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Equity Carry Trade in Emerging Markets

Evidence from 11 emerging economies

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ABSTRACT:
This thesis studies the implementation of the concept of the "carry trade" in equity markets using data from 11 emerging economies over the period of 1999-2021. The period of 21 years includes both the financial crisis of 2008 and the global pandemic of 2020. The data availability is scarcer for emerging markets than for developed markets, hence the sample consists only about half of all countries that fall within the definition of an emerging market.

The first part of this thesis focuses on theories of international parity relationships, history of the carry trade as well as application of that strategy in asset classes other than currency markets. As a concept, the carry trade has proven to be an effective strategy to earn positive excess returns even though its existence contradicts the financial theory called uncovered interest parity. In the common currency carry trade, an investor makes profit by going long the securities with high carry and shorting the securities with low carry. With the currency carry trade, the carry is the interest rate differential between two countries. However, according to uncovered interest parity, carry trade should not yield nonzero returns because the interest rate differential is offset by the exchange rate change.

Extending the concept of the currency carry trade, this thesis attempts to apply a generalized version of carry to equity markets. Using data of 11 emerging market equity indices, the carry for each index is measured with the expected dividend yield over the local risk-free interest rate. Then, a long-short portfolio is constructed using individual indices' carry as a trading signal. The strategy is executed using futures contracts, that is, buying futures contracts of high-carry markets and short selling futures contracts of low-carry markets. Finally, the carry trade strategy's return is calculated by summing the portfolio carry and the portfolio's capital change.

This study finds support for carry trade strategy in equity markets with a Sharpe ratio of 0.60. It is significantly higher than that of a passive, long-only strategy which yields a Sharpe ratio of 0.14. The findings of this thesis can be summarized into three main points. First, the results suggest that the concept of carry can be extended outside the currency markets to equity markets. In a practical context, an investor could benefit from a simple carry trade strategy by buying index futures with high expected dividend yields and selling index futures with low expected dividend yields. Second, carry is an important component of expected return as it acts as a trading signal and contributes to the profit as well. Finally, the backtest and the regression analysis strengthen the evidence against the uncovered interest/equity parity, and thus also against the "rational expectations" hypothesis.

KEYWORDS: carry trade, equity carry trade, emerging markets, uncovered interest parity, UIP, rational expectations.

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TIIVISTELMÄ:
Tämä tutkimus tutkii "carry trade" -kaupankäyntistrategian implementointia osakemarkkinoilla käyttäen dataa kehittyviltä markkinoilta. Dataa kerätään 11 markkinasta ajanjaksolta 1999–2021. 21 vuoden ajanjakso sisältää näin ollen sekä vuoden 2008 finanssikriisin että vuoden 2020 maailmanlaajuisen pandemian. Datan saatavuus on niukempaa kehittyvien markkinoiden osalta kuin kehittyneiden markkinoiden ja siksi tutkimuksen otos sisältää vain noin puolet maista, jotka kuuluvat kehittyvän markkinan määritelmään.

Tutkimuksen ensimmäinen osa keskittyy kansainvälisiin talousteorioihin, kuten ostovoima- sekä korkopariteettiin, "carry traden" historiaan sekä sen soveltamiseen muissa omaisuusluokissa kuin valuuttamarkkinoilla. Konseptina "carry trade" on todistettu olevan tehokas strategia, jolla on mahdollista saavuttaa positiivista ylituottoa, vaikkakin sen olemassaolo on ristiriidassa talousteorioiden kanssa. Harjoittamalla "carry tradea" valuuttamarkkinoilla sijoittaja voi hyötyä ostamalla korkean "carryn" omaavia arvopapereita ja lyhyeksi myymällä matalan "carryn" omaavia arvopapereita. Valuuttakaupassa "carry" on kahden maan välinen korkoero. Kuitenkin kattamattoman korkopariteetin mukaan "carry traden" ei pitäisi toimia, sillä korkoeron tasoittaa valuuttakurssin muutos, jolloin sijoittajan lopullinen nettotuotto on nolla.

Laajentaen "carry traden" käsitettä, tässä tutkimuksessa yritetään soveltaa sen yleistettyä versiota osakemarkkinoille. Käyttämällä 11 osakeindeksin dataa kehittyviltä markkinoilta, kunkin indeksin "carry" mitataan sen odotetulla osinkotuotolla yli paikallisen riskittömän koron. Tämän jälkeen muodostetaan "long-short" portfolio, jossa käytetään yksittäisten indeksien "carrya" kaupankäyntisignaalina. Strategia toteutetaan käymällä kauppaa futuurisopimuksilla, eli ostamalla korkean "carryn" futuurisopimuksia ja lyhyeksi myymällä matalan "carryn" futuurisopimuksia. Lopuksi lasketaan strategian tuotto summaamalla yhteen portfolion "carry" ja sen arvonmuutos.

Tulokset tästä tutkimuksesta osoittavat, että "carry trade" -strategia osakemarkkinoilla tuottaa Sharpe-luvuksi 0.60, joka on merkittävästi korkeampi kuin passiivinen, osta-ja-pidä -strategia, jonka Sharpe-luku on 0.14. Tutkimuksen tulokset voidaan tiivistää kolmeen pääpointtiin. Ensinnäkin tulokset viittaavat siihen, että "carry trade" konseptia voidaan laajentaa valuuttamarkkinoista osakemarkkinoille. Tutkimus osoittaa, että sijoittaja voi käytännössä hyötyä ostamalla korkean odotetun osinkotuoton omaavia indeksifutuureja ja lyhyeksi myymällä matalan odotetun osinkotuoton omaavia indeksifutuureja. Toiseksi, "carry" on tärkeä osa odotettua tuottoa, koska se toimii sekä kaupankäyntisignaalina että kontribuoi tuottoon. Kolmanneksi, "backtest" ja regressioanalyysi vahvistavat näyttöä kattamattoman korko-/osakepariteetin pitävyyttä vastaan, ja sitä kautta myös "rationaaliset odotukset" -hypoteesia vastaan.

AVAINSANAT: carry trade, equity carry trade, emerging markets, uncovered interest parity, UIP, rational expectations.

Contents

Tables

Figures

1 Introduction

Carry trade is a well-known concept in currency markets, and it has been shown abundantly that currency carry trade strategy can (consistently) generate positive excess returns. Currency carry, at its simplest, is borrowing in a currency with a low interest rate and investing the proceeds in a currency with a higher interest rate. If the positive cashflow, i.e., positive carry, offsets the capital losses, there are profits to be made.

Uncovered interest parity is a theory that dictates that either the currency with the higher interest rate will face currency depreciation, or the low-interest currency will enjoy currency appreciation by as much as the interest rate differential to an extent that the two net out each other. Therefore, according to uncovered interest parity, the expected excess return on the currency carry trade is zero due to the exchange rate change offsetting the interest rate differential. However, there is a vast amount of literature indicating that the carry trade has consistently generated positive excess returns and Sharpe ratios higher than that of equity markets. (Doskov & Swinkels, 2015)

Early studies, such as Hansen and Hodrick (1980), Bilson (1981), and Fama (1984), empirically test the theory of uncovered interest parity using data samples after 1973, i.e., a period of post-Bretton Woods system, and a period of increasing amount of floating currency regimes. They all find violations of uncovered interest parity, that is, positive results for currency carry trade. The empirical evidence before and including the period of Bretton Woods is relatively limited. Doskov and Swinkels (2015) analyse carry trade earnings over the period of 1901-2012 and find a Sharpe ratio of 0.26 (0.4 when excluding Bretton Woods era) over the entire period which both are substantially lower than that of more recent samples. Flood and Rose (1996) study fixed exchange rates and find that uncovered interest parity holds better in this regime compared to a floating one, though they conclude that even when using fixed rates, the uncovered interest parity is far from unity where the theory holds exactly.

The deviation from uncovered interest parity is also known as the forward premium puzzle. Opposite to many economic models, that is when the interest rate differential and exchange rate change are negatively correlated. (Fama, 1984) The empirical evidence provides substantial support to the forward premium puzzle, though Bansal and Dahlquist (2000) point out that much of the evidence is based on G-7 countries' data. They imply that economic differences, such as per capita GNP, average inflation, and credit risk, between developed and emerging markets result in different implications for the expected excess return. Bansal and Dahlquist (2000) argue that the forward premium puzzle occurs only in developing markets, and that is also true only when US interest rate exceeds foreign rates.

Frankel and Poonawala (2010) find similar results suggesting that the bias is smaller for emerging economies, with the coefficient being on average positive. Though the bias averages only slightly above zero among emerging market currencies, the forward rate still points in the right direction. For developed economies, Frankel and Poonawala (2010) confirm the severeness of the bias with the coefficient being significantly less than zero instead of positive one when the forward exchange rate would be an unbiased predictor.

Doskov and Swinkels (2015) report in their study of over a century that carry traders would have suffered occasionally large losses during the sample period. This gives support to the theory of crash risk, one of the most common explanations for carry trade's excess returns. However, it is left open whether crash risk can be the only possible explanation, that is, whether the observed losses are sufficiently large to compensate the excess returns. Crash risk is not the only possible explanation at all as several academics have tried to provide other plausible explanations for the strategy, including associating excess returns to rare disaster risk (Farhi & Gabaix, 2014), 'peso problems' (Burnside et al., 2011), and currency convertible risk (Doukas & Zhang, 2013).

Neely and Weller (2013) investigate adaptive trading behaviour by backtesting a group of most used technical and carry trade rules over the period of 1973-2012. They find that not until from mid-1990s onwards does carry trade get much more recognition, overshadowing other technical rules. The authors point out that this could explain the lack of academic literature regarding carry trade before 2005. As the authors mention, Google Scholar shows only 5 academic articles titled “carry trade” over 1990-2005. (Neely & Weller, 2013) Therefore, the research regarding carry trade is fairly new but by no means scarce. Since 2005 there has been several hundreds of articles published on the subject, most of which focus on the currency carry trade.

1.1 Purpose of the study and contribution

Imitating the currency carry trading, this paper shows that the strategy of carry trade can be implemented successfully in the equity markets, meaning that the equity carry trade strategy is able to consistently generate profits on a risk-adjusted basis. I attempt to expand the existing literature by implementing the concept of carry to equity markets. The aim is to verify that the theory is supported by the data. Previous academic research does not cover much of carry trade in different asset classes other than the currency markets. However, understanding the workings of “carry“ might open a platform for discussion, which includes new ideas for trading in the financial markets. This paper particularly is focused on the emerging countries which are less studied.

Using a generalized version of uncovered interest parity, this paper attempts to show that the market does not take all of the carry away. In other words, the capital change in the equity markets does not offset the carry component by adjusting prices, therefore, there is consistent profit to be made. The study is done in a portfolio setting where the purpose is to find out whether carry is large enough to generate positive excess returns despite price adjustment. In addition to a backtest, I also provide a regression analysis the purpose of which is to confirm the results obtained through backtesting.

This paper complements a growing literature that studies the behaviour of carry trades. There are plenty of research focusing specifically on currency carry trades. Earlier literature analyses the mechanism of the carry trade (e.g., Doskov & Swinkels, 2015), explanations of it (e.g., Burnside et al., 2011), and combinations of currency carry with other trading strategies (e.g., Burnside et al., 2011; Bhansali et al., 2015).

However, equity carry is a far less discussed topic in the academic world. The scarcity may be related to the definition of the measure of carry. For currencies, the carry is the difference in interest rates and in exchange rates. For equities, it is not as clear which measure should be used. In case of currencies the interest rates tend to go back and forth but they usually end up in the same place as where they started. For equities the rates go back and forth as well but there tends to be a positive drift, e.g., an equity market may fall to a zero value, but the interest rates will eventually go back to a certain level. Hence, timing may play a larger role when working with equity carry.

1.2 Hypotheses

It is established that carry trade works in the currency markets. The purpose of this thesis is to extend that analogy outside the currency markets and see how carry behaves in equity markets. The aim is to apply carry strategy to equity markets and show that doing so can yield positive excess returns. Carry strategy is considered successful if it can yield higher excess returns in comparison with a traditional buy-and-hold strategy, which is evaluated by the Sharpe ratio. Therefore, the hypothesis of the thesis is as follows.

H: Equity carry trade strategy yields a higher Sharpe ratio than a passive, equal-weighted long equity strategy.

1.3 Structure of the thesis

While the main topic of this paper is equity carry, to understand the nature of carry and its workings it is important that the most researched form of carry strategy, currency carry trade, is reviewed and the key or primary theories attached to it are discussed. This paper extends the analogy from currency carry trade to equity carry trade. Therefore, chapter 2 covers equilibrium models that are associated with the currency carry trade. Chapter 3 discusses carry trade strategy in more detail. Data description is introduced in chapter 4. Methodology and results are covered in chapter 5, and chapter 6 provides practical implications for the study and discussions about limitations. Finally, chapter 7 concludes.

2 International Parity Relationships

In this chapter I present major international parity relationships that are important to consider when talking about carry trade. These are the purchasing power parity, the interest rate parity, and the equity return parity. The first can be separated into absolute purchasing power parity and relative purchasing power parity. The second branches into covered interest parity and uncovered interest parity. Finally, the third refers to uncovered equity parity which is a less known relationship and not as established as the other parities. The purchasing power parity explores exchange rate changes from commodity market perspective while the interest rate parity – mostly uncovered interest parity – looks at exchange rate formation from the financial market view.

2.1 Interest Rate Parity

Interest rate parity explores the relation between interest rates and currency exchange rates. The theory of uncovered interest parity is widely used in international finance and open economies to explain exchange rate movements. Uncovered interest parity is a continuation for covered interest parity which is why it is noteworthy to first look at interest rate parity before moving on to the concept of uncovered interest parity.

2.1.1 Covered Interest Parity

Covered interest parity assumes that an investor can hedge against exchange rate uncertainty by entering a currency forward contract to lock in a rate that they can settle in the future. (Isard, 2006) Covered interest parity is formulated as

$$1 + r_t = \frac{s_t}{f_t}(1 + r_t^*), \tag{1}$$

where r_t is the domestic risk-free rate, r_t^* is the foreign risk-free rate, s_t is the spot exchange rate and f_t is the forward exchange rate. An investor at time t holding an asset denominated in domestic currency will at time $t+1$ gain a return of $1+r_t$. The alternative option is to hold an asset denominated in foreign currency by using the current spot exchange rate s_t, gain a return of $s_t(1+r_t^*)$, and reconvert back into domestic currency. At time t the investor does not know the value of the spot exchange rate at time $t+1$, thus they would use the forward exchange rate f_t. This forward rate lets the investor to convert units in foreign currency into units in domestic currency at a specified amount at time $t+1$. Covered interest parity states that the return on holding an asset in domestic currency must equal the return on holding an asset in foreign currency converted back to domestic currency. If they are not equal, the investor would naturally prefer to hold an asset in the currency with the higher interest rate. This would lead to the exchange rate to adjust until the equilibrium is reached. (Isard, 2006)

2.1.2 Uncovered Interest Parity

In uncovered interest parity, the investor can leave the rate used in reconverting the foreign currency back to domestic currency unhedged at time t, i.e., at time t they do not lock in the future spot exchange rate. In uncovered interest parity, the forward exchange rate f_t is replaced with the expected spot exchange rate. (Isard, 2006) The "Rational Expectations" hypothesis, first introduced by John F. Muth in 1960s, states that an outcome depends on people's expectation of what is about to occur. Essentially, expectations are formed when people try to forecast what will happen in the future and they are utilizing all information that is available to them at that time. (Lucas & Sargent, 1977) Lucas (1972) extended the Muth's hypothesis by demonstrating that by repeating the process of forecasting and adapting the past occurrences, people tend to adjust their expectations to avoid past errors, leading to a pattern where past outcomes affect the current expectations.

"Rational expectations" hypothesis is fundamental for the theories of "random walk" and "efficient markets". Therefore, it is also linked to uncovered interest parity where an investor uses the expected value of spot exchange rate. The assumption of "rational expectations" hypothesis is that the expectation of the future is equal to the realised value plus an error term (Cuestas et al., 2017). If an investor's expectations are rational, they do not systematically diverge from zero. If they are irrational, there is systematic bias and limits to uncovered interest parity.

The uncovered interest parity states that the expected spot exchange rate is equal to the realised exchange rate. The theory contains exchange rate risk because it uses the expected value of the future spot exchange rate while the actual exchange rate can turn out to be something different. Uncovered interest parity can be written as

$$1 + r_t = E_t\left[\frac{s_t(1+r_t^*)}{s_{t+1}}\right] = s_t(1 + r_t^*)E\left(\frac{1}{s_{t+1}}\right), \quad (2)$$

where $E_t\left[\frac{s_t(1+r_t^*)}{s_{t+1}}\right]$ is the expected spot exchange rate. So, in contrast to covered interest parity, the main question in uncovered interest parity for an investor holding a position for a certain period is what the expected change to the spot rate is. Compared to covered interest parity, it is more challenging to examine the validity of uncovered interest parity because market expectations of future spot exchange rates cannot precisely be observed. Hence, the general way to test the latter is to assume that exchange market participants have rational expectations, i.e., assuming that the future exchange rate will equal the forward value at time t plus an error term u_{t+1}. (Isard, 2006) This leads to

$$s_{t+1}=f_t+u_{t+1}, \quad (3)$$

and

$$s_{t+1} - s_t = r_t - r_i^* + u_{t+1}. \quad (4)$$

The validity of uncovered interest parity is tested by estimating the α intercept and the β coefficient in the specification forms, where the error terms have a population mean of zero and are serially uncorrelated. (Isard, 2006) Thus, the specification forms are written as

$$s_{t+1} = \alpha_0 + \beta_1 f_t + u_{t+1}, \tag{5}$$

and

$$s_{t+1} - s_t = \alpha_0 + \beta_1 (r_t - r_i^*) + u_{t+1}. \tag{6}$$

For uncovered interest parity to hold, at least four conditions must statistically hold as well. The null hypothesis states that first, $\alpha = 0$. The second condition is that $\beta = 1$, and the third and fourth conditions state that error terms have zero means and are serially uncorrelated. In other words, four conditions must hold to uncovered interest parity to hold true consequently creating a quadruple hypothesis problem. When the slope coefficient β is negative, economists talk about a phenomenon where the country with the higher interest rate will see its currency appreciate while the lower interest rate country will have a currency depreciation. This phenomenon is known as forward premium anomaly, and it is opposite to what is implied by uncovered interest parity. (Baillie & Kilic, 2006)

Forward premium puzzle is an empirical regularity which depicts deviations from uncovered interest parity. It refers to an anomaly that forward exchange rate is a biased predictor of future nominal spot exchange rates. (Haab & Nitschka, 2020) Uncovered interest parity states that the difference in two countries' interest rates will offset the difference in exchange rate which leads to a non-arbitrage state whereas forward premium puzzle refers to an imbalance where a country's currency appreciates along with its interest rate. Therefore, the two contradict each other. The often-found anomaly is persistent and consequently discredits the validity of uncovered interest parity. Previous literature focuses on risk-based explanations for the phenomenon which I will go through briefly in chapter 3.

Lyons (2001) (as cited in Baillie & Kilic, 2006) brings out the arbitrage hypothesis which focuses attention on the Sharpe ratio. The Sharpe ratio in this context indicates whether a certain strategy should be executed or not. He postulates that the Sharpe ratio is zero if uncovered interest parity holds, i.e., $\alpha = 0$ and $\beta = 1$. When the slope coefficient diverges from one, the Sharpe ratio gets non-zero values. Therefore, a positive Sharpe ratio on a currency strategy is a potential indicator of an uncovered interest parity failure. Lyons (2001) states that an arbitrage opportunity emerges only if the Sharpe ratio exceeds a threshold provided by another alternative trading strategy, e.g., buy-and-hold equity strategy. That is when the excess return on carry trade strategy is large enough to attract speculative capital. If the Sharpe ratio from equity carry exceeds that of a buy-and-hold equity strategy, carry trade can be seen as successful and should be executed.

Uncovered interest parity deviations are much tested, and the validity of the theory is often rejected using data for floating exchange rates. In contrast, Flood and Rose (1996) identify that large part of uncovered interest parity deviations fade away for rate regimes with fixed exchange rates. They study data from the European Monetary System (EMS) and find that the slope coefficient hovers around +0.6 instead of being negative in most regressions with floating rate data. They also claim that outlier observations have better predicting power, i.e., uncovered interest parity holds better during abnormal (more volatile) time periods. While testing with fixed rate data, the authors point out that EMS has experienced multiple exchange rate realignments which have resulted in a “peso problem” bias. These realignments are anticipated devaluations by the markets. They test the “peso problem” bias by both including and excluding EMS exchange rate realignments. The former produces a slope coefficient typically above 0.5 and the latter reduces it by -0.5. Hence, the exchange rate regime and the EMS realignments seem to affect the magnitude of the deviations from uncovered interest parity.

Huisman et al. (1998) also find results opposite to common theoretical contributions. They report results with a slope coefficient averaging +0.5, significantly distant from zero

but also from 1. With a panel approach and inclusion of the random time effect, they control for small sample problem and biasing factors, such as market forecast errors, peso problems, and time-varying risk premiums. The authors find evidence that when the absolute forward premium is large, i.e., during extreme market periods, the slope coefficient is not significantly different from 1 and therefore uncovered interest parity cannot be rejected. During less volatile times, the slope coefficient drops, resulting to strong rejection of uncovered interest parity. Contrasting to common literature, these examples with outlier observations show that uncovered interest parity deviations are not as severe as commonly found. They are positive and significantly different from zero. However, they are also significantly below the threshold of 1 when uncovered interest parity holds exactly.

As the literature above shows, uncovered interest parity properties are commonly studied by looking at whether the forward premium as an independent variable can forecast the foreign exchange excess returns, i.e., deviations from uncovered interest parity. For uncovered interest parity to hold exactly, excess returns must follow random walk and be unpredictable. While it is established that uncovered interest parity deviations exist, they are statistically significant, and would technically provide an arbitrary situation, their economic significance may remain small due to limits to arbitrage. A textbook definition of arbitrage would be to buy low a certain security, sell high a certain security, where these both securities are almost identical. In such case an investor would earn riskless profit. However, actual arbitrage in the practical world is difficult to impossible to detect. Divergence of uncovered interest parity may offer speculation opportunities but in terms of textbook arbitrage, there are limits to the arbitrage that an investor can engage in. In practical context, the typical limits are funding and liquidity constraints, information and trading costs, and the fact that it is almost impossible to find a perfect substitute for an asset (Jones, 2015).

As discussed before, the Sharpe ratio of carry trade strategy should exceed that of an alternative trading strategy for investors to put in capital. If the Sharpe ratio is non-zero

but economically insignificant, the bias is left unexploited and therefore, it will persist. Lyons (2001) (as cited in Sarno et al., 2006) contributes to “limits-to-speculation” hypothesis by calculating lower and upper bounds for Sharpe ratio thresholds. According to Lyons (2001) a band of inaction is formed when β ranges between -1 and +3, and when β is outside of that range, financial institutions will have incentive to follow the carry strategy. However, the range of -1 and +3 seems quite large which raises a question of how often β is truly outside of that range and whether investors actually follow the lower and upper bounds.

Inside the band of inaction (inner regime) the uncovered interest parity deviations are not large enough to attract capital, and investors can gain better return from alternative strategies with lower risk. However, outside the band of inaction (outer regime) the Sharpe ratios are large enough and uncovered interest parity deviations become economically significant. (Sarno et al., 2006) Dumas (1992) states that when deviations are large enough, financial institutions will enter the market and exploit the arbitrage opportunity, resulting β to mean revert. Hence, it seems that uncovered interest parity holds true in outer regimes but not in inner regimes due to “limits-to-speculation” hypothesis. While uncovered interest parity does not hold most of the time, the deviations from it are small to the extent that they remain economically insignificant and will persist until speculative capital is encouraged to participate (Sarno et al., 2006). Having said that, the inner regime provided by Lyons (2001) is so broad that it almost makes the β meaningless.

2.2 Uncovered Equity Parity

Related to uncovered interest parity, uncovered equity parity deals with linkage between exchange rates and stock prices. Uncovered equity parity suggests that when the foreign equity market outperforms the domestic equity market, the exchange rate movements between the two markets will offset the return from the equity investments, leading to equilibrium. Again, the parity assumes that the “rational expectations” hypothesis holds

true and the equality between the expectation and realisation. The theory implies that a market with higher expected equity return will face a currency depreciation while a market with lower expected equity return will see its currency appreciate. For example, the currency carry is about the cashflow versus the foreign exchange adjustment, i.e., how much the interest rate differential is compared to the adjustment. In the equity carry, the cashflow or the dividend differential is compared to the adjustment which in equity comprises of two components of capital gain or loss. One is currency, just as in currency carry, and the other is market itself. Essentially the only fundamental difference is if two interest rates are driven by varied factors than two equity markets. A lot of factors driving interest rates are supposed to drive equity markets as well, such as growth, economy, and inflation. Uncovered interest parity and uncovered equity parity share similarities, but their main difference lies in the return differentials as uncovered interest parity considers them ex ante while uncovered equity parity uses expected values of future returns. (Cappiello & De Santis, 2005; 2007)

Cappiello and De Santis (2005; 2007) propose a model where returns on risky assets and exchange rate between two countries are interconnected. Semantic-wise, the authors term "uncovered equity parity" as "uncovered return parity." Hence, uncovered equity parity will be referred as uncovered return parity in this section. The model is as follows.

$$E\{(1+R_{x,t+1})|\Im_t\} = E\{(1+R_{y,t+1})|\Im_t\}E\left\{\frac{S_{ij,t+1}}{S_{ij,t}}\middle|\Im_t\right\} + riskpremium_{t+1}. \quad (7)$$

Here, $E\{(1+R_{x,t+1})|\Im_t\}$ and $E\{(1+R_{y,t+1})|\Im_t\}$ denote the expected total returns from producing goods x in country i and goods y in country j, given the information set $\Im_t$. $S_{ij,t}$ is the nominal spot exchange rate. Lastly, $riskpremium_{t+1}$holds equity and foreign exchange risk premia. It is clear from the expression that when expected returns in country i are higher than in country j, the nominal exchange rate must adjust so that the disparities in equity returns are rebalanced. (Cappiello & De Santis, 2005;2007)

The theory is tested using the euro, the British pound, Swiss franc, Deutsche mark, and French franc against the US dollar (Cappiello & De Santis, 2005). First, under the assumption of risk neutrality, Cappiello and De Santis (2005) find that an increase in equity returns in countries against the US is correlated with the US dollar appreciation. Second, under the assumption of investors' risk-aversion, the authors employ various explanatory variables as proxies for the risk premia. These variables include earnings' growth rates, short-term interest rate movements, inflation rates, and net equity flows. They find that this version of uncovered return parity is able to explain a significant part of variation in the European currencies, for instance the explanatory power for EUR/USD is 24.3%, for GBP/USD 34.6% and for the CHF/USD 5.5%. (Cappiello & De Santis, 2005) Their findings give support to uncovered return parity, differing from uncovered interest parity, which existing literature has continuously rejected. The uncovered return parity considers risky assets, such as equities while the investment opportunity in uncovered interest parity is reduced to risk-free assets. Therefore, it seems that the level of riskiness the asset holds makes a difference.

According to Hau and Rey (2006), the core of the uncovered equity parity condition is that when foreign investments manage to outperform the domestic ones, the investor is more exposed to the exchange rate risk. To mitigate this risk, they will rebalance their portfolio by reducing their foreign positions. As the capital moves from foreign market to domestic market, the domestic currency will see excess demand and consequently, appreciate accordingly. In contrast, selling the foreign currency will cause it to depreciate. They find support to uncovered equity parity by stating a negative correlation between returns in the domestic equity market and domestic currency movements. When the home equity market faces higher returns, its currency tends to depreciate. (Hau & Rey, 2006)

In contrast to the literature above, Cenedese et al. (2016) do not find support for uncovered equity parity. Their findings indicate that an investor can achieve significant returns

across countries because exchange rate movements fail to counterbalance the difference. They argue that the returns can entirely be attributed to equity differentials while exchange rate changes have little to none explanatory power.

Some mixed results have been found by Curcuru et al. (2014) as they define the uncovered equity parity condition more rigorously by parting it into two parts. The first step of uncovered equity parity is as follows. The outperformance by foreign equity relative to domestic equity exposes investors to higher exchange rate risk. Therefore, the first leg of uncovered equity parity has investors decreasing their exposure by selling some of the foreign holdings. The second leg states that the foreign currency will depreciate due to the selling of foreign currency in order to mitigate exchange rate exposure. The authors aim to particularly examine the first leg of uncovered equity parity as the second leg has been abundantly established in the literature. Curcuru et al. (2014) investigate the correlation between reallocations and past returns. A negative correlation would support uncovered equity parity and a positive would indicate returns-chasing behaviour.

Curcuru et al. (2014) use the active allocation adjustment of a country i in U.S. investors' foreign portfolio at time t, denoted by $X_{i,t}$.

$$X_{i,t} = w_{i,t} - w_{i,t-1}\left(\frac{1 + r_{i,total,t}}{1 + r_{p,total,t}}\right). \tag{8}$$

Here, $r_{i,total,t}$ is the return on country i equities during the total holding period, $r_{p,total,t}$ is the return on the portfolio the U.S. investors hold, and the weight of country i in the portfolio is indicated by $w_{i,t}$. In a buy-and-hold strategy $X_{i,t}$ would be zero.

To see whether investors move toward or away from foreign holdings after they have performed well, Curcuru et al. (2014) employ a momentum statistic, LM. If LM is positively significant, $X_{i,t}$ is positively correlated to past returns. This implies momentum

trading. Contrary, a significantly negative LM would indicate that investors participate in contrarian trading or rebalance their portfolio, as according to uncovered equity parity.

$$LM_k = \frac{1}{T}\sum_{t=1}^{T}\sum_{i=1}^{N_t}\left(r_{i,m,t-k} - r_{p,m,t-k}\right). \tag{9}$$

N_t accumulates to the number of countries in portfolio p at time t, m indicates the type of returns which can be total returns, underlying equity returns, or currency returns. The number of lagged months is denoted by k.

Based on their investigation, Curcuru et al. (2014) argue that while U.S. investors do reallocate their holdings away from outperforming equity markets (selling past winners, to be specific), this behaviour is a reaction to movements in underlying equity returns and not due to currency fluctuations. In addition, U.S. investors reallocate to markets they anticipate to generate high abnormal returns in near future, and these changes enhance short-term performance. uncovered equity parity states that investors rebalance their portfolios so that they are less exposed to FX risk. However, the data suggests that investors reallocate to earn higher future returns instead of reducing FX risk. Thus, the findings by Curcuru et al. (2014) are only partially consistent with uncovered equity parity.

The previous subchapters have focused on the traditional definitions of uncovered interest parity and uncovered equity parity. Both state that the differentials in interest rate levels or equity returns will be offset by exchange rate changes, leading to a non-arbitrage situation. In such case, there is no point for an investor to enter carry trading risk-freely. This paper considers generalized versions of uncovered interest parity and uncovered equity parity. Instead of attributing price appreciation or depreciation to exclusively exchange rate changes, the generalized versions can be stated as phenomena where the market takes back the carry component. Stated otherwise, a high carry is compensated by a low expected price appreciation, regardless of asset class. Again, this would result to a zero profit, supporting the generalized versions of uncovered interest parity and

uncovered equity parity. An investor cannot systematically achieve positive returns because the market stabilizes to an equilibrium where the positive cashflow is netted out by the capital loss. In the generalized versions, the carry component is simply the cashflow which in case of equities in this thesis, is the expected dividend yield. For other asset classes, such as fixed income and commodities, the carry is the yield spread and the basis, respectively (Koijen et al., 2018).

3 Carry trade and excess returns

This chapter covers the previous literature on carry trade and the effectiveness of it. The first subchapter presents the mechanism of currency carry trade. The second subchapter goes through possible explanations for carry premium that the academic world has provided. Lastly, I present other forms of carry trade in the final subchapter of chapter 3.

3.1 Currency carry trade

Research of carry strategy is centred around one form of it, the currency carry trade strategy. Currency carry trade is a strategy where an investor borrows in a currency of a country with low interest rate and invests the proceedings in a high interest rate currency. These currencies are called funding and investment (or asset) currencies, respectively. (Burnside et al., 2011). The payoff for a long position on foreign currency is as follows

$$z_{t+1}^{L} = (1 + i_t^*)\frac{S_{t+1}}{S_t} - (1 + i_t). \tag{10}$$

Here i_t denotes the risk-free rate in home country, i_t^* is the risk-free rate for foreign country, and S_t is the spot exchange rate. Transaction costs are not considered at this part. The currency carry trade's payoff is

$$z_{t+1}^{C} = sign(i_t^* - i_t) z_{t+1}^{L}. \tag{11}$$

If the exchange rates stay unchanged, the investor gains the difference of interest rates as profit. According to uncovered interest parity, this kind of strategy cannot work because the funding currencies will experience appreciation while the investment currencies will depreciate. Hence, the exchange rate movement will offset the possible gain provided by the interest rate differential. However, as previously discussed, the uncovered interest parity generally does not hold which has been proven by the exchange rates

going opposite directions from what is implied by uncovered interest parity. Carry trade exploits the failure of uncovered interest parity and is supported by the forward premium puzzle.

Burnside et al. (2011) study 20 major currencies over the period of 1976-2010. They find that the equal-weighted carry trade strategy yielded an average return of 4.6% with a standard deviation of 5.1%, and a Sharpe ratio of 0.89. For comparison, the numbers for U.S. stock market over the same period are 6.5%, 15.7% and 0.41. The first note from the results is that the average return for the carry trade strategy is only slightly less than for the U.S. stock market, but at the same time, stocks are three times more volatile. The Sharpe ratio is twice for the carry trade compared to U.S. stocks, meaning it would have been considerably more profitable on a risk-adjusted basis to execute a carry trade strategy instead of following the market. Burnside et al. (2011) show that diversification doubles the Sharpe ratio by examining the carry strategy for both individual carry trades and a portfolio of carry trades. The former generates a Sharpe ratio of 0.42 and the latter 0.89.

3.2 Explanations for the currency carry premium

The violation of uncovered interest parity has gotten the world of international finance to debate on what could explain the high excess return that carry trade generates. A common explanation for high returns in case of carry trade has been that high returns are a compensation for crash risk (Brunnermeier et al., 2008). Brunnermeier et al. (2008) show that high-carry currencies tend to deliver negatively skewed returns due to funding constraints and sudden unwinds of their positions. This leads to a further price push down, an increase of funding problems, and a rise in volatility, amongst other things.

Froot and Frankel (1989) decompose the forward discount bias into two attributes, the risk premium and expectational errors. A common test for forward market unbiasedness is to regress the future change in the spot rate on the forward discount. Many authors

agree on the rejection of the null hypothesis, i.e., the forward discount is a biased predictor of future changes in the spot rate. However, there is dispersion amongst authors on whether the bias is the consequence of risk premium or investors' systematic expectation errors. Froot and Frankel (1989) test two hypotheses, one of which tests whether the bias is attributable to the time-varying risk premium and other one tests whether the bias is evidence of a failure of investors' rational expectations. First, they find, like most other authors, that they can reject the hypothesis of unbiasedness. Second, the most significant finding Froot and Frankel (1989) discover is that excess returns are mainly cause of systematic errors of prediction and not exchange risk premiums. They can reject the hypothesis that all of the bias is a consequence of the risk premium, and simultaneously they cannot reject the hypothesis that all of the bias is a result of investors' systematically recurring expectational errors. They also challenge the investigation by Fama (1984) and Hodrick and Srivastava (1984) that the variance of the risk premium is greater that the variance of the expected depreciation. On the contrary, the authors find that the variance of the expected rate of depreciation is greater compared to that of the risk premium, implying that former component has a more significant role in determination of spot and forward exchange rates.

Other explanations have been provided as well. Lustig and Verdelhan (2007) claim that the high-carry currencies have higher consumption betas, and high excess returns are compensation for consumption risk. They propose that the consumption CAPM is able to explain the excess returns of carry trade. They implement an alternative carry strategy by utilizing timeseries variation of interest rate difference between US and the rest of the world. Because the foreign interest rate is typically above the US rate during US recessions, they go long on foreign currencies and short US dollar whenever the foreign interest rate is higher than the US rate. Vice versa, they go short on foreign currencies and long US dollar when the interest rate difference is other way around.

Lustig et al. (2014) argue that when US investors long the foreign currency and short the dollar, they are undertaking the risk that dollar appreciates when the US pricing kernel

experiences a bad shock. Contrarily, when a US investor shorts foreign currencies and long dollar, they bear the risk that dollar depreciates in good times. The authors claim that the "dollar carry trade" returns correlate with the average growth rate of consumption. However, Burnside (2011) disagrees by arguing that consumption betas of currency portfolios are not statistically significant and economically large enough to have explanatory power for expected returns. For Lustig and Verdelhan's (2007) risk-based narrative to explain the excess returns of currency carry, the returns must correlate with the proposed stochastic discount factor. Burnside (2011) argues that their consumption-based SDF is uncorrelated to the nonzero returns due to the difficulty of estimating precise betas of consumption factors. Therefore, consumption risk explains little to none of the variation in expected returns.

Lustig et al. (2011) study whether carry returns can be explained by volatility risk. They suggest that the dollar-neutral high-minus-low carry trade returns are affected by the movements in global financial market volatility. The dollar-neutral high-minus-low carry trade differs from the "dollar carry trade" such that the former uses the ranking of interest rates in portfolio forming while the latter focuses on one market's short-term interest rate difference and compares it to the rest of the world. Lustig et al. (2011) identify a "slope" factor on which high interest rate currencies have more loading than low interest rate currencies. They show that this global risk factor relates to the variation in volatility of global financial markets. The authors demonstrate that the loadings on the global risk factor is aligned with the average returns on the carry trade and the factor explains about two-thirds of the cross-sectional variation in average returns of carry trade. Therefore, when an investor is lending in high interest currencies and borrowing in low interest currencies, they are more exposed to this risk factor. However, volatility risk can only partly explain the excess returns. For example, Cenedese et al. (2016) test an equity carry strategy using data of 42 countries and find that the returns are linked to international risk factors, particularly to global equity volatility risk but the exposure explains the returns only partially. Significant risk-adjusted returns and large Sharpe ratios remain after controlling for that said risk and they exceed conventional strategies.

According to Brunnermeier et al. (2008), high-carry currencies generate investors positive return to compensate for liquidity risk. They show that currency crashes, VIX and TED spread are positively correlated. When volatility rises, margins and capital requirements tighten up as well which then reduces available speculator capital. Consequently, traders withdraw from their carry trade activities.

Burnside et al. (2011) offer an alternative explanation for high average payoff to the carry trade. They state that the returns reflect a peso problem, which is a problem of low-probability events and the effects they cause. Said differently, carry trade's positive return is a compensation for the fact that the funding currency has a small probability to appreciate and likewise, the investment currency has a small probability of depreciating.

Koijen et al. (2018) test carry's exposure to liquidity risk and volatility risk and conclude that carry strategies tend to perform poorly during illiquid and volatile times, resulting to lower returns during market turbulence and global recessions. Their results suggest that liquidity and volatility explain part of the carry premium, but they cannot explain it fully. (Koijen et al., 2018)

Dobrynskaya (2014) proposes a new risk factor to explain the currency carry returns, the global downside market risk factor. The author argues that the high return of a currency carry is a compensation for its high downside market risk. High-interest rate currencies express high and statistically significant downside market risk while low-interest rate currencies have zero downside risk which is why they can be used as a safe haven and a hedging instrument.

The academic literature provides many arguments for the effectiveness of carry. However, there are not explicit conclusions as to which factors are able to fully explain the excess returns of carry. Risk-based explanations to the failure of uncovered interest parity do, to some extent, explain the behaviour of returns but none of them offer a

comprehensive explanation to positive risk-adjusted returns. Therefore, academic world has not been able to provide risk-based explanations for the forward premium anomaly. However, behavioural finance offers plausible reasonings for the anomaly since the outcomes of economic situations are often influenced by psychological biases. For example, people's expectations are not unbiased which is often assumed in financial models.

3.3 Equity carry and other forms of carry trade

As shown, currency carry trade strategy has a history of generating positive excess return, beating the market, and rejecting the theory of uncovered interest parity. The phenomenon raises a question whether the concept of carry trade can be applied to other major asset classes as well.

Research on other forms of carry trade is scarcely to be found. However, some have aimed to relate returns of other asset classes to the returns of currency carry trade. Ready et al. (2017) can tie commodity returns to foreign exchange carry trade. They claim that countries that produce basic goods, such as raw commodities, offer higher interest rates compared to countries that export final goods. The spread between interest rates converts into average returns on foreign exchange carry trade, making the commodity country's currency risky and the consumption country's currency a safe haven.

Bakshi et al. (2019) implement carry and momentum strategies to commodities to study the cross-sectional variation in returns. They find that four out of five of both strategies generate statistically significant average returns. Moreover, they argue that the carry factor is sensitive to innovations in global equity return volatility, meaning that the unpredictable component in the volatility makes the carry factor yield low returns during times when global equity volatility increases. Vice versa, the carry factor delivers high returns in periods where volatility is low.

Cenedese et al. (2016) analyse the correlation between international equity returns and foreign exchange returns by implementing a strategy that utilizes margins in expected returns of equity indices. They term the strategy, which in this paper is called equity carry trade, as “UEP strategy” as they remind that the strategy aims to take advantage of the uncovered equity parity violation. The UEP strategy is carried out by first computing the returns using three variables: dividend yields, term spreads, and 12-month momentum. Then, the equity indices are sorted based on their expected return differentials against the domestic (here, the US) market. The carry trade is executed by going long the countries with the highest expected equity return while shorting the countries with lowest expected equity return.

Cenedese et al. (2016) find significant excess returns, ranging from 7% to 12% p.a. covering all three predictors. They argue that the excess returns can solely be attributed to local-currency equity differential while the exchange rate fluctuations do not account to the returns at all. In other words, they do not find any correlation between equity markets and exchange rates. Thus, the UEP strategy used in this study can generate significant alpha and large Sharpe ratios, and the findings hold true even after controlling for exposure to market volatility risk. Their conclusion indicates zero support for uncovered equity parity because their results do not show that exchange rate movements would offset equity market return differentials. This finding is in line with the currency carry literature which acknowledges that exchange rate fluctuations do not balance out the spread in interest rates between two countries, i.e., the acknowledge of the violation of uncovered interest parity.

While investigating the seasonal phenomenon in the foreign exchange market and its relation with the stock markets, Girardin and Salimi Namin (2019) first discover that the seasonality effect in the US dollar–Deutsche mark (euro) is still present and has not been arbitraged away. They then aim to explain the observed pattern with corresponding seasonality in equity markets. They uncover that seasonal pattern of the return differential between US and German equity markets may attract capital movements between the

two and thereby, create the seasonal pattern that the researchers find in the US dollar–Deutsche mark (euro) returns. Girardin and Salimi Namin (2019) give support to the rationale that the relationship between returns differential in the equity market and returns in the foreign exchange may not be due to investors' risk aversion but to carry trades, i.e., investors positioning to the equities of countries with appreciating currencies to earn higher returns instead of mitigating risk (as suggested by Curcuru et al., 2014).

As previously established, uncovered equity parity theory states that investors are expected to rebalance their portfolio when their foreign holdings outperform domestic ones to avoid excess exchange risk. However, carry trade advises to react in the opposite way. When foreign investments generate greater cashflows compared to domestic investments, investor should increase the equity positions of countries whose currency has gone up. Therefore, in addition to its role as a hedging strategy, carry can be seen as a return-chasing strategy as well.

Koijen et al. (2018) go a step further and explore the concept of carry across different asset classes. They do not think of carry relating merely to interest rates or currencies but rather they re-define the concept of carry. They define any asset's return into three parts in which carry is the return on a futures position.

$$return = \underbrace{carry + E(price\ appreciation)}_{expected\ return} + unexpected\ price\ shock. \qquad (12)$$

The expected return for any asset is the sum of its carry and expected price appreciation. The first part, carry, can be observed ex ante from futures (or synthetic futures) prices. Koijen et al. (2018) set carry for all asset classes as the return on a futures position when the spot price stays unchanged. The second part, expected price appreciation, needs to be estimated using an asset pricing model. The authors explore a generalized version of uncovered interest parity according to which the market takes away the carry and leaves the investor with zero profit.

Koijen et al. (2018) study the concept of carry in six different asset classes: global equities, global government bonds, currencies, commodities, credit, and options. They are able to find support that carry is a strong positive estimator of returns in each asset class, generating on average an annualized Sharpe ratio of 0.8. Moreover, they construct a portfolio consisting of all asset classes earning a Sharpe ratio of 1.2. In terms of global equities, the study uses data on spot contracts, first and second generic contracts from equity index futures from 13 markets over a period of 1988-2012. The study reports a high Sharpe ratio of 0.91 for global equities, versus a Sharpe ratio of 0.33 if the carry strategy is replaced with an equal-weighted strategy that goes long on all equities.

To investigate carry's predictability, Koijen et al. (2018) perform a panel regression of future returns on carry (i.e., to answer whether this month's high carry imply next month's high return). A coefficient of one would indicate that carry is unrelated to price appreciation. An investor would get their carry, but the market would still follow a random walk. Uncovered interest parity assumes that the coefficient is zero, meaning that though carry is high, the price of the asset depreciates and therefore the market takes the carry back. This would indicate that the return is mean reverted and goes back to equilibrium, supporting market efficiency.

Koijen et al. (2018) define that the coefficient can vary between zero and one or even be greater than one. They find that for global equities, the regression coefficient is positive, exceeding one, indicating that when the dividend yield is high, the investor gets a high carry plus a stock price appreciation. Hence, carry is a strong predictor for price increases in case of equities.

4 Data description

In this chapter, I present the data and data sources used in this study. The geographical allocation of this research is emerging markets because there is not a study on this topic that specifically targets the emerging countries. This thesis uses the same classification of the emerging countries as it is used in MSCI Emerging Markets Index. MSCI is a global provider of stock market indices and portfolio analysis tools. Its classification of markets follows the MSCI Market Classification Framework which consists of three criteria: economic development, size and liquidity requirements, and market accessibility criteria. (MSCI, 2021)

MSCI classifies 25 markets under emerging markets. The full list is provided in Table 1. From this list, 11 emerging markets are selected for this research and 14 are dropped. This is due to insufficient data availability as not every emerging market have data covering 21 years. 8 of the chosen 11 markets do not satisfy the condition of exactly 21 years but their historical data is regarded to be extensive enough. Also, to keep the data quality consistent, every market must have four data points described more thoroughly below. These are the spot price, the monthly dividend, the futures' price, and the risk-free rate.

Table 1. Emerging markets (MSCI, 2021).

Americas	**Europe, Middle East & Africa**	**Asia**
Brazil	Czech Republic	China
Chile	Egypt	India
Colombia	Greece	Indonesia
Mexico	Hungary	South Korea
Peru	Kuwait	Malaysia
	Poland	Philippines
	Qatar	Taiwan
	Russia	Thailand
	Saudi Arabia	
	South Africa	
	Turkey	
	United Arab Emirates	

Considering a period of 21 years, from December 1999 to December 2021, this thesis uses data from 11 emerging markets. Data on equity index futures include Brazil (Ibovespa), China (CSI 300), Hungary (Budapest SE), India (Nifty 50), Malaysia (FTSE Bursa Malaysia KLCI), Mexico (Mexican IPC), Poland (WIG20), South Africa (FTSE/JSE Top 40), South Korea (KOSPI 200), Taiwan (Taiwan Taiex), and Thailand (SET 50).

The data for equity indices is collected from Bloomberg. I collect data on spot and nearest-to-expiration contracts to calculate the carry. All data is on monthly basis. For each equity index, the last price, and the most recently announced gross dividend per share is collected. The last price and the dividend are in each market's local currency. Nearest-to-expiration contracts refer to 1-month first generic futures prices from Bloomberg which are automatically rolled each month. Bloomberg tickers for data used in this paper are listed in Table 2. As for the short risk-free rate, I use the local 1-month deposit or interbank rate of each equity market. The risk-free rates are collected from Refinitiv. The interest rates of each market are shown in Table 3.

Table 2. Bloomberg tickers for equity index futures.

	Market	**Spot ticker**	**Future ticker**	**Name**
1	Brazil	IBOV	BZ1 Index	Ibovespa
2	China	SHSZ300	IFB1 Index	CSI 300
3	Hungary	BUX	UO1 Index	Budapest Stock Exchange Index
4	India	NIFTY	NZ1 Index	Nifty 50
5	Malaysia	FBMKLCI	IK1 Index	FTSE Bursa Malaysia KLCI
6	Mexico	MEXBOL	IS1 Index	Mexican IPC
7	Poland	WIG20	KRS1 Index	WIG20
8	South Africa	TOP40	AI1 Index	FTSE/JSE Africa Top40 Index
9	South Korea	KOSPI2	KM1 Index	KOSPI 200
10	Taiwan	TWSE	FT1 Index	Taiwan Taiex Index
11	Thailand	SET50	BC1 Index	Thai Set 50 Index

Table 3. 1-month interest rates.

	Market	1-month interest rate
1	Brazil	Brazilian Cash Deposit 1-month
2	China	China Repo 1-month
3	Hungary	Hungary Interbank 1-month
4	India	Indian Rupee OIS 1-month
5	Malaysia	Malaysia Deposit 1-month
6	Mexico	Mexican Zero Curve 1-month
7	Poland	Polish Zloty OIS 1-month
8	South Africa	South Africa Interbank 1-month
9	South Korea	Korean Won Deposit 1-month
10	Taiwan	Taiwan Interbank 1-month
11	Thailand	Thailand Interbank 1-month

The development of each equity index futures' prices is visualized in Figure 1. Out of 11 markets, two are in the Americas, two are in Europe, one is in Africa, and the rest six markets are in Asia. All prices are indexed to begin from 100 on December 31st, 1999, for them to be more comparable. It can be seen from the graph that about half of the indices went down during the following years of the financial crisis. Four markets stand out when looking at the price development. India (yellow line), South Africa (brown line), Mexico (green line), and to some extent Brazil (violet line) have all seen major upward trend during the sample period.

Few markets, such as China, has seen some rallying in 2015 but then plummeted the next year. Poland, on the other hand, has stayed quite close to 100, but however plunged fairly below 100 when the Corona crisis hit the world in March 2020. The effects of the COVID-19 pandemic can be seen in all markets. Most have bounced back to their level prior to COVID-19, and for example, by the end of 2021 India had reached new hights.

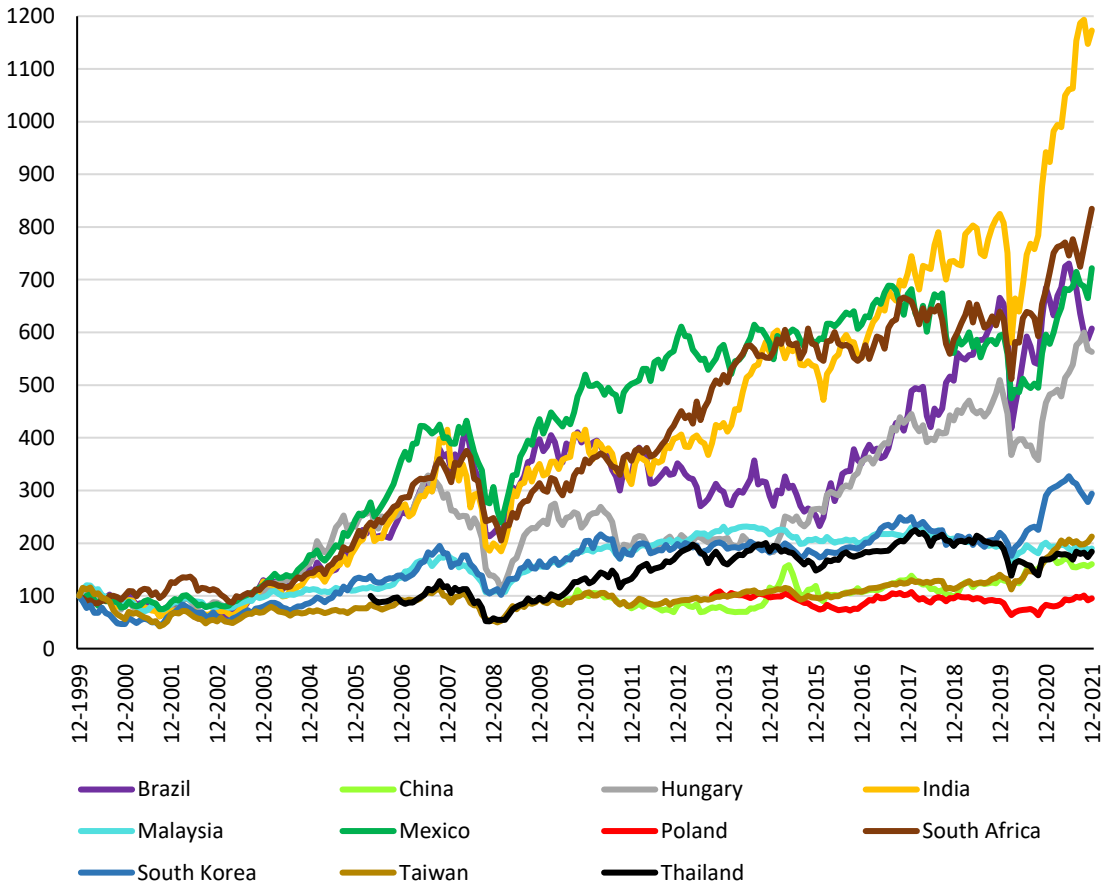

Figure 1. Time series of equity index futures 31.12.1999-31.12.2021.

Figure 2 displays monthly returns for equity markets used in this thesis. The monthly returns vary significantly over the sample period with highest positive return being 28.20% for India in 2009 and lowest negative return of -32.73% for Thailand in 2008. Overall, it can be concluded that these 11 emerging equity indices exhibit high volatility. The effects of the financial crisis and COVID-19 pandemic can be detected from Figure 2 as there are significant negative returns during those periods. One distinctive gain worth to mention is of India's on May 2009. The Nifty 50 increased by 28% in one month in response to Indian general election (The Economic Times, 2009). Another highlight is the sharp spike upward for Shanghai Shenzhen 300 in December 2014. This is explained by introduction of Stock Connect Scheme which for the first time allowed non-Chinese retail investors to participate in Shanghai stock market (Kitchen, M. 2014).

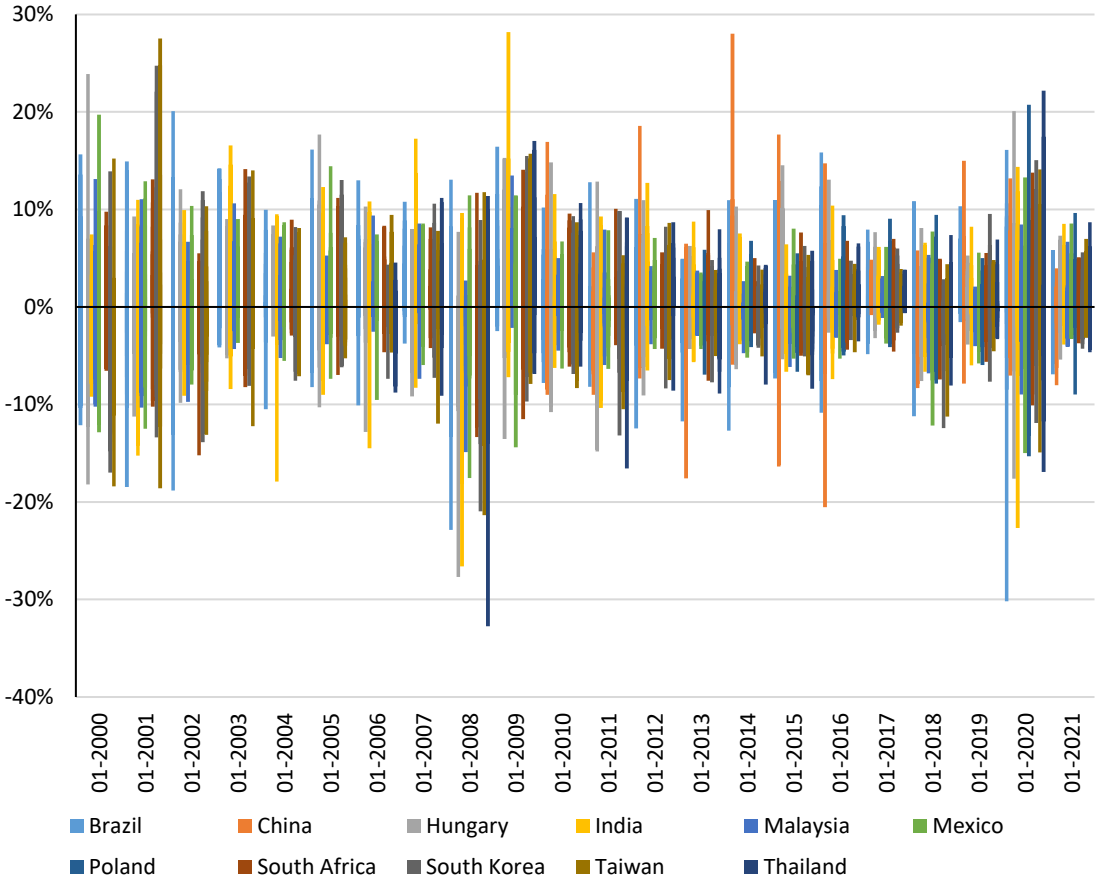

Figure 2. Monthly returns of equity index futures 31.12.1999-31.12.2021.

The descriptive statistics for each market is shown in Table 4. The data shows that while the average returns (mean and median) for each market range between -0.4% and 1.2%, there are extreme data points on both sides of the axis. Highest returns for each market range between 13.5% to 28.2% and respectively, lowest returns vary between -14.9% to -32.7%.

When looking at the median and mean for Taiwan and Thailand, the difference between the two key figures is remarkable. The median for both is much higher than their means, indicating that their distributions are very skewed. This holds true for Thailand as its distribution is negatively skewed the most with the most extreme negative value being -32.7%. However, this is not the case for Taiwan. Its skewness is only slightly above zero which may be due to the fact that there are more positive returns than negative returns, in terms of quantity and value. Also, its most positive value is 27.5% and its most negative

value is -21.4%. The higher absolute value of 27.5% pulls the distribution to the right. Most of the other markets exhibit negative skewness, meaning that the outliers are further on the left side of the distribution.

In terms of standard deviation, Malaysia stands out as its returns vary the least with a standard deviation of only 4.0%. It is significantly lower compared to the rest of the markets whose range is between 5.1% and 7.4%. Almost all markets have a kurtosis less than 3, except for Thailand whose kurtosis is by far the highest. This indicates that the returns have a smaller probability to experience extreme values. The lowest kurtosis is found for South Africa and Brazil, indicating that their distributions are flatter than a normal distribution. The number of observations range from 99 to 264. The small number for Poland is due to data availability of KRS1 Index.

Table 4. Descriptive statistics for 11 emerging equity indices.

	Country	Index	Mean	Median	St.dev.	Max	Min	Skewness	Kurtosis	n
1	Brazil	BZ1 Index	1.0 %	0.8 %	7.4 %	20.1 %	-30.2 %	-0.3	0.9	264
2	China	IFB1 Index	0.6 %	0.8 %	6.9 %	28.0 %	-20.5 %	0.3	2.2	140
3	Hungary	UO1 Index	0.9 %	0.9 %	6.4 %	23.9 %	-27.7 %	-0.2	2.1	264
4	India	NZ1 Index	1.2 %	1.1 %	6.7 %	28.2 %	-26.6 %	-0.4	2.3	258
5	Malaysia	IK1 Index	0.3 %	0.4 %	4.0 %	13.5 %	-14.9 %	-0.1	1.5	264
6	Mexico	IS1 Index	0.9 %	1.1 %	5.3 %	19.7 %	-17.5 %	-0.2	1.0	264
7	Poland	KRS1 Index	0.1 %	-0.4 %	5.4 %	20.7 %	-15.3 %	0.3	1.6	99
8	South Africa	AI1 Index	0.9 %	0.8 %	5.1 %	14.1 %	-15.2 %	-0.1	0.4	264
9	South Korea	KM1 Index	0.6 %	0.7 %	6.5 %	24.7 %	-20.9 %	0.0	1.1	264
10	Taiwan	FT1 Index	0.5 %	1.0 %	6.4 %	27.5 %	-21.4 %	0.1	2.2	264
11	Thailand	BC1 Index	0.5 %	1.1 %	6.4 %	22.2 %	-32.7 %	-0.7	4.4	188

5 Methodology

In order to backtest the carry strategy, it is important to understand how carry is formed. This chapter covers the methodology used in this thesis. The first subchapter explains the mechanism of equity carry trade and the theoretical framework behind the strategy. The second subchapter defines the construction of an equity carry trade portfolio. The basic concept is to go long the securities with highest carry and go short securities with lowest carry. I will use the carry of each equity market as a trading signal, i.e., go long the equity indices with highest forward-looking dividend yields in excess of the risk-free rates and go short the ones with lowest forward-looking dividend yields in excess of the risk-free rates. I run a regression analysis and present the findings in the third subchapter.

5.1 Equity carry

This paper focuses on equity carry trade, in which the carry consists of the expected dividend yield. In the simplest form, following an equity carry trade strategy means investing in equity futures contracts with high expected dividend yields and shorting equity futures contracts with low expected dividend yields at the same time. In this sense, equity carry is related to value investing in which the main factor that investors look at is the dividend yield. However, the value strategy utilizes past performance while the carry is forward looking. (Pedersen, 2019)

This study follows closely to Koijen et al.'s (2018) research design in terms of calculating the carry for equities. They propose a method based on 1-month futures contract F_t. Carry C_t is defined as the futures return in excess of a risk-free rate. The rationale is as follows. Assume a futures contract at time t with a current price of F_t and a current spot price of S_t. This futures contract expires in the next period $t+1$. The capital amount an investor allocates to finance each futures contract is denoted by X_t and the risk-free interest rate is r_t^f. At time $t+1$, the margin capital and the futures contract are valued as

$\mathrm{X}_t\left(1+r_t^f\right)+F_{t+1}-F_t$. Hence, the return from allocating capital into a futures contract over a period of t to $t+1$ is

$$r_{t+1}^{total\ return}=\frac{X_t\left(1+r_t^f\right)+F_{t+1}-F_t-X_t}{X_t}=\frac{F_{t+1}-F_t}{X_t}+r_t^f, \tag{13}$$

and the excess return is

$$r_{t+1}=\frac{F_{t+1}-F_t}{\mathrm{X}_t}. \tag{14}$$

Assuming that market conditions remain unchanged, spot prices will stay constant from t to $t+1$, making $S_{t+1}=S_t$. Furthermore, because the price of a futures contract expires at the future spot price $F_{t+1}=S_{t+1}$, we have $F_{t+1}=S_{t+1}=S_t$. Based on the specification above, carry is defined as

$$C_t=\frac{S_t-F_t}{X_t}. \tag{15}$$

In this thesis, it is assumed that the capital invested is the same as the futures price, i.e., the position is "fully collateralized", and the investor does not use leverage. Thus, applying the position size $X_t=F_t$, we obtain

$$C_t=\frac{S_t-F_t}{F_t}. \tag{16}$$

The equation above is the general definition of carry. Next, I will look at how equity carry can be defined more precisely. First, I will describe how equity futures price is connected to equity carry. In case of global equities, the price for a futures contract can be written

as $F_t = S_t\left(1 + r_t^f\right) - E_t^Q(D_{t+1})$, where S_t denotes the equity spot price, $E_t^Q(D_{t+1})$ is the expected dividend under the risk-neutral measure Q, and r_t^f is the risk-free interest rate of said equity market's country.

Placing the expression for futures contract price in the generalized form of carry, the equity carry is following

$$C_t = \frac{S_t - F_t}{F_t} = \left(\frac{E_t^Q(D_{t+1})}{S_t} - r_t^f\right)\frac{S_t}{F_t}. \tag{17}$$

It can be seen from Eq. (17) that the equity carry comprises of the expected dividend yield subtracted by the local risk-free rate and multiplied by the scaling factor $\frac{S_t}{F_t}$.

Gordon's growth model elaborates more on the relation between carry and expected returns. Consider Gordon's growth model where the price S_t consists of the dividend D in relative to the expected return $E(R)$ and the constant dividend growth g, $S_t = \frac{D}{E(R)-g}$. This equation indicates that the expected excess return $E(R) - r^f$ is equal to the carry $\frac{D}{S} - r^f$ plus the price appreciation coming from expected dividend growth g, that is

$$E(R) - r^f = \frac{D}{S} - r^f + g. \tag{18}$$

Presuming expected returns $E(R)$ to remain unchanged, then a decrease in dividend yield $\frac{D}{S}$ would lead to the dividend growth g to increase such that the differential between the two would be cancelled out. Then, the dividend yield would not necessarily be a return predictor. On the other hand, if the dividend yield changes separately from the dividend growth, the dividend yield may be seen as a predictor for expected returns. (Koijen et al., 2018)

In case of variation in expected returns $E(R)$, one would expect carry to correlate with expected returns. If the left-hand side of the Eq. (18) increases while the dividend D stays constant, the security's price S would fall and therefore its dividend yield $\frac{D}{S}$ hikes up. (Koijen et al., 2018) The authors argue that a high expected return predicts a high carry, and a high carry predicts a high expected return. To support their hypothesis, Koijen et al. (2018) do find that in equities, a high dividend yield tends to offer an investor a large dividend and additionally an equity price appreciation, as well. Furthermore, as carry is time-varying, expected returns are also expected to vary over time and to be predictable by carry.

Using Eq. (17) I compute carry for all equity indices. The following assumptions are made. First, I am using local currency for all indices and local 1-month short rate for r_t^f. Second, the approximation of the expected dividend yield is used, $D_{t+1} \cong E_t^Q(D_{t+1})$. Hence, the final form of Eq. (17) is $C_t \cong \left(\frac{D_{t+1}}{S_t} - r_t^f\right)\frac{S_t}{F_t}$. (Koijen et al., 2018)

Table 5 presents summary statistics for the excess return, and the carry of each market used in this thesis. Starting date, annualized sample mean, and annualized standard deviation are reported. The data sets for each market are set to begin from the point when all datapoints are available, i.e., the dividend yield, the risk-free rate, and the spot and futures prices.

Table 5. Summary statistics.

			Begin	Excess Return		Carry	
	Country	**Index**	**sample**	**Mean**	**St.dev.**	**Mean**	**St.dev.**
1	Brazil	IBOV	Jun 2006	-1.5	26.7	-4.2	1.5
2	China	SHSZ300	Apr 2010	0.3	25.2	-1.6	1.0
3	Hungary	BUX	Dec 1999	2.5	25.2	-3.2	2.2
4	India	NIFTY	Jun 2000	5.1	26.2	-4.7	0.7
5	Malaysia	FBMKLCI	Dec 1999	0.3	15.1	0.9	0.8
6	Mexico	MEXBOL	Aug 2003	4.3	18.0	-4.3	0.7
7	Poland	WIG20	Sep 2013	-2.3	20.4	1.2	1.3
8	South Africa	TOP40	Oct 2002	3.3	18.1	-4.0	1.2
9	South Korea	KOSPI2	Sep 2001	6.4	22.0	-0.4	1.6
10	Taiwan	TWSE	Dec 1999	1.9	23.9	1.9	2.0
11	Thailand	SET50	Apr 2006	1.4	23.9	1.3	1.2

It can be seen from Table 5 that while for most markets the carry has lower annualized mean than the traditional passive long investment, the former has much lower standard deviations compared to the latter. The standard deviation for carry is small due to the expected dividend yield which does not variate significantly during the sample period.

Figure 3 visualizes the carry of each equity index. The carry displays major seasonal variation in case of some indices, such as Taiwan (gold line), South Korea (blue line), Hungary (grey line), and Thailand (black line). This is a result of the dividend pay-out behaviour which is concentrated in certain months of the year. For some markets, the carry mostly stays below zero, indicating that the local risk-free rate is taking a substantial portion of the carry. For example, Brazil (violet line), South Africa (brown line), India (yellow line), and Mexico (dark green line) consistently generate negative carry. For some markets, the carry reaches up to almost 3.00%, indicating that either the dividend yield is high, or the local interest rate is low or both.

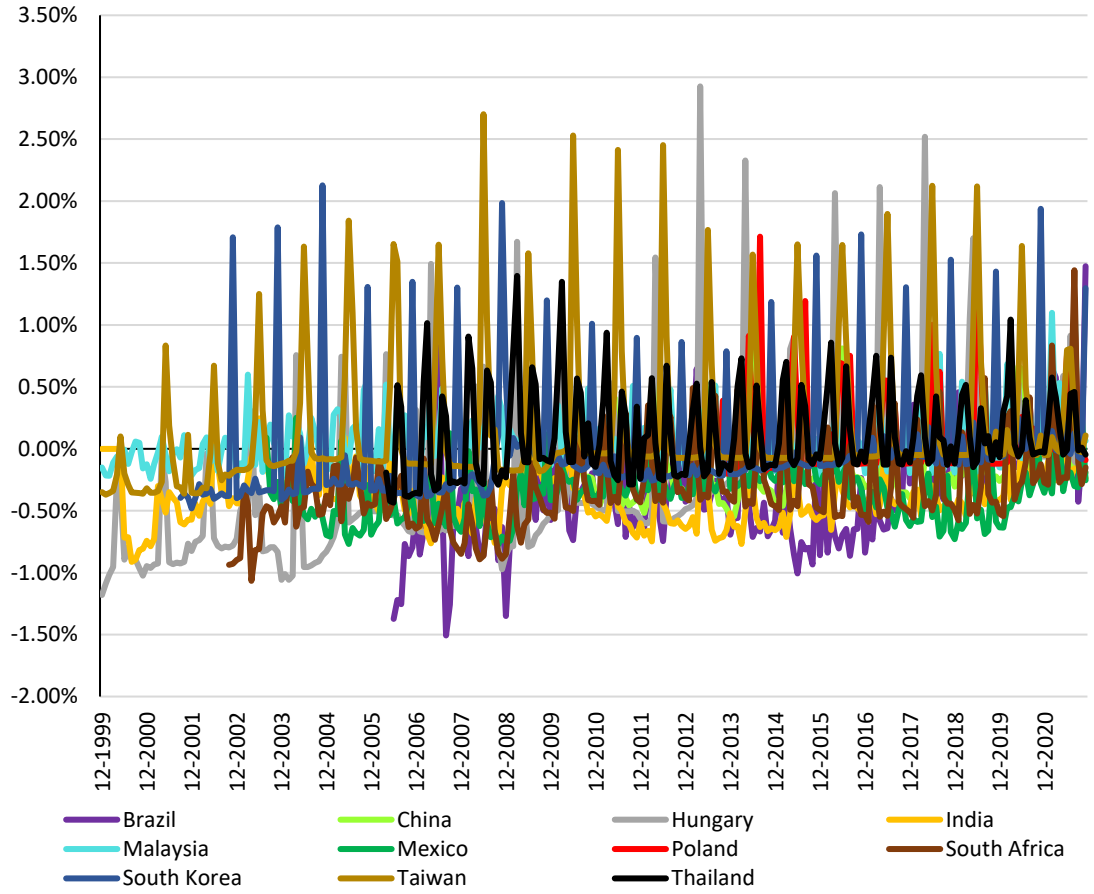

Figure 3. Carry of each equity index.

5.2 Equity carry trade strategy

The construction of an equity carry trade portfolio is described in this subchapter. The purpose is to construct a zero-cost portfolio which can earn a higher annualized Sharpe ratio compared to a standard buy-and-hold strategy. There are multiple ways to assign weights to securities in a carry trade portfolio. In this paper, the weights are allocated equally based on the ranking of the assets' carry. The portfolio goes long on the top 50% of securities and goes short on the bottom 50% of securities. This weighting scheme applies equal weights to all securities and therefore, may place considerable weight on the extremes. However, this method is chosen because it is simple and straightforward. The portfolio is monthly rebalanced.

The carry is measured at the end of each month. The carry of the portfolio is computed as in Koijen et al. (2018). As previously stated, all securities are equally weighted in this thesis for the carry trade portfolio. Eq. (19) shows the formula for a portfolio's carry which is a weighted-average carry of all securities in a long (short) portfolio.

$$C_t^{portfolio} = \sum_i w_t^i C_t^i. \tag{19}$$

The carry of the carry trade portfolio as shown by Eq. (20) is computed as the weighted-average carry of the top 50% carry securities subtracted by the weighted-average carry of the bottom 50% carry securities. Hence, the carry of the carry trade portfolio is always positive and above zero. (Koijen et al., 2018)

$$C_t^{carry\ trade} = \sum_i w_t^i C_t^i = \sum_{w_t^i>0} w_t^i C_t^i - \sum_{w_t^i<0} \left|w_t^i\right| C_t^i > 0. \tag{20}$$

Below is Table 6 showing the annualized mean, annualized standard deviation, maximum, and minimum values for the carry of the carry trade portfolio. It can be seen that the cross-sectional dispersion of the constituent equity indices is small as the annualized standard deviation of 0.79 implies.

Table 6. Carry of the carry trade portfolio.

Carry of the carry trade portfolio	
Mean	6.92
Standard deviation	0.79
Max monthly carry (%)	1.38 %
Min monthly carry (%)	0.16 %

Next, the trading strategy is formed. I use a strategy which utilizes the carry of each individual market as a trading signal. I go long on those equity index futures whose carry is above the sample median. Respectively, I go short on those equity index futures whose carry is below the sample median. The return of this carry trade strategy is carry plus the return on buying equity index futures minus the return on short selling equity index futures as Eq. (21) shows.

$$strategy\ return = carry + portfolio\ price\ change. \qquad (21)$$

Table 7 presents the annualized mean, standard deviation, Sharpe ratio, maximum and minimum monthly return, skewness, and kurtosis for the carry strategy and equal-weighted long strategy. The equity carry trade strategy yields an annualized mean return of 7.92% while the equal-weighted strategy yields a mean return of 2.48%. Not only is the mean of carry strategy over three times as much as that of the alternative strategy's, the standard deviation of carry strategy is also significantly lower than that of long-only strategy. The standard deviation for the former is 13.15 and for the latter 17.84, resulting to the Sharpe ratios of 0.60 and 0.14, respectively. The Sharpe ratio differential is remarkably significant as the former is over four times greater than the latter. The kurtosis of 5.60 found for carry strategy is also significantly higher than the kurtosis of 2.06 for equal-weighted strategy.

The results agree with the findings of Koijen et al. (2018) who report a Sharpe ratio of 0.91 for global equities versus a Sharpe ratio of 0.33 for traditional buy-and-hold strategy. Even though their geographical concentration differs from that of this thesis, the findings in this thesis support their hypothesis of carry trade's success. However, the difference in findings may be attributed to the fact that Koijen et al. (2018) used a larger sample of 30 years, and their data consists of developed markets where, as previously stated, the bias is more pronounced. In addition, the dividend pay-out behaviour and the risk-free interest rates between developed and emerging markets may affect the carry and therefore, the return.

Table 7. Summary for carry and long strategies.

Strategy	**Carry**	**EW**
Mean	7.92	2.48
Standard deviation	13.15	17.84
Sharpe ratio	0.60	0.14
Max monthly return (%)	15.31 %	13.93 %
Min monthly return (%)	-17.87 %	-21.50 %
Skewness	-0.52	-0.49
Kurtosis	5.60	2.06

Figure 4 displays the performance of the long-short portfolio constructed in this thesis. The variation is much larger in the early years of the sample period and stabilizes over time. This is because more equity indices are introduced later during the sample period. For example, there are only a handful of observations during the first few years. By mid-2006, the sample includes 9 out of total 11 equity markets. The annualized mean and Sharpe ratio of this thesis being lower to that of Koijen et al. (2018) may be due to the equal-weighted method used in this thesis. The outliers, i.e., the first few years of the sample period only including 5 markets, are getting as much weight as the rest of the period of broader sample. The annualized mean and Sharpe ratio calculations do not consider this disproportion. Also, Koijen et al. (2018) use a different weighting scheme when constructing their long-short portfolio. They rank securities based on their carry and assign more weight to the highest (lowest) carry yielding securities while I place equal weight across the portfolio.

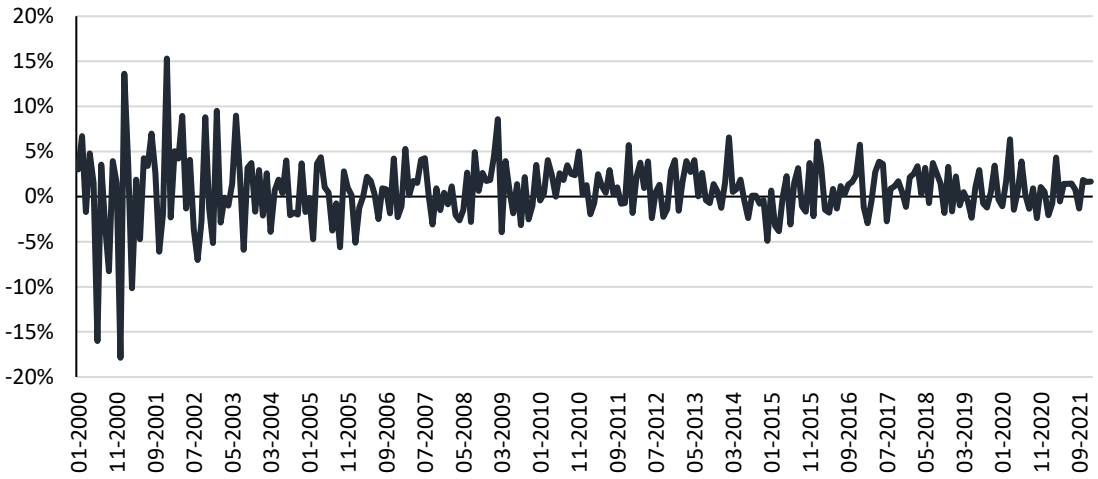

Figure 4. Performance of the long-short portfolio.

5.3 Regression

Next, I will report the regression results for equity carry portfolio's returns on a set of other portfolio returns. Table 8 reports the intercepts (alphas) and betas on two sets of portfolio returns to show the exposure of the equity carry trade returns to these other strategies. I regress the holding period return of carry strategy on two sets of what are considered as neutral portfolios. The first strategy is an equal-weighted long-only portfolio consisting of the same 11 indices as used in this study for the carry portfolio. The second strategy is supposed to measure the market exposure, hence the MSCI Emerging Markets Index is used. The MSCI Emerging Markets Index consists of 24 emerging market countries, covering over 1 400 large- and mid-cap securities (MSCI, 2022).

The alpha is in both cases positive and statistically significant, implying that the equity carry strategy offers excess returns significantly over and above the passive strategies. When regressing the carry portfolio's returns on the passive long portfolio consisting of same constituents, the beta is basically zero. When adding the "local" market return, i.e., the MSCI Emerging Markets Index, the beta increases a little but is still not significantly different from zero. As the slope coefficient describes the risk, the regression results obtained indicate that equity carry trade can provide higher return at lower risk. The slope

coefficient of positive one would indicate average risk and uncovered interest parity would hold true in that case. When it is below one and approaching zero, there is conflict with market efficiency. As previously established, for uncovered interest parity to hold true, alpha must equal to zero, beta must equal to one, and error terms must be uncorrelated and have zero means. The results in Table 8 show that alpha is not equal to zero and beta is not equal to one. The error terms have zero means but seem to be autocorrelated. Therefore, the results strongly indicate that uncovered interest parity does not hold in this setting.

Table 8. Carry trade risk exposures.

Alpha	0.700 %	0.703 %
t-stat	3.193	3.194
Passive long	0.000	0.017
t-stat	-0.003	0.186
Market exposure		-0.017
t-stat		-0.217
R^2	0.00 %	0.02 %

6 Discussion

This chapter summarizes the results and presents the key findings for the thesis. To reiterate, the results are obtained by first computing carry for 11 emerging market equity indices, then using the carry as a trading signal to construct a long-short portfolio. Equity index futures contracts are used in computing the strategy's performance. The results are examined in contrast to the alternative trading strategy, which in this thesis is a buy-and-hold strategy.

Out of 11 equity markets, 4 markets exhibit positive annualized carry ranging between 0.9% - 1.9% with standard deviations ranging from 0.8% to 2.0% (see Table 4), indicating that the forward-looking dividend yield over the local risk-free rate for these markets is positive and variate very little when compared to excess return. The carry is negative for the rest of the markets, ranging from -0.4% to -4.7%. However, the standard deviation for these markets is low as well.

The differences between carry can be explained by the local short rates that vary significantly between sample countries. For example, India with the carry of -4.7% has an average interest rate of 6.41% p.a. over the sample period while Taiwan with the carry of 1.9% has an average interest rate of 0.86% p.a. In addition to the interest rate, the difference between carry is also due to the dividend pay-out behaviour of different markets. Using same examples as previously, India's Nifty 50 pays out dividend every month whereas Taiwan's Taiex pays out roughly seven months a year.

The results reported in Table 7 show that the average return and Sharpe ratio of carry strategy exceed those of the passive long strategy. Looking at the higher moments of the carry trade, I find some negative skewness for equities in emerging markets. This finding goes against that of Koijen et al.'s (2018) who report positive skewness for equities. The carry strategy applied in this thesis exhibits excessive kurtosis whereas the alternative strategy shows low kurtosis. In this study, the equity carry exhibits negative skewness and large kurtosis which indicate that it enjoys extreme positive returns in good market

conditions and suffers from even more extreme negative returns during troubled times. However, the maximum holding period returns for the carry strategy is better compared to the alternative strategy. In addition, the minimum monthly return is less negative for the carry strategy. These observations are in line with the skewness differential between the two strategies.

Under the hypothesis “Equity carry trade strategy yields a higher Sharpe ratio than passive, equal-weighted long equity strategy “, the long-short portfolio returns obtained in this thesis exceed the returns of the alternative long-only strategy. The findings indicate that implementing the equity carry trade strategy in the futures market not only generates lower standard deviation compared to the buy-and-hold strategy, but the excess return of carry trade strategy is also much higher than that of the alternative strategy. Therefore, the results of this thesis cannot reject the hypothesis of equity carry trade strategy outperforming the traditional long-only strategy in terms of risk-adjusted return measured by Sharpe ratio.

Having said that, it is worth mentioning that carry is mostly driven by the risk-free rate. The higher the chosen risk-level is, the lower is the carry. In this paper, local 1-month interest rates are used. Alternatively, the strategy could utilize a common risk-level for all markets, for example US 1-month T-bill rates.

6.1 Practical result

This study contributes to the practical aspect of trading. Using the backtesting method this paper shows that carry trade in equity markets yields a significant Sharpe ratio of 0.60. The obtained Sharpe ratio using historical data of 11 emerging economies is over four times greater than that of the alternative strategy, which in this case is a long-only strategy. The purpose of this study was to generate higher profits with lower risk, and it was achieved. The risk went down, and the holding period return went up, resulting in a

Sharpe ratio differential beyond significant. The findings of this study offer traders and investors new possibilities within carry trade, particularly in terms of emerging markets.

As shown in previous chapters, an investor can implement a version of carry trade in emerging markets where they are focusing mostly on the higher dividend paying index through futures. The expected dividend yield is the first part of the holding period return which can be observed ex ante. Another practical implication of equity carry trade is that to optimize the profits, the investor should be trying to time the market. In that case, the investor not only gets the positive carry but also the capital gain.

Even though trading costs were not considered in this setting, I expect the results to remain, at least to certain kind of investors, such as institutional and professional investors, who trade in large quantities and may by doing so enjoy lower trading costs. Trading costs would lessen the net profits but the differential ratio between the two strategies would more or less remain the same in that sense that the carry trade strategy would still overperform its counterpart.

6.2 Limitations

It is important to consider the limitations for the empirical research of this thesis due to multiple factors that affect the results of this paper and hence, offer possibilities for improvement in future studies. Next, I will provide the most important limitations regarding this study.

Firstly, the sample consists of 11 emerging markets which is less than half of all emerging markets. Data availability plays a key role in this sense because there is not sufficiently data on most emerging markets. Consequently, this thesis is unable to form explicit conclusions about the carry's effectiveness on emerging equity markets.

Secondly, no trading costs are considered in this paper. It is worthwhile to note that even though the equity carry strategy yields a higher Sharpe ratio in this study, it may not be economically significant as this thesis makes some assumptions to keep the research straightforward and simple. The trading costs, such as transaction fees, management fees, and other ongoing charges, would lessen the returns and might affect the frequency of portfolio rebalancing. In this paper, the portfolio is rebalanced monthly but when costs are introduced, it may not be economically efficient to trade in such frequency. Fees matter much more in equity markets compared to foreign exchange markets. For example, transaction costs for large institutional investors in foreign exchange markets are close to zero whereas transaction costs in equity markets are much higher. Trading costs undoubtedly affect the effective returns of an investment which is why depicting an equity carry trade strategy where costs are omitted only gives a simplified overview of what returns could be.

Thirdly, as mentioned before, the risk-level chosen in calculations is fundamentally driving the results. Therefore, using different interest rates could result in different empirical results as the securities would shift between long and short portfolios. Moreover, when using a similar interest rate for all markets, the determination of carry would swift emphasis from interest rates to expected dividend yields.

As the concept of carry is less familiar in equity markets, the approximation used in this study should be taken as one attempt at measuring equity carry with potential for improvement. Constructing an equity carry strategy portfolio can be done in many ways and this study attempts to provide a straightforward approach utilizing every asset in a portfolio and keeping the strategy at zero cost. For instance, instead of going long top 50% and short bottom 50% no matter what the absolute value of carry is, another way to execute the equity carry strategy is to take long positions only in markets with positive carry and short positions in markets with negative carry. This, however, would not be a zero-cost trading strategy and would involve margin requirements.

7 Conclusions

Investors continuously seek new trading ways to achieve above the average returns. Carry trade is not a newly discovered trading strategy but its implementation to asset classes other than currency markets is a subject that has not been academically researched much before. The academic literature focuses mainly on two perspective when it comes to the "carry trade". One branch focuses on whether the currency carry trade outperforms its counterpart and different modifications within that framework, and the other searches explanations to rationalize the success of currency carry trading.

Intrigued by the effectiveness of currency carry trade, the main purpose of this study is to examine whether the carry trade strategy can be utilized in equity markets as well. Using a portfolio setting, I attempt to show that carry trade strategy in equities generate higher excess returns than a buy-and-hold strategy. This study contributes to the scarcely existing literature about the carry trade in the asset class of equities. The method used in this study follows closely to the one by Koijen et al. (2018) in terms of defining the measure for equity carry.

This thesis uses equity index price data for 11 emerging markets provided by Bloomberg. The chosen markets follow the definition of an emerging market defined by a global provider of financial services (MSCI Inc. (2021)). In addition to price data, the study utilizes local short-term interest rates of each market. The carry for each market is estimated by calculating the forward-looking dividend yield less the risk-free rate. The expected dividend yield is the benefit of holding the security while the local rate is the cost of financing it.

The equity carry strategy is implemented as follows. First, the carry for each market is computed using the methodology by Koijen et al. (2018). Then, long, and short portfolios are constructed using individual carry as a trading signal. The equity indices with highest carry, i.e., the top 50% are placed in a long portfolio while the bottom 50% with lowest carry are placed in a short portfolio. Finally, the return of the equity carry trade strategy

is the return of equity index futures which are traded according to their respective carry signals plus the carry of the carry trade portfolio.

The findings of the empirical analysis suggest that the hypothesis of this study cannot be rejected as the equity carry trade strategy provides a significantly higher Sharpe ratio than the passive, long-only equity strategy. While both strategies provide positive returns, the return for equity carry strategy is much higher due to the carry component which is measured by the expected dividend yield. Furthermore, the returns of carry strategy vary less, resulting in a higher Sharpe ratio. The outcome is in line with the findings of Koijen et al. (2018) who, in fact, claim that carry strategy generates higher returns in every asset class, and not just in equities.

To conclude, this thesis finds support for the effectiveness of the carry strategy. The results can be summarized into three main points. First, the concept of carry can be applied successfully to equities, and it is not limited to only currencies. Second, as expected return can be broken down into two main components, cashflow and capital change, this thesis shows that carry is an important component of expected returns in addition to the capital change. Not only does it act as a trading signal but also contributes to the holding period return as well. Third, the significant excess returns obtained through backtesting, and the regression results shown in this study strengthen the evidence against the uncovered interest/equity parity, and thus also against the “rational expectations” hypothesis. This study implies that investors must have biased expectations because carry works against to what is suggested by the hypothesis.

The practical implication derived from this thesis is that an investor would benefit from constructing a long-short portfolio where trading is guided by the expected dividend yield. This study shows that equity carry trade can yield a Sharpe ratio four times larger compared to a traditional long-only equity strategy. The differential is significant and would likely to continue to be so even if trading costs are introduced. For somebody that

is trying to make money in the market, the practical implication of this study is certainly beneficial.

The academic literature has not explored carry trading in equity markets that extensively, hence the subject requires more empirical research, a broader set of data, and an introduction of costs in order to strengthen the evidence that it would pay off to execute an equity carry strategy instead of a more cost-efficient long-only equity strategy. Furthermore, including the behavioural aspect in addition to risk-based explanations to explain the excess returns for carry strategy would reduce the puzzling nature of forward premium anomaly.

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Appendices

Appendix 1. Summary of carry trade signals

Signal	Brazil	China	Hungary	India	Malaysia	Mexico	Poland	South Africa	South Korea	Taiwan	Thailand
Long	38	38	78	28	228	29	68	51	138	231	152
Long (%)	20 %	27 %	30 %	11 %	86 %	13 %	69 %	22 %	57 %	88 %	81 %
Short	148	102	185	230	35	191	31	179	105	32	36
Short (%)	80 %	73 %	70 %	89 %	13 %	87 %	31 %	78 %	43 %	12 %	19 %

Appendix 2. Summary of carry trade signs

Sign	Brazil	China	Hungary	India	Malaysia	Mexico	Poland	South Africa	South Korea	Taiwan	Thailand
Positive	33	28	36	10	152	12	36	27	49	81	92
Pos. (%)	18 %	20 %	14 %	4 %	58 %	5 %	36 %	12 %	20 %	31 %	49 %
Negative	153	112	228	248	112	208	63	203	194	183	96
Neg. (%)	82 %	80 %	86 %	96 %	42 %	95 %	64 %	88 %	80 %	69 %	51 %

Appendix 3. Trading signals

1 = long, 0 = short, "No pos." = Not enough data to take a position.

Date	Brazil	China	Hungary	India	Malaysia	Mexico	Poland	South Africa	South Korea	Taiwan	Thailand
31.12.1999	No pos.	No pos.	0	No pos.	1	No pos.	No pos.	No pos.	No pos.	0	No pos.
31.1.2000	No pos.	No pos.	0	No pos.	1	No pos.	No pos.	No pos.	No pos.	0	No pos.
29.2.2000	No pos.	No pos.	0	No pos.	1	No pos.	No pos.	No pos.	No pos.	0	No pos.
31.3.2000	No pos.	No pos.	0	No pos.	1	No pos.	No pos.	No pos.	No pos.	0	No pos.
28.4.2000	No pos.	No pos.	0	No pos.	1	No pos.	No pos.	No pos.	No pos.	0	No pos.
31.5.2000	No pos.	No pos.	0	No pos.	0	No pos.	No pos.	No pos.	No pos.	1	No pos.
30.6.2000	No pos.	No pos.	0	0	1	No pos.	No pos.	No pos.	No pos.	1	No pos.
31.7.2000	No pos.	No pos.	0	0	1	No pos.	No pos.	No pos.	No pos.	1	No pos.
31.8.2000	No pos.	No pos.	0	0	1	No pos.	No pos.	No pos.	No pos.	1	No pos.

Date	Bra-zil	China	Hun-gary	India	Ma-lay-sia	Mex-ico	Po-land	South Af-rica	South Ko-rea	Tai-wan	Thai-land
	No	No				No	No	No	No		No
29.9.2000	pos.	pos.	0	0	1	pos.	pos.	pos.	pos.	1	pos.
	No	No				No	No	No	No		No
31.10.2000	pos.	pos.	0	0	1	pos.	pos.	pos.	pos.	1	pos.
	No	No				No	No	No	No		No
30.11.2000	pos.	pos.	0	0	1	pos.	pos.	pos.	pos.	1	pos.
	No	No				No	No	No	No		No
29.12.2000	pos.	pos.	0	0	1	pos.	pos.	pos.	pos.	1	pos.
	No	No				No	No	No	No		No
31.1.2001	pos.	pos.	0	0	1	pos.	pos.	pos.	pos.	1	pos.
	No	No				No	No	No	No		No
28.2.2001	pos.	pos.	0	0	1	pos.	pos.	pos.	pos.	1	pos.
	No	No				No	No	No	No		No
30.3.2001	pos.	pos.	0	1	1	pos.	pos.	pos.	pos.	0	pos.
	No	No				No	No	No	No		No
30.4.2001	pos.	pos.	1	0	1	pos.	pos.	pos.	pos.	0	pos.
	No	No				No	No	No	No		No
31.5.2001	pos.	pos.	0	0	1	pos.	pos.	pos.	pos.	1	pos.
	No	No				No	No	No	No		No
29.6.2001	pos.	pos.	0	0	1	pos.	pos.	pos.	pos.	1	pos.
	No	No				No	No	No	No		No
31.7.2001	pos.	pos.	0	0	1	pos.	pos.	pos.	pos.	1	pos.
	No	No				No	No	No	No		No
31.8.2001	pos.	pos.	0	0	1	pos.	pos.	pos.	pos.	1	pos.
	No	No				No	No	No			No
28.9.2001	pos.	pos.	0	0	1	pos.	pos.	pos.	0	1	pos.
	No	No				No	No	No			No
31.10.2001	pos.	pos.	0	0	1	pos.	pos.	pos.	0	1	pos.
	No	No				No	No	No			No
30.11.2001	pos.	pos.	0	0	1	pos.	pos.	pos.	0	1	pos.
	No	No				No	No	No			No
31.12.2001	pos.	pos.	0	0	1	pos.	pos.	pos.	0	1	pos.
	No	No				No	No	No			No
31.1.2002	pos.	pos.	0	0	1	pos.	pos.	pos.	0	1	pos.
	No	No				No	No	No			No
28.2.2002	pos.	pos.	0	0	1	pos.	pos.	pos.	1	0	pos.
	No	No				No	No	No			No
29.3.2002	pos.	pos.	0	0	1	pos.	pos.	pos.	0	1	pos.
	No	No				No	No	No			No
30.4.2002	pos.	pos.	1	0	1	pos.	pos.	pos.	0	0	pos.
	No	No				No	No	No			No
31.5.2002	pos.	pos.	1	0	0	pos.	pos.	pos.	0	1	pos.
	No	No				No	No	No			No
28.6.2002	pos.	pos.	0	1	0	pos.	pos.	pos.	0	1	pos.
	No	No				No	No	No			No
31.7.2002	pos.	pos.	0	1	0	pos.	pos.	pos.	0	1	pos.
	No	No				No	No	No			No
30.8.2002	pos.	pos.	0	0	1	pos.	pos.	pos.	0	1	pos.
	No	No				No	No	No			No
30.9.2002	pos.	pos.	0	0	1	pos.	pos.	pos.	0	1	pos.
	No	No				No	No				No
31.10.2002	pos.	pos.	0	0	1	pos.	pos.	0	1	1	pos.
	No	No				No	No				No
29.11.2002	pos.	pos.	0	0	1	pos.	pos.	0	1	1	pos.
	No	No				No	No				No
31.12.2002	pos.	pos.	0	0	1	pos.	pos.	0	1	1	pos.
	No	No				No	No				No
31.1.2003	pos.	pos.	0	0	1	pos.	pos.	0	1	1	pos.
	No	No				No	No				No
28.2.2003	pos.	pos.	0	0	1	pos.	pos.	0	1	1	pos.
	No	No				No	No				No
31.3.2003	pos.	pos.	0	1	1	pos.	pos.	0	0	1	pos.
	No	No				No	No				No
30.4.2003	pos.	pos.	1	1	1	pos.	pos.	0	0	0	pos.

Date	Bra-zil	China	Hun-gary	India	Ma-lay-sia	Mex-ico	Po-land	South Af-rica	South Ko-rea	Tai-wan	Thai-land
	No	No				No	No				No
30.5.2003	pos.	pos.	0	1	1	pos.	pos.	0	0	1	pos.
	No	No				No	No				No
30.6.2003	pos.	pos.	0	1	1	pos.	pos.	0	0	1	pos.
	No	No				No	No				No
31.7.2003	pos.	pos.	0	1	1	pos.	pos.	0	0	1	pos.
	No	No					No				No
29.8.2003	pos.	pos.	0	0	1	1	pos.	0	0	1	pos.
	No	No					No				No
30.9.2003	pos.	pos.	0	1	1	0	pos.	0	0	1	pos.
	No	No					No				No
31.10.2003	pos.	pos.	0	0	1	0	pos.	0	1	1	pos.
	No	No					No				No
28.11.2003	pos.	pos.	0	0	1	0	pos.	0	1	1	pos.
	No	No					No				No
31.12.2003	pos.	pos.	0	1	1	0	pos.	0	0	1	pos.
	No	No					No				No
30.1.2004	pos.	pos.	0	1	1	0	pos.	0	0	1	pos.
	No	No					No				No
27.2.2004	pos.	pos.	0	0	1	0	pos.	1	0	1	pos.
	No	No					No				No
31.3.2004	pos.	pos.	0	0	1	0	pos.	1	0	1	pos.
	No	No					No				No
30.4.2004	pos.	pos.	1	0	1	1	pos.	0	0	0	pos.
	No	No					No				No
31.5.2004	pos.	pos.	0	0	1	0	pos.	0	1	1	pos.
	No	No					No				No
30.6.2004	pos.	pos.	0	1	1	0	pos.	0	0	1	pos.
	No	No					No				No
30.7.2004	pos.	pos.	0	1	1	0	pos.	0	0	1	pos.
	No	No					No				No
31.8.2004	pos.	pos.	0	1	1	0	pos.	0	0	1	pos.
	No	No					No				No
30.9.2004	pos.	pos.	0	0	1	0	pos.	1	0	1	pos.
	No	No					No				No
29.10.2004	pos.	pos.	0	0	1	0	pos.	0	1	1	pos.
	No	No					No				No
30.11.2004	pos.	pos.	0	1	1	0	pos.	0	1	0	pos.
	No	No					No				No
31.12.2004	pos.	pos.	0	0	1	0	pos.	0	1	1	pos.
	No	No					No				No
31.1.2005	pos.	pos.	0	0	1	0	pos.	0	1	1	pos.
	No	No					No				No
28.2.2005	pos.	pos.	0	0	1	0	pos.	1	0	1	pos.
	No	No					No				No
31.3.2005	pos.	pos.	0	0	1	0	pos.	1	0	1	pos.
	No	No					No				No
29.4.2005	pos.	pos.	1	0	1	1	pos.	0	0	0	pos.
	No	No					No				No
31.5.2005	pos.	pos.	1	1	0	0	pos.	0	0	1	pos.
	No	No					No				No
30.6.2005	pos.	pos.	0	1	1	0	pos.	0	0	1	pos.
	No	No					No				No
29.7.2005	pos.	pos.	0	1	1	0	pos.	0	0	1	pos.
	No	No					No				No
31.8.2005	pos.	pos.	0	1	1	0	pos.	0	0	1	pos.
	No	No					No				No
30.9.2005	pos.	pos.	0	0	1	0	pos.	1	0	1	pos.
	No	No					No				No
31.10.2005	pos.	pos.	0	0	1	0	pos.	0	1	1	pos.
	No	No					No				No
30.11.2005	pos.	pos.	0	0	1	0	pos.	0	1	1	pos.
	No	No					No				No
30.12.2005	pos.	pos.	0	0	1	0	pos.	0	1	1	pos.

Date	Bra-zil	China	Hun-gary	India	Ma-lay-sia	Mex-ico	Po-land	South Af-rica	South Ko-rea	Tai-wan	Thai-land
31.1.2006	No pos.	No pos.	0	0	1	0	No pos.	0	1	1	No pos.
28.2.2006	No pos.	No pos.	0	0	1	0	No pos.	1	0	1	No pos.
31.3.2006	No pos.	No pos.	0	0	1	0	No pos.	1	0	1	No pos.
28.4.2006	No pos.	No pos.	1	0	1	0	No pos.	0	0	1	1
31.5.2006	No pos.	No pos.	0	1	1	0	No pos.	0	1	1	0
30.6.2006	0	No pos.	0	1	1	0	No pos.	0	1	1	0
31.7.2006	0	No pos.	0	0	1	0	No pos.	1	0	1	1
31.8.2006	0	No pos.	0	0	1	0	No pos.	1	0	1	1
29.9.2006	0	No pos.	0	0	1	0	No pos.	0	1	1	1
31.10.2006	0	No pos.	0	0	1	0	No pos.	0	1	1	1
30.11.2006	0	No pos.	0	1	1	0	No pos.	0	1	1	0
29.12.2006	0	No pos.	1	0	1	0	No pos.	0	0	1	1
31.1.2007	0	No pos.	0	0	1	0	No pos.	0	1	1	1
28.2.2007	0	No pos.	0	0	1	0	No pos.	1	0	1	1
30.3.2007	0	No pos.	0	0	1	1	No pos.	0	0	1	1
30.4.2007	0	No pos.	1	0	1	0	No pos.	0	0	1	1
31.5.2007	1	No pos.	0	0	1	0	No pos.	0	1	1	0
29.6.2007	1	No pos.	0	0	1	0	No pos.	0	0	1	1
31.7.2007	0	No pos.	0	1	1	0	No pos.	0	0	1	1
31.8.2007	0	No pos.	0	0	1	0	No pos.	0	1	1	1
28.9.2007	0	No pos.	0	0	1	1	No pos.	0	0	1	1
31.10.2007	0	No pos.	0	0	1	0	No pos.	0	1	1	1
30.11.2007	0	No pos.	0	0	1	0	No pos.	0	1	1	1
31.12.2007	0	No pos.	0	0	1	0	No pos.	0	1	1	1
31.1.2008	0	No pos.	0	0	1	0	No pos.	0	1	1	1
29.2.2008	0	No pos.	0	0	1	1	No pos.	0	0	1	1
31.3.2008	1	No pos.	0	0	1	0	No pos.	0	0	1	1
30.4.2008	0	No pos.	1	0	1	0	No pos.	0	0	1	1
30.5.2008	0	No pos.	0	0	1	0	No pos.	0	1	1	1
30.6.2008	0	No pos.	1	0	1	1	No pos.	0	0	1	0
31.7.2008	0	No pos.	0	0	1	0	No pos.	0	1	1	1
29.8.2008	0	No pos.	0	0	1	0	No pos.	1	0	1	1

Date	Bra-zil	China	Hun-gary	India	Ma-lay-sia	Mex-ico	Po-land	South Af-rica	South Ko-rea	Tai-wan	Thai-land
30.9.2008	0	No pos.	0	0	1	0	No pos.	0	1	1	1
31.10.2008	0	No pos.	0	0	1	0	No pos.	0	1	1	1
28.11.2008	0	No pos.	0	0	1	0	No pos.	0	1	1	1
31.12.2008	0	No pos.	0	0	1	0	No pos.	0	1	1	1
30.1.2009	0	No pos.	0	0	1	0	No pos.	0	1	1	1
27.2.2009	0	No pos.	0	0	1	0	No pos.	0	1	1	1
31.3.2009	0	No pos.	1	0	1	0	No pos.	0	1	0	1
30.4.2009	0	No pos.	0	0	1	0	No pos.	0	1	1	1
29.5.2009	0	No pos.	0	1	1	0	No pos.	0	1	1	0
30.6.2009	0	No pos.	0	1	1	0	No pos.	0	1	1	0
31.7.2009	0	No pos.	0	0	1	0	No pos.	0	1	1	1
31.8.2009	0	No pos.	0	0	1	0	No pos.	0	1	1	1
30.9.2009	0	No pos.	0	1	1	0	No pos.	0	1	0	1
30.10.2009	0	No pos.	0	0	1	0	No pos.	0	1	1	1
30.11.2009	0	No pos.	0	0	1	1	No pos.	0	1	0	1
31.12.2009	0	No pos.	0	0	1	0	No pos.	0	1	1	1
29.1.2010	1	No pos.	0	0	1	0	No pos.	0	0	1	1
26.2.2010	0	No pos.	0	0	1	0	No pos.	0	1	1	1
31.3.2010	1	No pos.	1	0	0	0	No pos.	0	0	1	1
30.4.2010	0	1	0	0	1	0	No pos.	0	1	1	1
31.5.2010	0	1	0	1	1	0	No pos.	0	1	1	0
30.6.2010	0	1	0	0	1	0	No pos.	0	1	1	1
30.7.2010	0	1	0	0	1	0	No pos.	0	1	1	1
31.8.2010	0	1	0	0	1	0	No pos.	1	0	1	1
30.9.2010	0	0	0	0	1	0	No pos.	1	1	1	1
29.10.2010	0	1	0	0	1	0	No pos.	0	1	1	1
30.11.2010	1	0	0	0	1	0	No pos.	0	1	1	1
31.12.2010	0	1	0	0	1	0	No pos.	0	1	1	1
31.1.2011	0	0	0	0	1	1	No pos.	0	1	1	1
28.2.2011	0	0	0	0	1	0	No pos.	1	1	1	1
31.3.2011	1	0	0	0	1	1	No pos.	0	0	1	1
29.4.2011	1	0	1	0	1	0	No pos.	0	0	1	1

Date	Bra-zil	China	Hun-gary	India	Ma-lay-sia	Mex-ico	Po-land	South Af-rica	South Ko-rea	Tai-wan	Thai-land
31.5.2011	0	1	1	0	1	0	No pos.	0	1	1	0
30.6.2011	0	0	0	0	1	1	No pos.	0	1	1	1
29.7.2011	1	0	0	0	1	0	No pos.	1	0	1	1
31.8.2011	0	0	0	0	1	0	No pos.	1	1	1	1
30.9.2011	0	0	0	0	1	0	No pos.	1	1	1	1
31.10.2011	0	0	0	0	1	1	No pos.	0	1	1	1
30.11.2011	0	1	0	0	1	0	No pos.	0	1	1	1
30.12.2011	0	0	0	0	1	1	No pos.	0	1	1	1
31.1.2012	0	0	0	0	1	0	No pos.	1	1	1	1
29.2.2012	0	0	0	0	1	0	No pos.	1	1	1	1
30.3.2012	1	0	0	0	1	1	No pos.	0	0	1	1
30.4.2012	0	1	1	0	1	0	No pos.	0	0	1	1
31.5.2012	0	1	1	0	1	0	No pos.	0	1	1	0
29.6.2012	0	1	0	0	1	1	No pos.	0	1	1	0
31.7.2012	0	1	0	0	1	0	No pos.	1	0	1	1
31.8.2012	0	1	0	0	1	0	No pos.	1	0	1	1
28.9.2012	1	0	0	0	1	0	No pos.	1	1	1	0
31.10.2012	0	0	0	0	1	1	No pos.	0	1	1	1
30.11.2012	1	0	0	0	1	0	No pos.	0	1	1	1
31.12.2012	0	1	0	0	1	0	No pos.	0	1	1	1
31.1.2013	0	0	0	0	1	1	No pos.	0	1	1	1
28.2.2013	1	0	0	0	1	0	No pos.	1	0	1	1
29.3.2013	1	0	0	0	1	0	No pos.	1	0	1	1
30.4.2013	1	1	1	0	1	0	No pos.	0	0	0	1
31.5.2013	0	1	1	0	1	0	No pos.	0	1	1	0
28.6.2013	0	1	0	0	1	1	No pos.	0	1	1	0
31.7.2013	0	0	0	0	1	0	No pos.	1	1	1	1
30.8.2013	0	0	0	0	1	0	No pos.	1	1	1	1
30.9.2013	0	0	0	0	1	0	1	1	0	1	1
31.10.2013	0	0	0	0	1	1	1	0	0	1	1
29.11.2013	0	0	0	0	1	1	0	0	1	1	1
31.12.2013	0	0	0	0	1	0	1	0	1	1	1
31.1.2014	0	0	0	0	1	0	1	0	1	1	1
28.2.2014	0	0	0	0	1	0	1	1	0	1	1
31.3.2014	1	0	0	0	1	0	1	1	0	0	1
30.4.2014	0	0	1	0	1	0	1	0	0	1	1
30.5.2014	0	1	1	0	1	0	1	0	0	1	0

Date	Bra-zil	China	Hun-gary	India	Ma-lay-sia	Mex-ico	Po-land	South Af-rica	South Ko-rea	Tai-wan	Thai-land
30.6.2014	0	1	0	0	1	1	1	0	0	1	0
31.7.2014	0	0	0	0	1	0	1	1	0	1	1
29.8.2014	0	0	0	0	1	0	1	1	0	1	1
30.9.2014	0	0	1	0	1	0	0	0	1	1	1
31.10.2014	0	0	0	0	1	1	0	0	1	1	1
28.11.2014	0	0	0	0	1	0	1	0	1	1	1
31.12.2014	0	0	1	0	0	0	1	0	1	1	1
30.1.2015	1	0	0	0	1	0	1	0	0	1	1
27.2.2015	0	0	0	0	1	0	1	1	0	1	1
31.3.2015	0	0	0	0	1	1	0	1	0	1	1
30.4.2015	0	0	1	0	1	1	1	0	0	1	0
29.5.2015	0	1	1	0	0	0	1	0	1	1	0
30.6.2015	0	1	0	0	0	0	1	0	1	1	1
31.7.2015	0	0	0	0	1	0	0	1	1	1	1
31.8.2015	0	0	0	0	1	0	1	1	0	1	1
30.9.2015	0	0	1	0	1	0	1	0	0	1	1
30.10.2015	0	0	1	0	1	1	1	0	0	1	0
30.11.2015	0	0	1	0	1	0	0	0	1	1	1
31.12.2015	0	0	1	0	0	0	1	0	1	1	1
29.1.2016	0	0	1	0	1	0	1	0	0	1	1
29.2.2016	0	0	0	0	1	0	1	1	0	1	1
31.3.2016	0	0	1	0	1	0	1	0	0	1	1
29.4.2016	0	1	1	0	1	0	1	0	0	0	1
31.5.2016	0	1	1	0	1	0	1	0	0	1	0
30.6.2016	0	1	1	0	0	0	1	0	0	1	1
29.7.2016	0	1	1	0	1	0	0	0	0	1	1
31.8.2016	0	0	0	0	1	0	1	1	0	1	1
30.9.2016	0	0	1	0	1	0	1	0	1	1	0
31.10.2016	0	0	1	0	1	0	1	0	1	1	0
30.11.2016	0	0	1	0	1	0	0	0	1	1	1
30.12.2016	0	0	1	0	0	0	1	0	1	1	1
31.1.2017	0	0	1	0	1	0	0	0	1	1	1
28.2.2017	0	0	1	0	1	0	0	1	1	0	1
31.3.2017	0	0	1	0	0	0	1	0	1	1	1
28.4.2017	0	0	1	0	1	0	1	0	0	1	1
31.5.2017	0	1	1	0	0	0	1	0	1	1	0
30.6.2017	0	1	1	0	0	0	1	0	1	1	0
31.7.2017	0	0	1	0	1	0	0	0	1	1	1
31.8.2017	0	0	0	0	1	0	1	1	0	1	1
29.9.2017	0	0	1	0	1	0	0	0	1	1	1
31.10.2017	0	0	1	0	1	0	1	0	1	1	0
30.11.2017	1	0	1	0	1	0	0	0	1	0	1
29.12.2017	0	0	1	0	0	0	1	0	1	1	1
31.1.2018	1	0	1	0	0	0	0	0	1	1	1
28.2.2018	0	0	1	0	1	0	0	1	1	0	1
30.3.2018	0	0	1	0	1	0	0	0	1	1	1
30.4.2018	0	0	1	0	0	0	1	0	1	1	1
31.5.2018	0	1	1	0	1	0	0	0	1	1	0
29.6.2018	0	1	1	0	0	0	1	0	1	1	0
31.7.2018	1	0	1	0	0	0	1	0	0	1	1
31.8.2018	0	0	0	0	1	0	1	1	1	0	1
28.9.2018	0	0	1	0	0	0	1	0	1	1	1
31.10.2018	0	0	1	0	1	0	1	0	1	1	0
30.11.2018	1	0	1	0	0	0	0	0	1	1	1
31.12.2018	0	0	1	0	0	0	1	0	1	1	1
31.1.2019	1	0	1	0	0	0	1	0	0	1	1
28.2.2019	0	0	1	0	1	0	0	1	1	0	1
29.3.2019	0	0	1	0	0	0	1	1	0	1	1
30.4.2019	0	1	1	0	1	0	1	0	0	0	1
31.5.2019	0	1	1	0	0	0	1	0	1	1	0
28.6.2019	0	1	1	0	0	0	1	0	0	1	1
31.7.2019	1	0	0	0	1	0	1	0	0	1	1
30.8.2019	0	0	0	0	1	0	0	1	1	1	1
30.9.2019	1	0	1	0	1	0	0	0	0	1	1
31.10.2019	0	0	1	0	1	0	0	0	1	1	1

Date	Bra-zil	China	Hun-gary	India	Ma-lay-sia	Mex-ico	Po-land	South Af-rica	South Ko-rea	Tai-wan	Thai-land
29.11.2019	1	0	1	0	0	0	0	0	1	1	1
31.12.2019	0	0	1	0	0	0	1	0	1	1	1
31.1.2020	1	0	1	0	0	0	0	0	1	1	1
28.2.2020	0	0	0	0	1	0	0	1	1	1	1
31.3.2020	0	0	0	0	1	0	1	1	1	0	1
30.4.2020	0	1	1	0	1	0	0	0	1	0	1
29.5.2020	0	1	1	0	1	0	0	0	1	1	0
30.6.2020	1	1	0	1	0	0	1	0	0	1	0
31.7.2020	0	0	0	0	1	0	1	0	1	1	1
31.8.2020	1	0	0	0	1	0	0	1	1	1	0
30.9.2020	1	0	0	0	1	0	1	0	1	1	0
30.10.2020	1	0	0	0	1	1	1	0	1	0	0
30.11.2020	1	0	0	0	1	0	1	0	1	1	0
31.12.2020	1	0	0	0	1	0	1	0	1	0	1
29.1.2021	1	0	0	0	1	0	1	0	1	0	1
26.2.2021	1	0	0	0	1	0	0	1	1	0	1
31.3.2021	1	0	0	0	0	1	1	0	0	1	1
30.4.2021	0	0	1	0	1	1	1	0	0	0	1
31.5.2021	0	1	1	0	0	0	1	0	1	1	0
30.6.2021	0	1	0	0	0	0	1	0	1	1	1
30.7.2021	1	0	1	0	0	0	0	1	0	1	1
31.8.2021	1	0	0	0	1	0	1	1	0	0	1
30.9.2021	0	0	0	0	1	0	1	0	1	1	1
29.10.2021	0	0	0	0	1	1	1	0	0	1	1
30.11.2021	1	0	0	0	1	0	0	0	1	1	1