved data is widely available for the sample period using USD as the base currency. Having said this, according to Okunev et al. (2003), the base currency choice should have little effect on the results even when a multiple currency investment universe is chosen. This means that the study could be in the future also repeated using another base currency of choice to verify the evidence without major effects to end results.

Below table represents an overview of the FX market data collected. The dates refer to the first months when appropriate data is available. South Korean won is the only currency for which the forward data becomes available after the staring date. This means

that the currency is included in the investment universe only starting from August 1999 because excess returns cannot be calculated without spot and forward data. This does not have a significant effect on the investment universe as all other currencies are available through the whole sample period.

Table 4. Summary of the FX data.

	Currency code	Spot	Forward
Australia	AUD	1/1999	1/1999
Canada	CAD	1/1999	1/1999
Czech republic	CZK	1/1999	1/1999
Denmark	DKK	1/1999	1/1999
Eurozone	EUR	1/1999	1/1999
Hungary	HUF	1/1999	1/1999
Iceland	ISK	1/1999	1/1999
Japan	JPY	1/1999	1/1999
Korea	KRW	1/1999	8/1999
Mexico	MXN	1/1999	1/1999
New Zealand	NZD	1/1999	1/1999
Norway	NOK	1/1999	1/1999
Poland	PLN	1/1999	1/1999
Sweden	SEK	1/1999	1/1999
Switzerland	CHF	1/1999	1/1999
Turkey	TRY	1/1999	1/1999
United Kingdom	GBP	1/1999	1/1999

Collected FX market data is used to calculate returns for macroeconomic momentum portfolios. Let $S_{c,t}$ denote the exchange rate of currency c at time t. An increase implies the appreciation of the foreign currency and simultaneously the depreciation of the USD. The below equation denotes the excess return on investing in foreign currency c via forward contract $F_{c,t}$.

Equation 2. Excess return when investing via forward contracts.

$$R_{c,t+1} = (S_{c,t+1} - F_{c,t})/F_{c,t}$$

6 Methodology

To test the hypotheses, portfolios are constructed primarily following the approach of Dahlquist and Hasseltoft (2019). By keeping the approach similar, comparability between the studies is achieved. In addition to constructing the macroeconomic momentum portfolio, a set of benchmark strategies, namely carry and momentum, are considered. The macroeconomic momentum portfolios' performance is later compared to the benchmark strategies in order to determine and identify any added value that the macroeconomic momentum might bring to a foreign exchange investor. In addition, market factors for volatility and funding conditions are also considered.

6.1 Macroeconomic momentum portfolio

Datasets introduced in the previous chapter are now used in portfolio construction. Following Dahlquist and Hasseltoft's (2019) approach, the constructed macroeconomic momentum portfolios are rebalanced at the end of each month based on the relative strength of countries macroeconomic trends. Monthly rebalancing frequency is also supported by other previous literature on momentum that find relatively short holding periods to be optimal (Dahlquist & Hasseltoft, 2019; Medhat & Schmeling, 2021; Zaremba et al., 2019, Leivo & Pätäri, 2011).

The first step in portfolio construction is to use the data of macroeconomic indicators to calculate corresponding growth rates for economic activity, inflation, and the combination of the forementioned for each country. Combination of economic activity and inflation is referred to as 'combo' from here on. First, monthly growth rates are calculated of each of the individual indicators by dividing monthly datapoints with the last tenors datapoint. These monthly growth rates are then used to calculate an average growth rate considering all of the available indicators. This insight is then used to form indices for

economic activity, inflation and the combination as presented in equations 3,4 and 5. The first observation month of each index is set as the basis index value of 100.

Equation 3. Country specific economic activity index.

$$FI_{econ,x,t} = \frac{\frac{1}{3}\left(\frac{Retail_{x,t}}{Retail_{x,t-1}} + \frac{Industrial_{x,t}}{Industrial_{x,t-1}} + \frac{\frac{1}{Unemployment_{x,t}}}{\frac{1}{Unemployment_{x,t-1}}}\right)}{FI_{econ,x,t-1}} * 100$$

Equation 3. Country specific inflation index

$$FI_{inflation,x,t} = \frac{\frac{1}{2}\left(\frac{CPI_{x,t}}{CPI_{x,t-1}} + \frac{PPI_{x,t}}{PPI_{x,t-1}}\right)}{FI_{inflation,x,t-1}} * 100$$

Equation 5. Country specific combo index

$$FI_{combo,x,t} = \left(\frac{1}{5}\left(\frac{Retail_{x,t}}{Retail_{x,t-1}} + \frac{Industrial_{x,t}}{Industrial_{x,t-1}} + \frac{\frac{1}{Unemployment_{x,t}}}{\frac{1}{Unemployment_{x,t-1}}} + \frac{CPI_{x,t}}{CPI_{x,t-1}} + \frac{PPI_{x,t}}{PPI_{x,t-1}}\right) + 1\right) * FI_{combo,x,t-1}$$

The next step is to form sub-strategies based on different lookback periods. Lookback period refers to the time period from which the momentum trends in economic activity and inflation are observed. This study considers lookback periods ranging from 1 to 60 months. By considering a large set of lookback periods, more diversified portfolios are achieved. In addition to this, it may possibly shed a light on which lookback period is the most optimal for macroeconomic momentum strategy. The first step in sub-strategy

formation is to calculate a trend measure for each of the indices and countries. The trend measure measures macroeconomic trends as log changes. Equations six, seven and eight demonstrate how trend measures are formed. Let j represent lookback period, x represents currency and t represent time.

Equation 6. Trend measure for economic activity.

$$TM_{econ,j,x,t} = \log\left(FI_{econ,x,t}\right) - \log\left(FI_{econ,x,t-j}\right)$$

Equation 7. Trend measure for inflation

$$TM_{inflation,j,x,t} = \log\left(FI_{inflation,x,t}\right) - \log\left(FI_{inflation,x,t-j}\right)$$

Equation 8. Trend measure for combo

$$TM_{combo,j,x,t} = \log\left(FI_{combo,x,t}\right) - \log\left(FI_{combo,x,t-j}\right)$$

Trend measures are then used to assign long and short positions for each currency included in the investment universe. Half of the countries' currencies are assigned positive weights. These are countries that exhibit the strongest macroeconomic trends. Negative weights are assigned to the other half that exhibit negative macroeconomic trends. Positively weighted are equally weighted compared to each other as well as negatively weighted are assigned equal weights compared to each other. The method results in comprising a zero-cost and dollar neutral portfolio with long positions in past macroeconomic "winners" and short positions in "losers". Because the amount of currencies in the investment universe is not stable thorough the whole study period, the amount of long and shorted currencies varies. If the investment universe has an uneven number of investable assets at any given time, long positions are taken in one asset more than short

positions. However, this does not cause imbalance to the zero-cost structure because then a smaller weight is assigned to each long position currency.

The advantages of the chosen portfolio construction method are that it produces zero-cost portfolios and is essentially dollar neutral (Dahlquist & Hasseltoft, 2019). In terms of diversification, the method is also optimized as all assets in the investment universe are included in the portfolios. Moreover, selection biases are rooted as positions are not taken only in a restricted pool of the investment universe. Simultaneously data outliers, revisions and measurement errors are also diminished (Asness et al., 2013; Koijen et al., 2018; Dahlquist & Hasseltoft, 2019).

When the portfolio construction is done, excess returns are calculated of the sub strategy portfolios. Equation 9 presented below indicates the excess returns of the sub-strategy portfolios at time t+1. Excess return at time t+1 for investing in currency c through USD is calculated as stated in equation 10. Where S denotes the denotes the spot rate and F denotes.

Equation 9. Excess returns of sub-strategy portfolios.

$$R_{i,l,t+1} = \sum_{c=1}^{c_t} W_{c,i,l,t} R_{c,t+1}$$

Equation 10. Excess returns of a single currency.

$$R_{c,t+1} = \frac{S_{c,t+1} - F_{c,t}}{F_{c,t}}$$

6.2 Benchmark portfolios

Carry and momentum portfolios are constructed as benchmark portfolios to compare the results of the macroeconomic momentum strategy to some of the most well-known strategies in the FX markets. Portfolio construction settings are kept as close to the ones used for the macroeconomic momentum portfolio to retain comparability: cross-sectional ranking, dollar-neutral portfolios, end of month rebalancing. Investment universe is the same as the one used in macroeconomic momentum portfolios. Dahlquist and Hasseltoft (2020) consider both carry and momentum portfolios as benchmarks but instead of only using 12-month momentum another momentum benchmark with a 3 month lookback period is added to account for a shorter lookback period.

6.2.1 Carry portfolio

The Carry portfolio is constructed similarly to Dahlquist and Hasseltofts' approach (2019). The portfolio composition utilizes forward premias and discounts. These figures are used to rank currencies included in the investment universe for cross-sectional ranking. Equation 11 demonstrates the calculation of forward premia/discount. Forward premia is detected by comparing currency pairs spot to the one month forward. If $F_{c,t} < S_{c,t}$ the currency pair trades at a discount and a long position is entered. Vice versa, if $F_{c,t} > S_{c,t}$ the currency pair trades at a forward premium and a short position is entered.

Equation 11. Forward premia

$$Forward\ premia = S_{c,t} - F_{c,t}$$

As with macroeconomic momentum portfolios, long and short positions are equally weighted and portfolio rebalancing is done at a monthly sequence. To further cater towards comparability, one month lag is added to the investment signal construction and

application of that signal to the portfolio composition. In this strategy one dollar is invested on both the long and short side to end up with a zero-cost and dollar-neutral portfolio composition and to follow a similar strategy to which was used for the macroeconomic momentum portfolios. Once again long-short portfolios where the dollar amount invested in long-short positions are designed to be insensitive to the return of the wider market (Jacobs et al., 1999).

6.2.2 Momentum portfolios

Momentum portfolios are constructed similarly to Dahlquist and Hasseltoft (2020) as well as following the approach of Asness et al. (2013). In these approaches momentum trends are detected from past returns over a specific lookback period. In this study, separate portfolios are constructed using a lookback period of 3 months and 12 months. These lookback periods are some of the most researched ones but there is not specific consensus on which lookback period is the most favorable. Usually shorter than 3-month periods are not included as momentum anomalies have been seen to exhibit short term reversal effects. Dahlquist et al. (2020) use only 12-month momentum as a benchmark, but a shorter period of 3 months is added due to the fact that macroeconomic momentum portfolios are also formed for even shorter lookback periods.

Observed momentum trends are then used as investment signals. As with macroeconomic momentum portfolios and the carry benchmark, a one-month lag is included between investment signal creation and the application in order to account for short term reversal effects that have been seen with momentum strategies in previous academic research. In both portfolios long positions are taken on half of the currencies with higher returns and short positions are taken on currencies with lower returns. Once again, one dollar is invested in the long side as well as towards the short positions.

7 Empirical Results

This chapter concludes empirical results obtained from the macroeconomic momentum portfolios. First subsections focus on trend portfolios for economic activity, inflation, and combo. In the last subsection these portfolios are set besides selected benchmark strategies (3-month momentum, 12- month momentum and carry) in order to compare how the presented investment strategy performs besides some of the established and academically researched methods. In addition to presenting evidence found in this study, the results are also compared to findings of Dahlquist and Hasseltoft (2020) who are the only authors with comparable macroeconomic momentum portfolios.

7.1 Performance of Macroeconomic momentum portfolios

Performance of Macroeconomic momentum portfolios is separated to two sections. The first section considers the performance measures for the full sample. Moreover, portfolios for Economic activity, Inflation and Combo, that comprise 60 equally weighted sub strategies constructed based on different lookback periods. In the second sub section the aggregate portfolios are deconstructed to three different portfolios based on three lookback period buckets.

7.1.1 Full sample performance

As previously detailed in chapter 6.1, majority of this study encompasses a total of three macroeconomic momentum portfolios. Each of these portfolios are the product of 60 equally weighted sub portfolios that each consider a different lookback period for observing macroeconomic trends that are used as investment signals. Economic activity

portfolio invests based on trends found from retail sales, industrial production, and employment. Inflation portfolio's investment signals are based on retail and producer prices. Combo portfolio includes retail sales, industrial production, employment as well as retail and producer prices to generate investment signals.

TABLE 5. Distribution of long and short investment signals.

	Economic activity		Inflation		Combo	
Country	Long	Short	Long	Short	Long	Short
Australia	0,551	0,449	0,531	0,469	0,541	0,459
Canada	0,513	0,487	0,505	0,495	0,536	0,464
Czech republic	0,528	0,472	0,546	0,454	0,526	0,474
Denmark	0,519	0,481	0,525	0,475	0,404	0,596
Eurozone	0,571	0,429	0,471	0,529	0,571	0,429
Hungary	0,512	0,488	0,511	0,489	0,516	0,484
Iceland	0,510	0,490	0,509	0,491	0,595	0,405
Japan	0,540	0,460	0,558	0,442	0,546	0,454
Korea	0,450	0,550	0,523	0,477	0,489	0,511
Mexico	0,527	0,473	0,740	0,260	0,527	0,473
New Zealand	0,524	0,476	0,537	0,463	0,529	0,471
Norway	0,518	0,482	0,543	0,457	0,521	0,479
Poland	0,525	0,475	0,540	0,460	0,545	0,455
Sweden	0,536	0,464	0,541	0,459	0,532	0,468
Switzerland	0,523	0,477	0,514	0,486	0,523	0,477
Turkey	0,512	0,488	0,509	0,491	0,493	0,507
UK	0,545	0,455	0,566	0,434	0,553	0,447

Table 5 represents the distribution of long and short positions for each country separately for each trend measure. Portfolios composed with trend measures have an uneven number of currencies which means that in some of the figures one currency more is included in the long side. However, this does not inhibit from making conclusion on how the macroeconomic trends measures have evolved over time for a certain country compared to other investment possibilities.

From the distribution of long and short positions, general observations on how the sample countries macroeconomic indicators have been compared to each other can be made. In the economic activity portfolio, the Eurozone has the most long positions while Korea holds the most short positions. This means that the Eurozone has had the most improvement in economic activity compared to other countries, vice versa for Korea. The Eurozone does not provide much of a surprise. As a developed economic area, it could be assumed that the Eurozone has the foundation to provide exhilarating economic activity especially in terms of boom periods. Korea's positioning in the portfolio is on the other hand surprising as The World Bank (2023) recognizes Korea to have achieved rapid

economic growth between 1988 and 2022 with a real gross domestic product growth of 4,9% on average during a period, which is included in the sample period. Even though Korea is having most short positions within the sample, it does not necessary mean it being the economy with the lowest rate of economic activity. Instead, Korea might have the tendency to rank in the middle of the sample, yet on the lower side, making it fall on the short side of the spectrum.

Even though exhibiting strong economic activity, the Eurozone receives the largest number of short positions when inflation portfolio is decomposed. This indicates that inflation has exhilarated more in other economic areas, or the Eurozone could have experienced shrinking inflation figures. To this there is however a logical explanation as the European central bank (ECB) acts according to a price stability mandate targeting medium term inflation of two percent (European Central Bank, 2023). Enforcing the fact that large changes in inflation are generally unwanted. Shrinking inflation figures is also a reality because for instance, inflation average from 1999 to 2008 was 2,2 percent (ECB, 2022). From 2009 to 2019 the same average was 1,3%. Besides this, the strongest overweight position is found from the Inflation portfolio. Mexico has 74% of its position on the long side having the largest increase in inflation figures. Large sudden increases in inflation figures are sometimes attributed with emerging market economies such as Mexico due the fact that the central banks do not always have a similar mandate as the ECB to stabilize the figures (Lopez-Villavicencio and Pourroy, 2021).

Combo portfolio's composition follows the economic activity portfolio with the Eurozone having the largest set of long positions. Dahlquist and Hasseltoft (2020) do not provide a comprehensive breakdown of the composition of their economic momentum portfolios. However, they do show which currencies receive above or below median weight in their combo portfolio. The most weights are assigned to Spain, Portugal and Israel. As Spain and Portugal are essentially subsumed by the Eurozone, the weight distribution is fairly consistent. Some differences are apparent, as for instance Israel is not included in this study's scope in any shape. Going back to the newer results, the short position

trophy is now handed to Denmark. Based on country's positioning on the other portfolios, it looks like Denmark seems to rank somewhere in the middle of the countries. Here it could be the same case a suggested for Korea: Denmark received middle ranks often while barely falling to the shorted side of the sample.

TABLE 6. Performance measures for macroeconomic trend portfolios.

	Mean	Standard deviation	Skewness	Kurtosis	AR(1)	Sharpe ratio
Economic activity	0,1098	0,9397	0,6391	4,1826	-0,0806	0,1168
Inflation	0,1060	1,0602	0,8207	5,2617	0,2702	0,1000
Combo	0,1101	0,9278	0,4205	4,1658	-0,0777	0,1187

TABLE 6 presents performance measures for macroeconomic momentum portfolios comprised of trends measures economic activity, inflation and combo. Economic activity combines industrial production, retail sales and employment. Inflation is a combination of consumer and producer price indices. Combo trends combines all five of the mentioned measures together. The portfolios rank currencies according to the relative strength of each trend and goes long on currencies with strong trend measures and short on currencies with weak trend indicators. Figures are based on monthly returns but mean, standard deviation and sharpe -ratio are annualized. AR(1) refer to the first order autocorrelation of returns.

Mean return provides evidence on the historical performance of the strategies as well as the risk exposure that the strategies exhibit. Sometimes this measure is simply referred to as expected returns. Overall, macroeconomic momentum portfolios do not exhibit large differences in term of mean returns with only a 0,41-percentage point difference between the highest and lowest value. Combo has the highest mean of the portfolios which suggests that macroeconomic momentum may result to larger expected returns when a wider set of macroeconomic indicators are considered.

Standard deviation demonstrates how the returns are dispersed relative to the mean and is often used as a measure of volatility. As a guideline, the larger the figure the more their returns are dispersed meaning a higher volatility. Once again, no significant differences are present. Inflation trend portfolio's standard deviation exceeds 1 slightly but remains close to the other portfolios figures. Most stability is presented by the Combo trend portfolio. Combining this evidence to previous notation made from mean returns it seems that the Combo trend portfolio exhibits the most favorable return-risk profile with the highest expected return and lowest volatility compared to the other portfolios.

While standard deviation gave some clues to how volatile the returns overall are, it did not give a specific picture on whether the deviating returns are more inclined to be larger than the mean or lower. To add more color to the evidence, skewness and kurtosis are calculated to paint a picture on how the return distribution is shaped when presented in visual form. Positive skewness found with all portfolios indicate that the returns are skewed to the right meaning that a larger portion of returns are larger than the mean. Even though Inflation portfolio had the lowest mean return, the returns exhibit the strongest skewness. With this it is expected that if individual monthly returns are taken from the inflation portfolio the values would be stronger than those taken from Economic activity or the Combo portfolio. Kurtosis on the other hand compares the distributions to normal distribution. High values indicate that the sample contains more extreme values compared to the normal distribution. Inflation portfolio once again deviates from the others with a larger observation for kurtosis leading to the conclusion that the sample contains larger number of extreme values. This correspond with the evidence from standard deviation which indicated return distribution of the portfolio to be the most volatile.

Sharpe ratios for macroeconomic momentum are throughout lower than those e obtained by Dahlquist and Hasseltoft (2020) where the lowest obtained sharpe is 0,39. Correspondingly the highest sharpe obtained in this study is 0,1187. Deviating results could be caused by slight differences in portfolio construction. Dahlquist and Hasseltoft (2020) adjust sub strategy weights according to past volatility. The same adjustments are not carried out in this study as the authors also state that equally weighted sub strategies should not produce significantly deviating evidence. Notable differences in sharpe ratios however indicate that these adjustments might in fact make a difference. Another possibility is that the slightly smaller sample size in this study causes the results to include more outliers.

Figure 1. Cumulative returns Economic activity, Inflation and Combo portfolios.

Figure 1 plots the cumulative returns of macroeconomic trend portfolios Economic activity, Inflation and Combo. Economic activity is composed of macroeconomic indicators industrial production, retail sales and employment. Inflation considers consumer and producer prices. Combo portfolio uses all of the five mentioned macroeconomic indicators. All portfolios are balanced end of each month and use one as the base value for observation. Returns are plotted from May 1999 to December 2022.

Overall Figure 1 strengthens the observations made before. As the standard deviation indicated, cumulative returns of Inflation portfolio are also visually more volatile compared to Economic activity and Combo which are fairly streamlined through a large portion of the sample period. However, with all portfolios, the most volatile movements in cumulative returns are obtained before year 2008. Inflation experiences a crash of cumulative returns but at the beginning of year 2012, it seems to also pick up a stream of positive return development. Positive cumulative returns on macroeconomic momentum portfolios suggest that an investor could be able to utilize the autocorrelation between macroeconomic indicators and currency values to create generate positive

returns while keeping the autocorrelation out of portfolio sample indicated by the AR(1) figures presented in table 6.

Compared to Dahlquist and Hasseltofts' (2020) results an interesting aspect is that the results presented suggest that Economic activity and Combo portfolios are more alike while the Dahlquist and Hasseltofts results suggest that Combo shows more similarities with the Inflation portfolio. It is possible that this is due to data availability. Overall, there were more data gaps with inflation than economic activity factors. Combo portfolio equally weights all available indicators meaning that in some cases the Combo portfolio has more economic activity indicators nested in the composition. This bias may arise easily since portfolios for economic activity and inflation were composed even in cases where not all underlying indicators were available.

Figure 2. Top 5 increases of macroeconomic momentum portfolios.

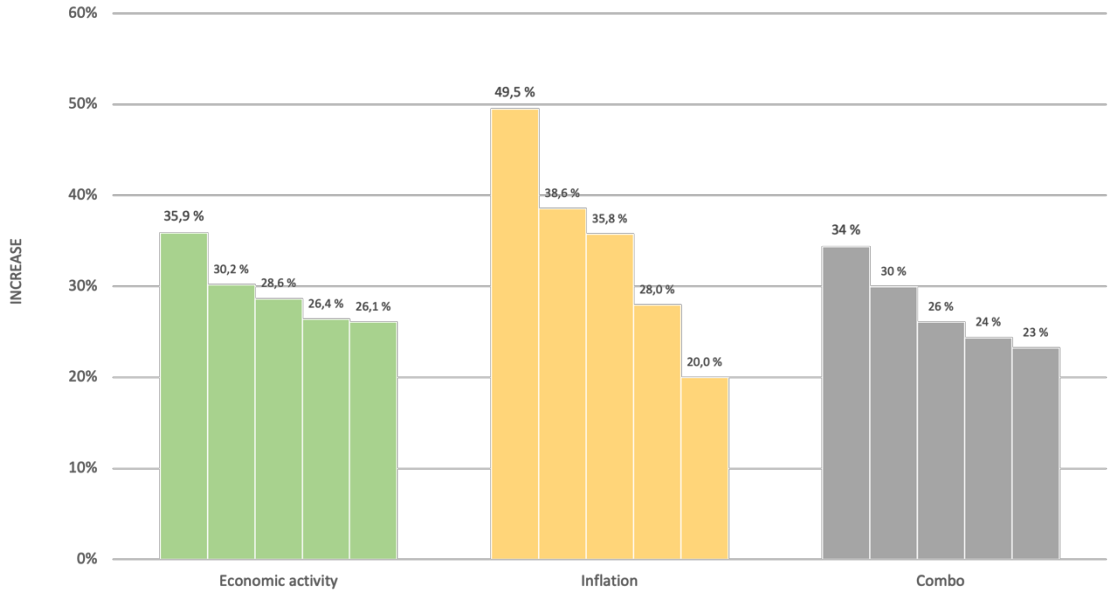


Figure 2 illustrates top five largest monthly increases in return for each of the macroeconomic trend portfolios. The portfolios are aggregate from sub strategies utilizing lookback periods of 1-60 months. The sub strategies are equally weighted in each portfolio.

Figure 3. Top 5 drawdowns of macroeconomic momentum portfolios.

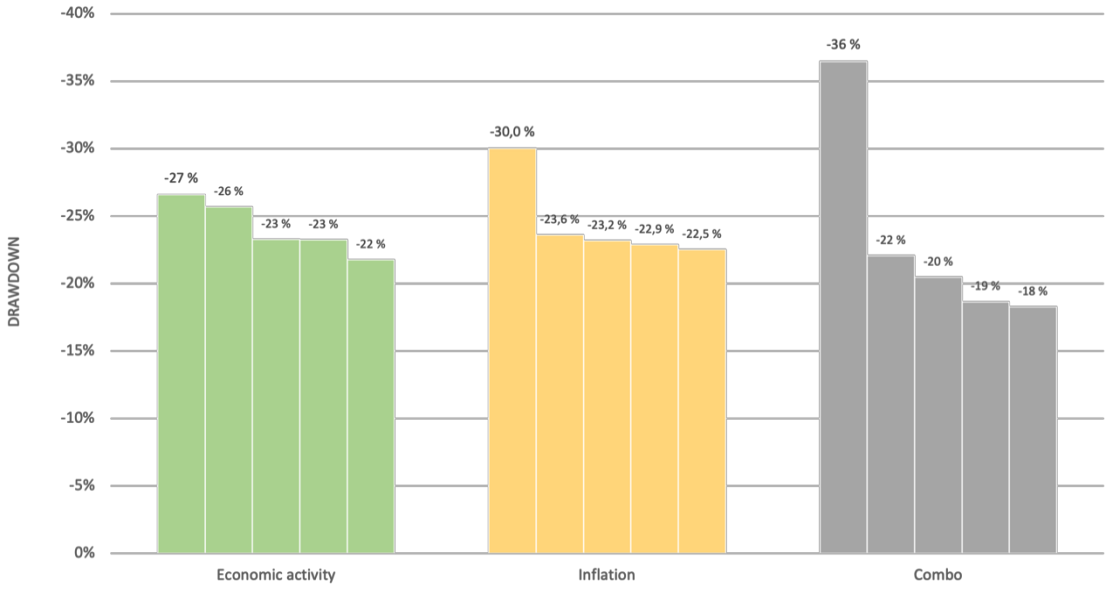


Figure 3 illustrates top five largest monthly drawdowns in return for each of the macroeconomic trend portfolios. The portfolios are aggregate from sub strategies utilizing lookback periods of 1-60 months. The sub strategies are equally weighted in each portfolio.

From the descriptive results it was gathered, that Inflation portfolio seemed to include more volatility in monthly returns. When looking at the top five increases and drawdowns, this volatility is seen on the top side of returns with the top 5 increases range being 29,5 percentage points while comparable ranges are 9,8 percent for economic activity and 10 percent for combo. The same trend does not continue with top drawdowns where selected monthly changes are more consistent with one clear outlier in the Combo portfolio. Cumulative returns showed that Inflation portfolio experiences larger drops than the other macroeconomic portfolios. This observation together with drawdowns in the inflation portfolio that do not deviate much from the others, suggests that although on a monthly level there are no large outliers in drawdowns Inflation portfolio is the most likely to experience drawdowns in larger sequences than the other portfolios.

Table 7. Timing of the top five largest monthly increases and drawdowns in macroeconomic momentum portfolios.

	Economic activity	Inflation	Combo
Top 5 increase			
1	Jul-2007	Dec-2006	Jul-2007
2	Apr-2007	Sep-2006	Apr-2007
3	Sep-2007	Apr-2007	Dec-2006
4	Dec-2006	Feb-2006	Aug-2006
5	Aug-2006	Apr-2014	Sep-2007
Top 5 drawdowns			
1	Sep-2006	Jul-2007	Sep-2006
2	Jan-2007	May-2007	Jan-2007
3	Oct-2006	Sep-2007	May-2007
4	May-2007	Aug-2007	Oct-2006
5	Jun-2007	Jul-2006	Jun-2007

The table presents largest monthly increase and drawdowns during the sample period of May 1999 to December 2022. As the portfolios are rebalanced at the end of each month, all figures represent end of month values.

When observing the timing of the largest movements, it is noted that all top 5 movements are dated to either year 2006 or 2007 with one exception in Inflation portfolios increases dated to 2014. For this result, there is one logical explanation in history. In 2008 the Global financial crisis gloomed over the global economy with major long-term effects. Macroeconomic portfolios exhibiting variation in two preceding calendar years represent the uncertainty preceding the historical events. During these years, volatility was experienced across asset classes. In addition to this, during these years central banks implemented unconventional monetary policy decisions such as quantitative easing to help economic recovery and influence deflation. With the fact that the forementioned events have direct implications on the factors that are used in this study, these results do not impose a large surprise element. Interestingly Dahlquist and Hasseltoft (2020) find the worst months in 2008 while the forementioned were some months ahead. Best months on the other hand were found scattered to 2001 and 2003 which fail to appear in the above table. As a result, it looks like Dahlquist and Hasseltofts' portfolios (2020) are strongly affected by economic downturns while overall market volatility is much more muted. As stated, before 2008 there was strong asset class encompassing volatility which could have suggested that on a monthly return level Dahlquist and Hasseltoft could have gained some of the largest increases at this time period too.

7.1.2 Performance of different lookback periods

Momentum anomalies have been studied using different lookback periods to identify how long the momentum trend should be in order for it to create an investment signal. Even since the first momentum study by Jegadeesh and Titman (1993), academics commonly use a lookback ranging from 3 to 12 months with a one-month lag (Tobias Wiest, 2022). The most used or “best” lookback period is fairly hard to pinpoint since it has been found that the most favorable lookback period depends on asset class as well as time period. To see if macroeconomic momentum portfolios can shed light on this matter, the portfolios are dismantled and reordered to three portfolios each considering a different set of lookback periods. Short term includes lookback periods from 1 to 12 months, medium term from 13 to 36 month and long term from 37 to 60 months. In this part, the combo portfolio receives extra attention due to the fact that this aggregates the effects of all macroeconomic indicators in the scope of this study. Although the portfolios are also looked at separately, it is beneficial to first draw overall conclusions to build up on with further evidence.

Figure 4. Cumulative returns of Combo portfolio based on lookback period.

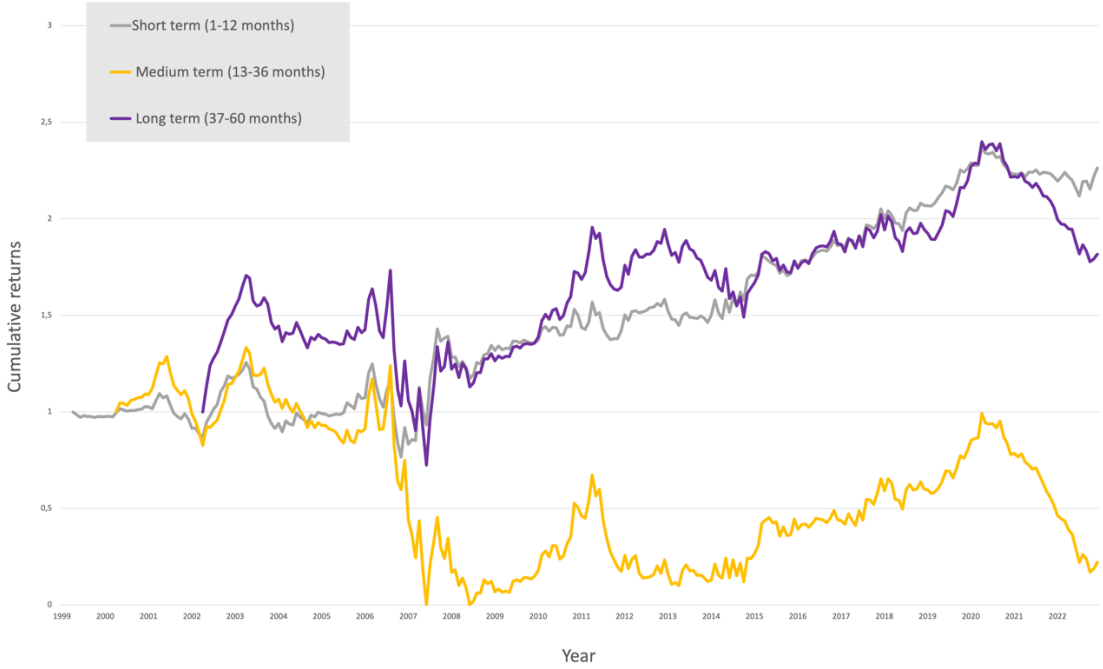


Figure 4. presents cumulative returns of the combo portfolio split into three term portfolios. The term portfolios each comprise of a different set of sub strategies with different lookback periods. The short-term portfolio comprises of sub strategies with lookback periods of 1 to 12 months. Medium term accounts for lookback periods 13-36 months and long term for lookback periods 37-60 months. All sub strategies include a one-month lag to diminish the effect of short-term reversal (Dahlquist & Hasseltoft, 2020). Cumulative returns start at different times due to the lookback periods effect on data availability.

The most apparent observation from the term portfolios is that medium-term lookback periods' returns drastically differ from the two other portfolios. This can be seen as the cumulative returns remain below the portfolio's starting value over majority of the sample period. This first handedly suggests that an investor exploring macroeconomic momentum investment strategy should refrain from using a lookback period of 13 to 36 month in the portfolio construction. Short-term and medium-term portfolios increase in cumulative returns largely over the sample period with only short periods of depreciating portfolio value. This is in line with previous momentum anomaly studies where excess returns have been similarly obtained from using lookback periods of 3 and 12 months. As an added value, the results now suggest also exceptionally long periods to yield similar results. With this, researching other momentum strategies with longer lookback periods could provide further insight into momentum anomalies in general and if

evidence is only applicable to momentum found in macroeconomic indicators used as investment signals in a currency portfolio.

Academic research has proposed slow information diffusion and under or over-reaction to public information to be possible sources for momentum (Leivo & Pätäri, 2011). Significantly higher cumulative returns obtained with long lookback periods suggest that the first mentioned factor may in fact be a potential source for momentum anomaly. Slow information diffusion would explain why it is seemingly possible to benefit from publicly released macroeconomic data points even long after the event dates.

Table 8. Performance measures for Macroeconomic momentum portfolios including results of term portfolios.

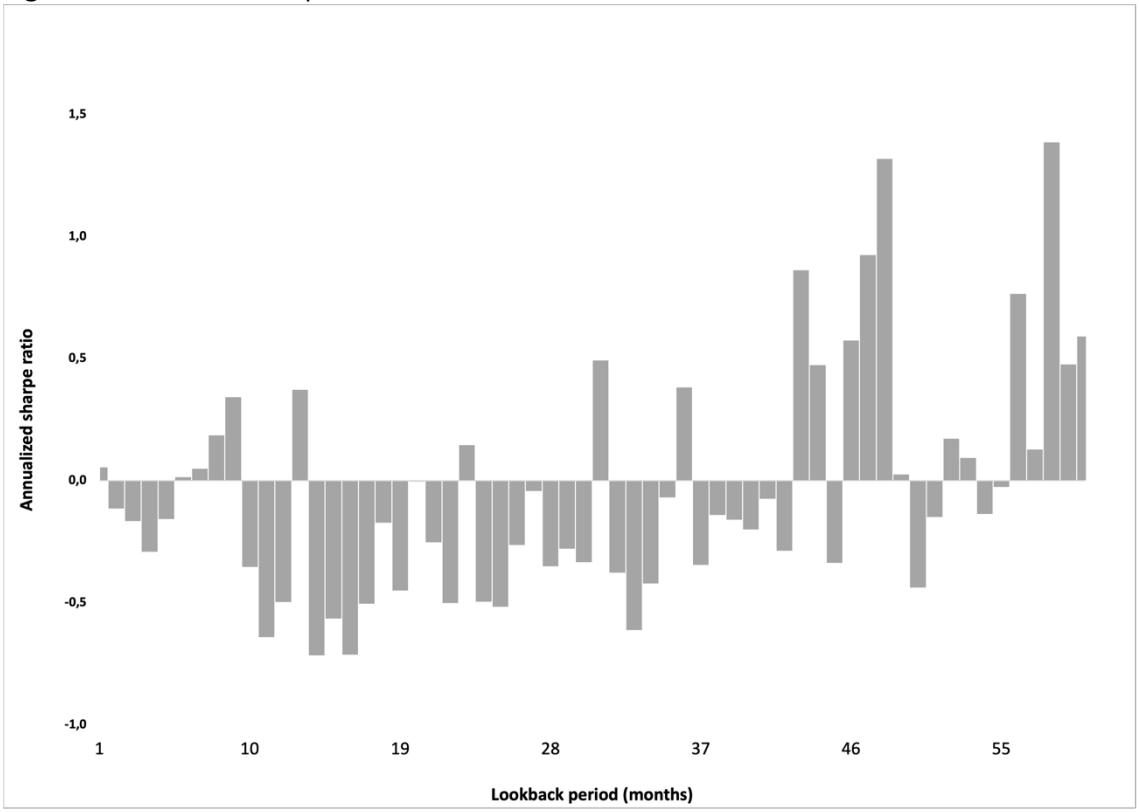
	Mean	Standard deviation	Skewness	Kurtosis	AR(1)	Sharpe ratio
Panel A: Economic activity						
Full sample	0,1098	0,9397	0,6391	4,1826	-0,0806	0,1168
Short term	0,0634	0,0354	0,9016	6,8155	-0,0619	1,7908
Medium term	0,0948	1,0708	0,5361	3,4608	-0,0699	0,0885
Long term	0,1827	1,1087	0,6313	3,7886	-0,0626	0,1648
Panel B: Inflation						
Full sample	0,1060	1,0602	0,8207	5,2617	0,2702	0,1000
Short term	0,1914	1,1084	1,0993	5,6174	0,3237	0,1727
Medium term	0,1611	1,0233	0,8941	3,6281	0,3159	0,1575
Long term	0,0602	1,2083	0,5685	4,9998	0,2339	0,0498
Panel C: Combo						
Full sample	0,1101	0,9278	0,4205	4,1658	-0,0777	0,1187
Short term	0,0533	0,5815	0,9556	6,1550	-0,0657	0,0917
Medium term	-0,0344	0,8629	-0,8057	5,3918	-0,0512	-0,0398
Long term	0,0333	0,8762	-0,4931	4,9201	-0,0346	0,0380

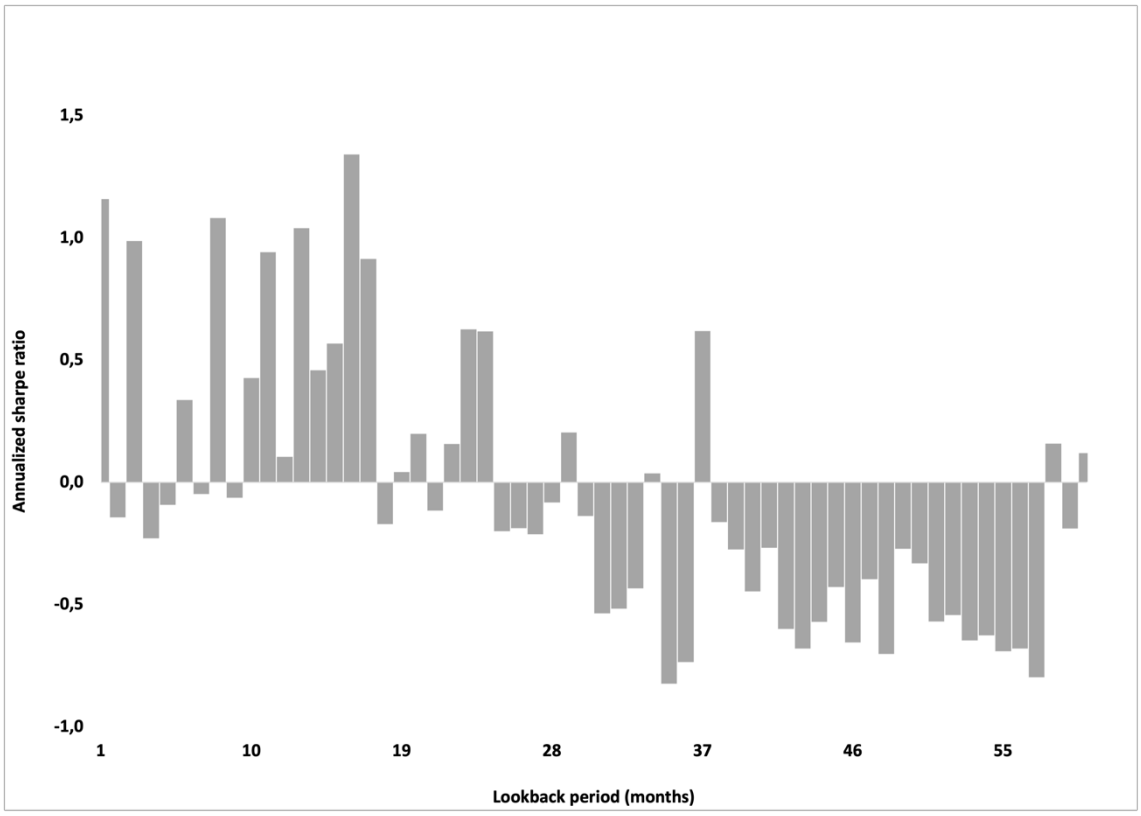
Table 8 presents performance measures for macroeconomic momentum portfolios comprised of trends measures economic activity (Panel A), inflation (Panel B) and combo (Panel C). Figures are based on monthly returns but mean, standard deviation and sharpe -ratio are annualized. AR(1) refer to the first order autocorrelation of returns. Aggregate trend portfolios comprising all lookback period buckets are presented once more in the table for comparison.

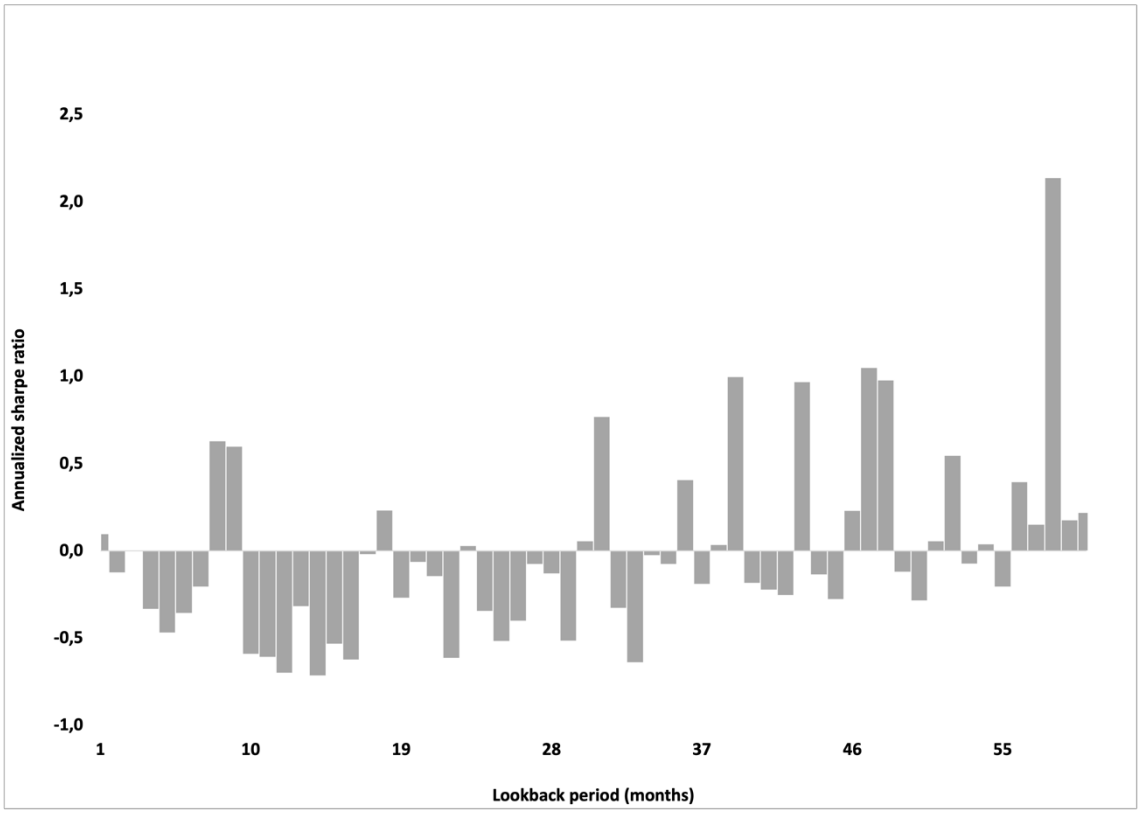
Momentum strategies have historically been cast as unappealing to investors due to strong crashes in returns sometimes also found as negative skewness and kurtosis (Barroso and Santa-Clara, 2015b). Above table shows that negative skewness is found from the combo portfolio from medium term and long-term lookback periods. Term portfolios already previously indicated low performance of the medium-term portfolio which is apparent also from these figures as the negative skewness is double that of the long lookback periods. Previous momentum research has also casted lookback periods up to 12

months to be favorable (Weist, 2022; Medhat & Schmeling, 2021; Zaremba 2019). This argument seems to be supported by macroeconomic momentum portfolios as for instance these lookback periods receive mostly the highest sharpe ratios and mean values.

Figure 5. Annualized sharpe ratios.







Figures present annualized sharpe ratios according to lookback period. First figure is for economic activity, second for inflation and bottom one for combo.

Evidence on the relationship between risk adjusted returns and lookback period is divided between inflation portfolio and the two other macroeconomic momentum portfolios. Annualized Sharpe ratio, used as a measure of risk adjusted returns, seems to follow a similar pattern in economic activity and combo portfolios. Momentum portfolios have been found to offer investors high sharpe ratios while also experiencing some of the largest crashed (Barroso and Santa-Clara, 2015b). A specific trend is hard to distinguish from the above figures, but overall positive Sharpe ratios are found more with longer lookback periods. Inflation portfolio's figures are essentially opposite with the longest lookback period providing disappointing Sharpe ratios. Here the trend between lookback periods is also much stronger. This suggests that an investor seeking momentum from inflation data should choose one of the shorter lookback periods to gain positive risk adjusted returns. On the other hand, an investor observing only macroeconomic activity datapoints or those datapoints together with inflation data, a longer lookback period might provide better risk adjusted returns. This being said, since only inflation portfolio showed a clear trend pattern relying on this evidence with the other portfolios for expected return evaluation is not enough. Dahlquist and Hasseltoft (2020) find consistently positive sharpe ratios through all portfolios. This comparison enforces the picture of more unstable portfolios comprised in this study.

7.2 Macroeconomic momentum vs benchmark strategies

To see how the macroeconomic momentum portfolios compare to other well-known investment strategies in the currency market three benchmark portfolios are constructed. Two momentum portfolios: one with a three-month lookback period and the other with a 12-month lookback period. In addition to momentum strategies, a portfolio for carry is constructed. The sample stays the same as with macroeconomic momentum portfolios but there is a difference in the investment signal generation.

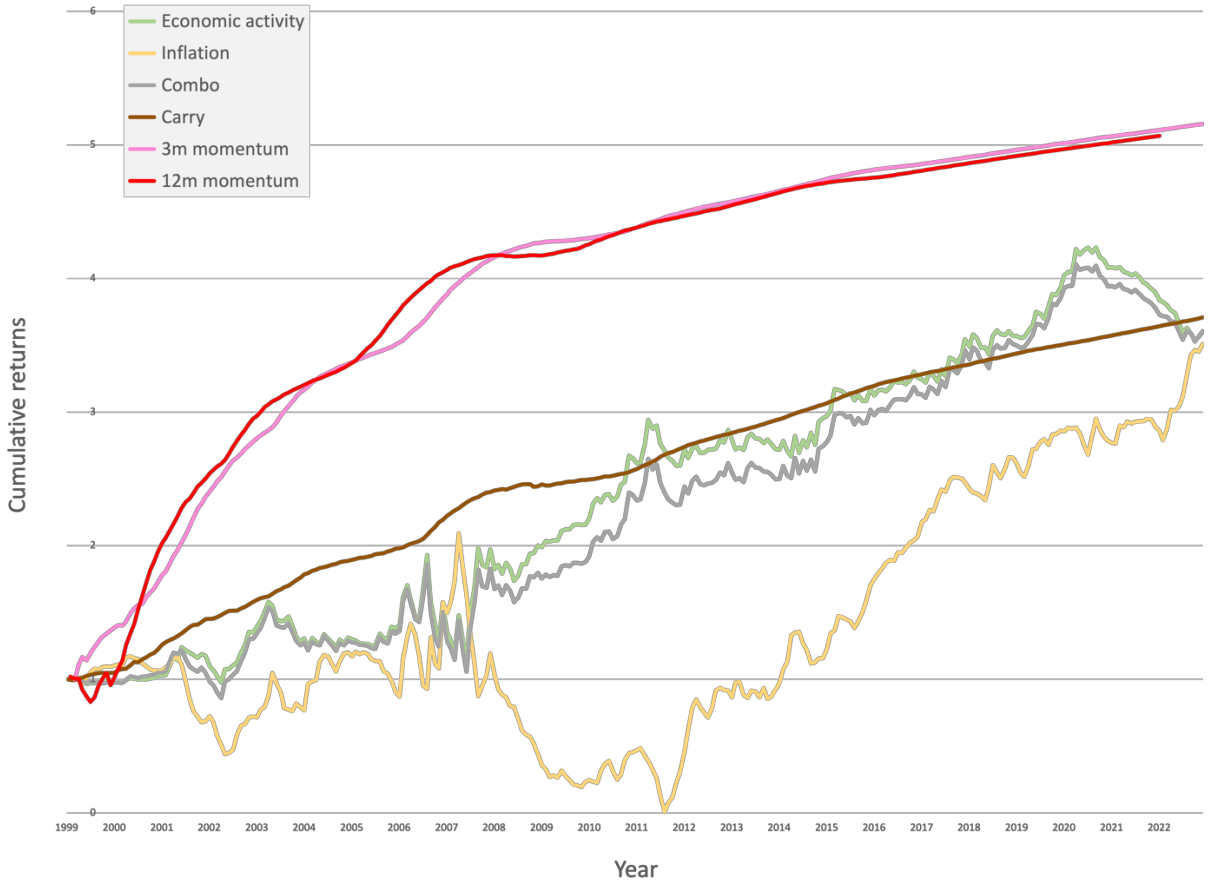
Table 9. Performance measures for Benchmark portfolios.

	Mean	Standard deviation	Skewness	Kurtosis	AR(1)	Sharpe ratio
Panel A: Benchmark strategies						
Carry	0,1132	0,0809	0,7397	3,0219	0,5468	1,3985
3 month momentum	0,1746	0,1902	1,8998	4,8279	0,7997	0,9178
12 month momentum	0,1769	0,2724	0,9955	6,6262	0,7480	0,6495
Panel B: Macroeconomic momentum						
Economic activity	0,1098	0,9397	0,6391	4,1826	-0,0806	0,1168
Inflation	0,1060	1,0602	0,8207	5,2617	0,2702	0,1000
Combo	0,1101	0,9278	0,4205	4,1658	-0,0777	0,1187

Panel A reports performance measures for portfolios comprised according to the benchmark strategies. Carry uses forward premiums and discounts as investment signals. 3-month and 12-month momentum invest according to momentum found in currency pricing through a selected lookback period. Panel B presents figures for Macroeconomic momentum portfolios for comparison. Figures are based on monthly returns but mean, standard deviation and sharpe -ratio are annualized.

From the performance measures it is apparent that results from the benchmark portfolios deviate noticeably from those of the macroeconomic momentum portfolios. All benchmarks propose higher expected returns signaled by mean values. Carry portfolio's mean falls close to macroeconomic momentum portfolios deviating only by 0,31 percent from the mean of portfolio combo. Benchmark momentum portfolios on the other hand yield over 17 percent annualized monthly returns which is over five percent higher than any of the other portfolios. Standard deviations show an even more significant difference. For benchmark strategies these figures are much lower indicating a much lower volatility level. The return-risk profiles painted by the mean and standard deviation are enforced by the sharpe ratios which end up in much higher figures than the macroeconomic momentum portfolios.

Figure 6. Cumulative returns of Benchmark strategies



The figure plots benchmark portfolios: carry, 3-month momentum and 12-month momentum. Macroeconomic momentum portfolios are plotted for comparison.

When the cumulative returns of benchmark portfolios are plotted side by side with macroeconomic momentum portfolios, some interesting remarks can be made. Firstly, looking only at the benchmark strategies, it is apparent that cumulative returns of 3-month momentum and 12-month momentum do not exhibit sizeable differences. The largest differences are only experienced in the first reported months where 12-month momentum portfolio briefly reduces in value. Returns for carry on the other hand somewhat follow a similar path as economic activity and combo. Inflation ends up close to these portfolios but through a much volatile return pattern. Traditional momentum portfolios yield superior cumulative returns compared to other portfolios throughout the sample period. These results suggest that 3- and 12-month momentum may yield the best results. If an investor has on the other hand risk appetite, economic activity and combo

strategies could be ones to consider. All benchmark strategies produce more consistent and healthy income generation, however cumulative returns of macroeconomic returns are almost equal with carry trade at the end periods of the study. After roughly 2018 results of macroeconomic portfolios exceed those of carry making it an interesting choice for an investor with higher risk bearing capabilities. Although not producing consistently significant negative cumulative returns it is inevitably it is still clear that macroeconomic momentum portfolios do not seem like clear winners against other strategies used in the foreign exchange market.

In addition to comparing macroeconomic momentum portfolios to benchmark strategies, it is interesting to demonstrate how measures for market conditions such as market volatility and funding conditions have affected results of the macroeconomic momentum portfolios. To do this the VIX index is used as a measure of market volatility and TED spread represents the funding conditions. The TED spread is calculated as the difference between 3-month USD libor rate and 3-month US T-bill rate. Through these fundamentals macroeconomic momentum portfolios are taken through a tighter test and it is revealed how an actively managed investment strategy performs against major market conditions.

Macroeconomic momentum portfolios are firstly regressed with the benchmark strategies with a contemporaneous time-series regression. Secondly, macroeconomic portfolios are regressed against the VIX index as well as TED spread. Dahlquist et al. (2020) conduct a similar regression but only for the Combo trend portfolio. Table 9 presents regressions against Economic activity, Inflation and Combo separately to provide a more indebt review and articulate possible differences between the portfolios.

Table 10. Regression of monthly returns on benchmark strategies and market condition measures from May 1999 to December 2022.

	Constant	Carry	3m Momentum	12m Momentum	VIX	TED
Panel A: Economic activity						
Coefficient	0,0035	-0,0504	-0,0191	0,0276		
(t-statistic)	(0,2402)	(0,2353)	(-0,3255)	(0,5491)		
Coefficient	-0,0059				0,0000	0,0161
(t-statistic)	(-0,4200)				(0,0037)	(1,0740)
Panel B: Inflation						
Coefficient	-0,0166	0,527950**	0,0477	-0,0595		
(t-statistic)	(-1,1232)	(2,5300)	(-0,2380)	(-0,3201)		
Coefficient	0,0059				-0,0002	-0,0087*
(t-statistic)	(1,3081)				(-0,7606)	(-1,8233)
Panel C: Combo						
Coefficient	0,0174	-0,0557	-0,1962	0,1891		
(t-statistic)	(1,3359)	(-0,3026)	(-1,1097)	(1,1542)		
Coefficient	-0,0024				-9,67E-05	0,0130
(t-statistic)	(-0,1686)				(-0,1390)	-0,8767

The table represents coefficients estimated from regressing monthly returns of macroeconomic momentum trend portfolios on benchmark strategies and market condition factors. Coefficients and t-statistics using benchmark portfolios (carry, 3-month momentum, 12-month momentum) are reported first in each panel. Volatility measure VIX and funding conditions measure TED spread are used in the second sequence of results. Panel A report results with Economic activity trend portfolio as the independent variable, Panel B with Inflation trend portfolio and Panel C with combo trend portfolio. Statistical significance at 1% and 5% are reported using indicators * and **.

Regressing macroeconomic momentum portfolios' returns with the benchmark portfolios and market conditions the strongest and statistically significant evidence of the regression are found between Inflation and Carry. Through this is apparent that a large portion of Inflation trend's returns reflect cross sectional differences in interest rate differentials. A similar connection is not found with the other portfolios where the coefficients are negative, meaning that when returns of carry rise, economic activity and combos' returns decreases. However, it should be noted that only approximately a five percent causation is found which does not reach statistical significance.

Although the benchmark momentum strategies followed a similar return pattern compared to each other, regress with macroeconomic momentum strategies the results appear twofold. 3 -month momentum provides negative causations towards economic activity and combo while when regressed with inflation the causation is positive. In terms

of the 12 -month momentum these coefficients are the opposite with negative causation found with Inflation. The coefficient found are low and do not hold statistical significance.

Regressing with market conditions it is once again found that these fundamentals hold a limited significance towards the performance of macroeconomic momentum portfolios. Dahlquist and Hasseltoft (2020) find Combo portfolio to have negative and statistically significant coefficients when regressed with VIX index and TED spread meaning that Combo trend performs poorly in times of high volatility and funding risk. A similar assumption cannot be confirmed with results presented in table 9. Here both coefficients are found negative only for the Inflation portfolio while only TED spread showing statistical significance. By this it can be concluded that Inflation trend performs poorly in times of funding risk. For the other macroeconomic momentum portfolios, TED spread has positive coefficients meaning that these portfolios perform better in times of high volatility and funding risk. However, these coefficients lack statistical significance of five percent or lower.

8 Discussion on empirical results

Upfront expectations for this study were introduced in the first sections or this thesis. In this section these expectations and hypotheses are further discussed in the light of empirical evidence obtained from this study. While some of the expectations were fulfilled, there are some parts that this study did not prove.

The first aspect that this study was expected to touch on was the opposing stance on Efficient market hypothesis. As discovered in section seven, macroeconomic momentum strategies were able to produce excess returns signaling that the foreign exchange market does not indicate to feature at least the highest level of efficiency. Moreover, this leaves room for anomalies and for investors to actively utilize this. For EHM to fully hold, macroeconomic momentum strategy should not be able to provide excess returns.

Based on the results by Dahlquist and Hasseltoft (2020) it was expected that macroeconomic momentum portfolios would also prove excess return generating nature of the macroeconomic momentum investment strategy. Results of this study do fulfill this expectation. As presented in chapter seven, all macroeconomic momentum portfolios eventually ended up delivering positive cumulative returns over the sample period. To add to this, none of the portfolios had negative expected return. However, the return patter of the portfolios created in this study did show discrepancies compared to those obtained by Dahlquist and Hasseltoft in 2020. Overall returns generation seemed to be more volatile in this newer research contribution indicating that an investor should not first handedly expect as high returns as the previous study indicated.

It was also hypothesized that macroeconomic momentum would provide best results by utilizing short- or medium-term lookback periods because previous momentum strategies suggest 3-to-12-month lookback periods to be the most beneficial choices for observing momentum and creating investment signal. Results of this thesis partially support this prediction. Short lookback periods from 1 to 12 month did yield compelling

evidence on the excess return generating capabilities of the researched momentum strategy. Beyond this prediction, the results indicate also that long lookback periods are in fact very profitable in macroeconomic momentum portfolios.

Based on previous research it was hypothesized that portfolios based on inflation data perform better than economic activity. On this aspect, the results do not support the hypothesis or the results of previous research. Over the sample period, overall cumulative returns end up in almost the same levels for inflation and economic activity. However, Inflation portfolios returns appeared much more unstable compared to economic activity. As such, it seems that there were some large monthly increases in the inflation portfolio but the possibility of these being outliers in the sample cannot be overruled as the portfolio showed less consistency in monthly increases compared to other macroeconomic momentum portfolios.

Lastly, it was stated that macroeconomic momentum portfolios should show to yield superior returns compared to benchmark strategies. This assumption was based on previous evidence on a similar strategy where macroeconomic momentum portfolios were better than the benchmark strategies used. Similar evidence was expected for this study as the benchmark strategies used were similar to once used in other research contributions with a similar setting.

9 Limitations and suggestions for future research

Given that the scope of this thesis is limited, several potential topics and considerations for future research arise. Macroeconomic momentum has only caught attention in recent years which suggests that there are still many avenues for future academics to follow.

Firstly, it is a known characteristic that currency markets experience large movements during times of major news releases (Ayadi et al., 2020). Due to the market operating on a 24-hour basis on banking days, the pricing of assets reacts instantly to news. This proposes a possible control variable to be explored regarding this study: how do specific data release dates affect results from the investment strategy. In this study, major data release dates on portfolio balancing dates were not controlled for. It is possible that market moves from these releases could create noise in the obtained or endured returns especially if event days fall close to portfolio rebalancing date.

From the evidence of this study, it is apparent that macroeconomic momentum portfolios provide volatile monthly returns which limits the investment strategy's appeal towards investors. This evidence could be a derivative of a limited investment universe but nonetheless a notable discovery. In terms of academic research, this proposes and opportunity to build on this. For instance, in this case the return crashes experienced could be looked at in more detail. Momentum crashed are often associated with volatility and risk (Daniel & Moskowitz, 2016). To dive deeper into this, autoregression of macroeconomic momentum portfolios could be investigated further.

Macroeconomic momentum has thus far been only addressed in the foreign exchange market most likely due to the clear linkage between macroeconomic variable and currency returns. As a natural continuum to this the phenomena could be researched in other markets. Not only could it be researched in the fixed income market that is

sensitive to macroeconomic fundamentals but also in other markets to shed light on the phenomena’s possible asset class encompassing nature.

10 Conclusions

Momentum strategies have received vast amount of academic attention since it was first discovered in the equity market. Even though the phenomena has been studied in various markets with results indicating on the strategy's excess return bearing capabilities, the source for such returns remains uncertain. Motivated by the scarcity of consensus on this front, this thesis examines the possibility of composing an investable momentum strategy in the foreign exchange market by utilizing macroeconomic indicators as investment signals. The findings of this study are twofold. Macroeconomic momentum portfolios are able to produce positive returns while the portfolios fail to outperform benchmark strategies due to volatile return distribution.

Empirical research shows that macroeconomic momentum portfolios are able to reach excess returns unexplained by other currency strategies. The findings are consistent with previous literature on macroeconomic momentum portfolios; however, the results are not as compelling as found before. Sharpe ratios of the portfolios paint a puzzling picture on the consistency of macroeconomic momentum portfolios. While previous research indicated only consistent and positive Sharpe ratios throughout the portfolios and sample tenors, macroeconomic momentum portfolios monthly Sharpe ratios remain volatile and, in many tenors, negative. This casts doubt to the strategy's risk returns profile's attractiveness to an investor. Simultaneously for academics, this creates a doubt on the generalization of previously obtained research results and highlights the importance of further research. Having said this, differences in portfolio construction methods and sample selection are recognized as possible contributors to the found results compared to previous academic statements. Due to scarcity of previous research on macroeconomic momentum, the difficulty in generalizing the results is also recognized.

To build a robust picture on the profitability of the strategy, future research could adhere to the following concepts. As the return pattern of the portfolios experience sharp drawdowns, possibility of consistent momentum crashes could be explored. Additionally,

some of the discrepancies between this study's results and previous contributions could be rooted to the portfolio construction methods. To answer this, portfolios with varying sizes of investment pools could be considered. In addition to continuing academic efforts towards macroeconomic momentum, the results shed light on momentum research as a larger concept. Overall, it is evident that there is still room for further research in the field of momentum and more specifically macroeconomic momentum.

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