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DOES THE FINANCIAL CYCLE THEORY EXPLAIN SHORT TERM DEVIATIONS FROM COVERED INTEREST RATE PARITY?

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Abstract

We test one of fundamental theories in international finance: Covered interest rate parity (CIP). The most common explanations for the deviations from CIP are transaction costs, market frictions, and capital market imperfections. We propose an alternative explanation for the deviations that has been never tested in the literature before: composite financial cycle measure. Hence, this paper studies the relationship between CIP short term violations and financial cycle fluctuations using Vector autoregressive model (VAR) for the time span 1999-2016. We obtain CIP violations for seven currency pairs: EUR/NOK, EUR/SEK, EUR/DKK, EUR/CHF, EUR/CAD, EUR/AUD, EUR/NZD, and construct composite financial cycle measures for 7 countries and the Eurozone. We find positive evidence that there is a significant link between CIP violations and financial cycle. However, the relationship is exchange rate specific.

1. *Introduction*

Covered interest rate parity (CIP) is one of the most fundamental theories in international finance. It states that no-arbitrage condition should hold when an agent borrows in domestic markets and afterwards lends in foreign assets abroad by covering the position with a forward contract (Eiteman et al., 2004). However, empirical evidence shows that arbitrage opportunities exist as a result of short term CIP violations.

For the last two decades numerous research in international finance has studied the elucidations why CIP deviations persist. Up to now, several explanations have been proposed. Some of the most common justifications for CIP violations are transaction costs, credit risk, and market frictions like lower liquidity (Rivera-Batiz & Rivera-Batiz, 1994; Brunnermeier et al., 2008; Bhargava et al., 2011; Skinner & Mason, 2011). Findings of previous research suggests that deviations from CIP might be linked with turbulences in financial markets. Additionally, Balke and Wohar (1998) found non-linear patterns of CIP violations indicating that there are times when they are more severe compared to other periods.

We summarise previous empirical evidence and propose a hypothesis that short term deviations from CIP are linked with financial cycle fluctuations. Several studies investigated the effects of separate market characteristics on the deviations from CIP. However, so far there has been no study carried out so far proposing a broader explanation for CIP violations that includes overall situation in financial markets and the economy. The main advantage of the composite financial cycle measure used in this research is that it captures co-movement of several financial variables and aggregates overall trends in financial markets. As a result it avoids the situation that different measures counteract each other and a clear explanation for CIP contraventions cannot be identified.

Even though research for the euro as an anchor currency is rather limited, in this study, we use the euro because of its significance in international trade and negligible exogenous factors affecting the exchange rate. Thus, the main objective of this paper is to empirically test whether the financial cycle provides an explanation for CIP violations for the following currency pairs: EUR/NOK, EUR/SEK, EUR/DKK, EUR/CHF, EUR/CAD, EUR/AUD, and EUR/NZD. Hence, our research question is as follows: **Are the violations of covered interest rate parity interlinked with the fluctuations of financial cycle given the Euro as a centre currency?**

We explore the relationship between CIP contraventions and financial cycle using three-step methodology. Firstly, we obtain deviations from CIP accounted for transaction costs using the methodology of Taylor (1986). Secondly, we construct composite financial cycle measures for the whole Eurozone and for seven non-Eurozone countries (Norway, Sweden, Denmark, Switzerland, Canada, Australia, New Zealand) using methodology proposed by Drehmann et al. (2012). Finally, we use vector autoregressive model (VAR) to determine the relationship between CIP violations and the financial cycle.

We find positive evidence for the link between the financial cycle and deviations form CIP. However, the results are exchange rate and country specific. We propose two possible explanations for such dissimilarities: exchange rate regime and trade patterns.

Our findings contribute to previous literature in two ways. Firstly, we prepend to already existing financial cycle literature and contribute to its previously proposed capabilities of explaining fundamental puzzles in international finance. Secondly, the results provide an alternative to already existing explanations why CIP violations persist: overall state in financial markets with its respective characteristics. This exploratory research might serve as a basis for further studies. Moreover, it might be used by monetary policy makers and financial market participants as well.

The paper is structured as follows: section 2 contains overview of current academic standpoint of covered interest rate parity theory and explanations for short term violations of CIP. In this section, we also review existing literature on financial cycle characteristics and provide possible explanation for the linkages between the short term deviations from CIP and financial cycle fluctuations. In section 3, the methods used are introduced and econometric models are presented. In section 4, we describe the data and variables used. Section 5 presents results of CIP tests, financial cycle measures, and linkages between CIP violations and financial cycle. Lastly, section 6 contains discussion of results, and section 7 concludes.

2. Literature review

In this section, we define concepts of CIP and financial cycle, review literature on CIP short term violations and summarise main explanations why CIP does not hold in the short run. In addition, we present the theory of financial cycle, identify its main characteristics and establish a link between the CIP violations and the financial cycle.

2.1. Theory of covered interest rate parity

CIP theorem states that no-arbitrage condition should hold when one borrows in the domestic currency and afterwards invests in foreign assets, that are perfect substitutes to domestic ones with regard to default risk and liquidity, and covers the position with the same maturity forward contract (Aliber, 1972; Frenkel & Levich, 1975; Taylor, 1986; Madura & Fox, 2007). Hence, by definition, CIP implies that the Eq. 1 should hold:

$$\frac{F_t - S_t}{S_t} = (r_t^d - r_t^f) \qquad (1)$$

In Eq. 1, F_t denotes forward exchange rate expressed in units of domestic currency per one unit of foreign currency at time *t*; S_t is the spot exchange rate expressed in units of domestic currency per one unit of foreign currency observed at time *t*; r_t^d is the domestic interest rate at time *t*; and r_t^f is the foreign interest rate at time *t*.

Therefore if CIP holds, Eq. 1 clearly illustrates the dynamics behind interest rate changes and currency forwards pricing. If forward premium is positive, then it implies domestic currency's depreciation, and if it is negative, the appreciation of domestic currency. If domestic currency depreciates, then it should be compensated by higher interest rate at the domestic market, so the total return is equal; thus the interest differential is positive. If forward premium is negative, it implies domestic currency's appreciation, and the interest rate should be higher in foreign country to compensate for foreign currency's depreciation; thus the interest differential is negative. In this way dynamic adjustments of the forward price based on prevailing interest rates ensures that risk free assets in both countries yield the same return and CIP holds (Copeland, 2005).

Deviations from CIP occur when the forward premium differs from the anticipated interest differential. Higher forward premium than anticipated by the interest differential overcompensates for higher interest rate at domestic market. Thus, domestic currency depreciates more, and it is still profitable to invest in foreign market despite the lower foreign interest rate. Similarly, when the forward premium and interest differential are negative, higher forward premium undercompensates for lower interest rate. Although foreign interest rate is higher than the domestic one, the implied appreciation of domestic currency is too low to eliminate the profit opportunity from investing abroad at a higher interest rate. Therefore when deviations from CIP are positive, it is profitable to invest abroad and borrow domestically.

Alternatively, if the deviations are negative, the opposite occurs: depreciating domestic currency undercompensates for higher interest rate in the home market, or appreciation of domestic currency overcompensates for lower interest rate in the domestic market. Therefore, when deviations are negative, it is profitable to invest domestically and borrow abroad (Madura and Fox, 2007). Deviations from CIP can be expressed by the following formula:

$$Dev_t = \frac{F_t - S_t}{S_t} - (r_t^d - r_t^f) \qquad (2)$$

If $Dev_t > 0$ => *Invest abroad, Borrow domestically*

If $Dev_t < 0$ => *Invest domestically, Borrow abroad*

In Eq. 2, Dev_t denotes deviations from CIP at time *t*. However, such generalisation only holds if there are no transaction costs (Frenkel & Levich, 1979; Taylor, 1986).

CIP is ensured by several fundamental principles of economics and finance. One of them is the law of one price assuming that investors are rational and markets are efficient. Foreign exchange markets are indeed considered liquid and efficient, meaning that investors' expectations are based on all publicly available information (Froot & Thaler, 1990). Moreover, the assumption of perfect capital mobility should hold, which ensures that both investments are identical for investors in terms of return, costs and risk. Failures of this assumption and other reasons behind CIP failure are explained in the following subsection.

2.2. Covered interest rate parity violations

Empirical evidence shows that CIP theorem holds in the long run. However, there is also proof that short term deviations from CIP persist. Several explanations for those violations have been proposed which are associated with the failure of primary CIP assumptions. The summary of the most common explanations is provided in Table 1.

Table 1. Summary of empirical findings on the violations of CIP.

Explanation	**Paper(s)**
Transaction costs	Skinner and Mason (2011); Taylor (1986); Frenkel and Levich (1977); Clinton (1988); Bhargava et al. (2011); Fletcher and Taylor (1994); Taylor (1989); Aliber (1973); Balke and Wohar (1998)
Taxation	Levi (1977); Aliber (1973)
Credit risk	Skinner and Mason (2011); Fong et al. (2010); Rivera-Batiz and Rivera-Batiz (1994)
Hedging demand	Borio et al. (2016); Sushko et al. (2016)
Market frictions (increased volatility, lower liquidity, inelastic demand/supply for interest yielding assets)	Brunnermeier et al. (2008); Aliber (1973); Cho (2015); Fong et al. (2010); Baba and Packer (2009); Mancini-Griffoli and Ranaldo (2011)
Capital market imperfections (controls, political risk, imperfect substitutability)	Blenman (1991); Prachowny (1970); Frenkel (1973); Dooley and Isard (1980); Otani and Tiwiari (1981); Bhargava et al. (2011); Liao (2016)

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One of the most common explanations for short term CIP violations is transaction costs. Due to its prominence in academic literature, we overview it separately from other capital market imperfections (Skinner & Mason, 2011; Taylor, 1986; Frenkel & Levich, 1977; Clinton, 1988, Bhargava et al., 2011; Fletcher & Taylor, 1994; Taylor, 1989; Aliber, 1973; Balke and Wohar, 1998).

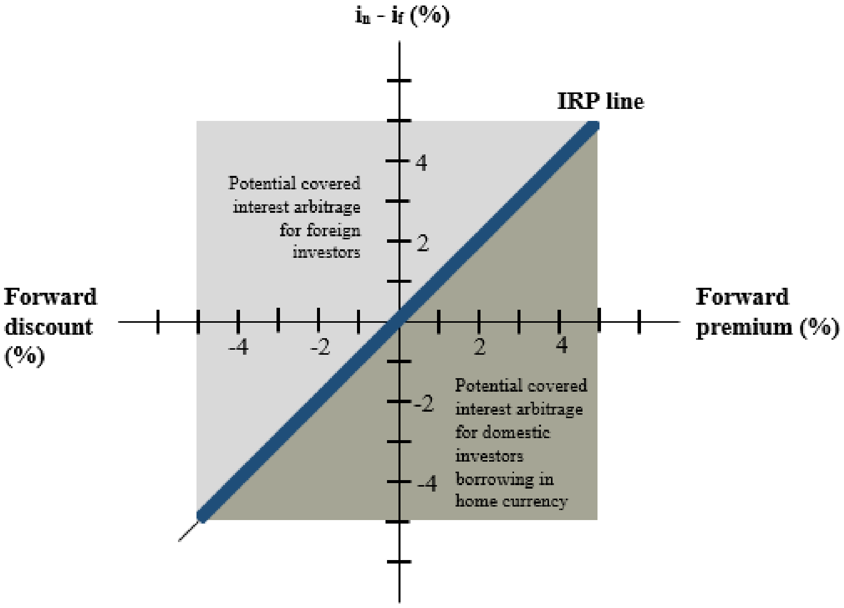
Transaction costs can be best captured by following the transactions of two types of investors: the ones borrowing domestically and depositing abroad and vice versa. If the deviation is positive, investors intend to borrow domestically, exchange the currency into foreign currency units, deposit at the foreign rate and exchange back using a forward contract. In this case they would face an ask price of the spot rate and bid price of the forward rate. Similarly, if the deviation is negative, investors intend to borrow abroad and deposit domestically facing a bid price for the spot rate and ask for the forward rate. In this way the transaction cost band is established which limits the CIP violations by the transactions costs incurred when establishing a domestic or foreign carry trade position. Therefore, the deviations within the transaction costs band are not exploitable as they are inaccessible to investors facing the costs of each transaction. However, when CIP violations exceed the transaction costs band, an arbitrage opportunity appears (Figure 1). In such case one of the following holds:

$$(1 + r_d^a) \geq \frac{F^b}{S^a}(1 + r_f^b) \tag{3}$$

$$(1 + r_f^a) \geq \frac{S^b}{F^a}(1 + r_d^b) \tag{4}$$

In Eq. 3 and Eq. 4, r_d^a, r_d^b denote domestic ask and bid interest rates respectively, r_f^b, r_f^a are foreign bid and ask interest rates respectively, S^b, S^a- bid and as spot rates expressed in units of domestic currency per one unit of foreign currency, F^b, F^a- bid and ask forward exchange rates with the same maturity as borrowing/lending respectively (Akram et al., 2008).

Figure 1. Potential covered interest arbitrage accounted for transaction costs.



(Adapted from Madura & Fox, 2007)

Similarly to transaction costs, differences in taxation are also used to explain why short term violations of CIP persevere (Levi, 1977; Aliber, 1973). When taxation policy is substantially unfavourable to arbitrager, deviations from CIP will not be eliminated alike violations within the transaction cost band.

One of the covered interest parity conditions is that domestic and foreign assets should be perfect substitutes in terms of risk. When one of the assets is different with regard to default and credit risk, it should be priced in the interest rate which affect the value of interest rate differential. Thus, deviations from CIP might arise which are not an arbitrage opportunity but rather a compensation for additional risk (Rivera-Batiz & Rivera-Batiz, 1994; Skinner & Mason, 2011; Fong et al., 2010).

Borio et al. (2016) and Sushko et al. (2016) proposed another explanation why CIP violations persisted even after the Great Recession. The authors concluded that the price of hedging instruments, including the forward contracts, is driven by the hedging demand. Hence it affects forward premium and causes CIP violations. Moreover, Borio et al. (2016) and Sushko et al. (2016) suggested that the financial position constraints of financial institutions limit the possibility to exploit arbitrage opportunities arising from CIP violations. Similar conclusions were made by Du et al. (2017) who proposed that CIP violations arise when financial intermediation costs increase and supply and demand of currencies in international markets are not in equilibrium.

Brunnermeier et al. (2008), Aliber (1973), Cho (2015), and Fong et al. (2010) found that market frictions such as increased volatility, lower liquidity and changes in supply or demand for assets justifies why CIP does not hold in short term. In addition, although during turbulent periods in the financial markets and the economy, market frictions are magnified to the level that CIP violations create riskless arbitrage opportunities, fall in liquidity prevents market participants from obtaining sufficient capital to profit and eliminate the arbitrage opportunity quickly. Mancini-Griffoli and Ranaldo (2011) found that in 2008 CIP violations were magnified due to liquidity constraints in the market which did not allow to exercise arbitrage opportunities.

Furthermore, Baba and Packer (2009) discovered that during financial crisis in 2008 severe CIP violations can be explained by the disparity in counterparty risk between financial institutions in the US and Europe. They also showed that large swings from CIP in the Eurozone were caused by decreased USD liquidity of ECB. Therefore, it suggests that during turbulent times in the economy, market frictions amplify deviations from CIP that cannot be eliminated.

Another part of explanations is related to capital market imperfections. Prachowny (1970) and Frenkel (1973) emphasized the importance of imperfect substitutability when covered arbitrage appears due to changes in interest rate differential. Dooley and Isard (1980) and Otani & Tiwiari (1981) found that capital controls and ex-ante political risk affects the interest rate differential leading to CIP violations. Bhargava et al. (2011) and Liao (2016) made similar conclusions that capital market imperfections, for example, regulatory restrictions and political risk restrict the exercising the arbitrage opportunity. In addition, Blenman (1991) added that CIP violations will more likely persist in segmented markets in which all investors do not face the same market conditions.

In sum, the main explanations for short-term CIP violations include transaction costs, taxation, credit risk, hedging demand, market frictions, and capital market imperfections.

2.3. Literature on financial cycle

In the most recent research financial cycle is defined as periodic fluctuations in financial asset prices over a medium term horizon. During the times of Great Depression in 1929-

1933, Irving Fisher was the first one who defined finance as one of the key determinants of real economic activity (Fisher, 1933, Claessens et al., 2012, Drehmann et al., 2012). Later Kindleberger (1978) reviewed past financial crises and explained the significance of irrational asset pricing in the whole economy while Minsky (1982) contributed by identifying amplifying effect of increased credit. He proposed an idea that fluctuations in financial markets are a result of financial crises that are caused by extreme and too optimistic borrowing during the growth phase of the real economy. Although, the financial instability hypothesis proposed by Minsky (1982) did not receive recognition among academics at that time, nowadays it is considered as basis of financial cycle theory.

Other fundamental characteristics of financial cycle were observed by Borio et al. (1994) and Borio (2012). The authors proposed that higher credit amplifies upswings and downswings in asset prices. Consequently, they empirically proved that credit is a significant factor in increasing financial fluctuations. Goodhart and Hofmann (2008) showed that there are significant multidirectional correlations between housing prices, GDP, CPI, and other monetary variables, which include short-term nominal interest rates, nominal broad money, and nominal bank credit to the private sector. Detken and Smets (2004) established a direct link between the financial variables and the business cycle by linking asset prices and GDP growth. However, they also noted that not all crises are associated with a decline in asset prices. Borio and Lowe (2004) contributed by discovering that deviations from long-term trends of private sector credit to GDP ratio and equity prices are good estimators of upcoming recession.

Even though financial cycle definition and characteristics became more prevalent among researchers after the financial crisis of 2008, there is still no consensus for the variables used to form the financial cycle. In the most recent researches credit to non-financial institutions and credit to GDP ratio, as well as residential property prices are used to create a composite financial cycle measure (Drehmann et al., 2012; Stremmel, 2015). In addition, Drehmann et al. (2012) found that that financial cycle is best defined as a medium term cycle (8 to 30 years) in contrast to shorter business cycles which are found to be up to 8 years.

The aim of developing financial cycle theory was to find the causes of the financial crisis and implement policies to prevent recurrence of such financial instability. Findings of Aikman et al. (2013) showed that probability of significant crisis in the next two years is increasing by 0.18% with 1% increase in credit to GDP ratio, meaning that credit cycle can be a good estimator of upcoming financial downturn. Furthermore, Claessens et al. (2012) suggested that credit and real estate cycles amplify each other when they move in the same direction, which helps to explain the severity of the most recent financial crisis.

Both Drehmann et al. (2012) and Claessens at al. (2012) noted that average financial cycle duration has increased in more recent years: cycles that reached their peaks after 1998 last for on average 20 years in contrast to whole timespan average of 16 years. They also provided a link between peaks of financial cycles and disruptions in financial stability that is followed by economic downturn. Furthermore, findings of Aikman et al. (2013) were in line with conclusions of previous research. The authors compared credit cycles of the UK and the US with the respective business cycles and found that there are periodicity differences between credit cycle and business cycle: credit cycle was found to last on average for 13 years while business cycle was found to be a short-term cycle of 4.5 years on average.

2.4. CIP violations and financial cycle

Although it has never been tested empirically, indirect evidence shows that CIP violations might be related to the financial cycle. Cornett et al. (2011) and Linnemann and Schabert (2015) showed that financial crises are associated with lower liquidity in the markets, increased credit risk, and higher volatility. In line with these findings, Claessens et al. (2012) also proposed that peaks of financial cycle are associated with conspicuous financial disturbances.

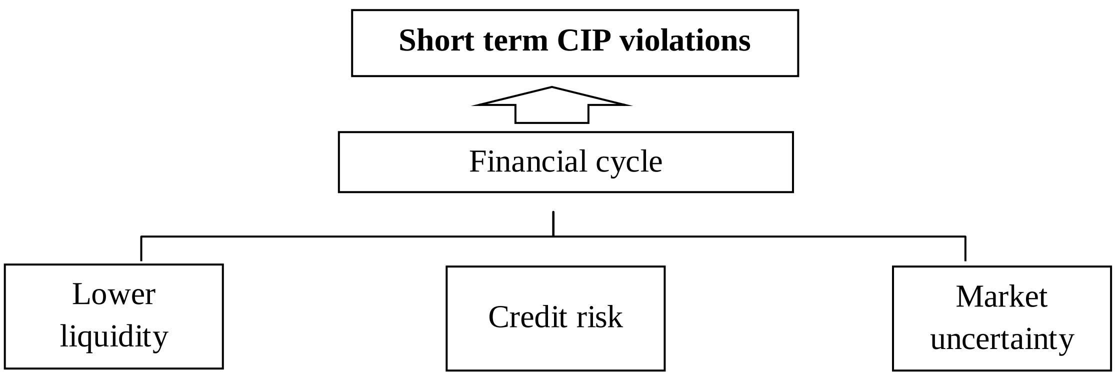
Liquidity in the markets might be a factor which is related to both deviations from CIP and the financial cycle. Brunnermeier (2009) contributed to the notion of liquidity by distinguishing market liquidity and funding liquidity. Market liquidity is referred to the ability to find a counterparty to complete a transaction without reductions in asset price while funding liquidity is regarded as a facility to obtain funds from other market participants. As size of CIP violations are rather small, abundant amounts of capital are required to exploit profit opportunity. Hence, funding liquidity is pivotal in order to take on capital intensive positions. When the liquidity is low, CIP violations will not be eliminated as for investors obtaining funding is strenuous. Consequently, as empirical evidence shows that during financial crisis liquidity dries up, and it provides a theoretical basis why CIP violations are more severe during crisis periods

(Brunnermeier, 2009; Brunnermeier & Pedersen, 2009; Rösch & Kaserer, 2014; Baba & Packer, 2009).

In addition to liquidity, credit risk and market uncertainty are also two of the factors that link CIP violations and the financial cycle. Rivera-Batiz and Rivera-Batiz (1994), Skinner and Mason (2011) and Fong et al. (2010) showed that CIP violations are associated with an increase in credit risk, which rises during the financial downturns. Moreover, Taylor (1989) found that CIP violations persist when the markets are uncertain and turbulent. This can be explained by the fact that uncertainty in the markets is priced as additional risk leading to higher forward premium. Therefore, CIP violations should also increase during turbulent times as higher uncertainty is associated with the peaks of financial cycle.

As summarised in Figure 2, current academic standpoint suggests that financial cycle might be linked with deviations from CIP. Relationship between CIP deviations and financial cycle may show whether overall financial stability in the markets and in the economy influences the size and severity of CIP violations. The main advantage of the composite financial cycle measure in this research is that it captures co-movement of several financial variables and avoids situations when different crisis-related measures counteract each other and clear explanations for CIP violations cannot be identified.

Figure 2. CIP violation possible linkage with financial cycle.



(Created by authors)

Furthermore, as previously described explanations of CIP violations and their characteristics are related to market frictions and turbulence in the financial markets, the financial cycle which accounts for these market disturbance may in this way serve as a general explanation for the time-varying severity of CIP violations.

As CIP violations may be positive or negative depending on whether the domestic or foreign currency is profitable to borrow, the expected relationship with the financial cycle is either positive or negative. Therefore, we formulate our *hypothesis 1* as follows:

H1: CIP violations are significantly related with the growth of financial cycle.

Market uncertainty increases before the crisis when the growth of economy reaches its peak and therefore the volatility in the markets increase. Hence, we test the link between the volatility of CIP violations and the growth of financial cycle to investigate the effect of market uncertainty and to explore the causal relationship between the two variables. Thus, we propose the following *hypothesis 2*:

H2: Volatility of CIP violations are significantly and directly related with the growth of financial cycle.

For cases where *hypothesis 2* is rejected but the determined effect is significant, we also propose an alternative:

Alternative H2: Volatility of CIP violations are significantly and inversely related with the growth of financial cycle.

3. Methodology

In order to test the relationship between CIP violations and the financial cycle, we applied a three-step approach. Firstly, CIP violations were determined. Secondly, we estimated aggregated financial cycle measures for the Eurozone and for the sample of seven foreign countries. Lastly, econometric analysis was conducted to investigate the relationship between CIP violations and the financial cycles.

3.1. CIP violations

Firstly, we tested whether CIP holds in the long-run across our sample of countries. For that we used the general CIP model which can be expressed as follows:

$$\frac{F_t - S_t}{S_t} = \beta_0 + \beta_1\left(r_{d,t} - r_{f,t}\right) + \varepsilon_t \qquad (5)$$

$$H_0\colon \beta_0 = 0 \; and \; \beta_1 = 1$$

In Eq. 5. β_0 denotes intercept coefficient or linear risk premium; β_1 denotes coefficient of the interest differential; $r_{d,t}$ is the domestic interest rate; $r_{f,t}$ denotes foreign interest rate; while ε_t is an estimation error.

In this model we disregarded the transaction costs and only tested whether the null hypothesis holds. It states that the intercept should be equal to zero and coefficient of the interest differential equal to one. If one can reject the null hypothesis, one can reject that CIP holds. For this analysis we applied OLS regression with Newey-West standard errors, choosing the number of lags using the Stock and Watson (2007) truncation *m* parameter of $m=0.75T^{(1/3)}$, where *T* denotes the number of available observations.

Furthermore, actual profit opportunity exists only when the deviations from CIP exceed the transaction costs band. Therefore, in order to obtain CIP violations used in further research, we adjusted the variables accordingly. In line with Taylor (1986), we accounted for transaction costs using bid-ask spread of spot and forward exchange rates. The positive and negative deviations can be expressed by the following system of equations:

$$\begin{cases} Dev_t > 0 \; if \; \frac{F_t^{BID} - S_t^{ASK}}{S_t^{ASK}} - \left(r_t^d - r_t^f\right) > 0 \\ Dev_t < 0 \; if \; \frac{F_t^{ASK} - S_t^{BID}}{S_t^{BID}} - \left(r_t^d - r_t^f\right) < 0 \end{cases} \qquad (6)$$

In Eq. 6, F_t^{BID} and F_t^{ASK} denote bid and ask prices of forward exchange rate contracts, respectively, expressed in units of domestic currency per one unit of foreign currency observed at time *t*; S_t^{BID} and S_t^{ASK} denote bid and ask spot exchange rates expressed in units of domestic currency per one unit of foreign currency observed at time *t*.

We also eliminated the observations where reported bid price exceeded the ask price as the bid-ask arbitrage is not the focus of this research and may cause errors in further regressions.

3.2. Financial Cycle

In order to investigate the relationship between financial cycles and CIP violations, we need to obtain financial cycles for the Eurozone and a sample of foreign countries. Methods to determine financial cycle are applied from business cycle research. The most common techniques to obtain cycle measures are turning-point analysis, and frequency based filters. The former was developed by developed by Burns and Mitchell (1946) and later adjusted by Bry and Boschan (1971) and by Harding and Pagan (2002). This model is based on identification of peak and through points determined by estimating local minimum and maximum points.

Frequency based filters analysis is a more novel approach developed by Hodrick and Prescott (1997), Baxter and King (1999), Christiano and Fitzgerald (2003) as well as Comin and Gertler (2006). It is based on filter analysis that alters the data by smoothing the fluctuations of different observations based on predefined frequencies: high frequency (up to 8 years) for business cycle and medium term frequency (8-30 years) for financial cycle (Comin & Gertler, 2006).

3.2.1 Christiano and Fitgerald (2003) band pass filter

We determined our financial cycles using a frequency based filter method in line with Drehmann et al. (2012). In contrast to the turning point analysis, this method provides a continuous nominal measure which results in more observations and can be widely applied in models which use nominal values in levels or first differences.

In their research, Drehmann et al. (2012) used three variables to define financial cycle: credit to GDP ratio, credit to non-financial institutions and residential property prices. Consequently, they developed a model to aggregate the three cycles into one composite financial cycle measure for each country. One of the problems with credit and real estate prices, is the effect of inflation, which means that even though nominal values increase, it can be a result of pure inflation effect without real changes in credit or real estate price levels. Therefore, we accounted for inflation by reducing the growth of these variables by the rate of change in consumer price index (CPI). These growth rates were cumulated to obtain real variables.

Having conducted these adjustments, we proceeded by obtaining annual growth rates for each variable on quarterly basis by subtracting the fourth lagged value from the natural logarithm of financial cycle variables. Then, Christiano and Fitzgerald (2003) band pass filter was applied in order to isolate medium term cycles. Detailed description of this filter is presented in Appendix A. We defined our medium term cycle to be between 8 and 30 years, and thus, used band pass filter analysis to capture data within the frequency from 32 to 120 quarters. The Christiano and Fitzgerald (2003) band pass filter uses Fourier integration and a random walk assumption to smoothen the data and generate a cyclical, detrended component. Then, we cumulated the obtained filtered growth rates, and in this way determined individual cycles for each of the three variables by country. Finally, we aggregated these cycles to form a composite financial cycle measure by taking an arithmetic average of the three cycles, which is in line with Drehmann et al. (2012). In order to ensure comparability of the data and allow it to be aggregated arithmetically, we normalised all cycles with respect to the first quarter of 2000.

As quarterly data from 1999 to 2016 provides few observations per country (maximum 72), for the robustness checks we also obtained interpolated weekly financial cycles in this way increasing the number of observations of CIP violations that can be used in the regressions. We repetitively reported each quarterly observation of financial cycle variables 13 times (13 weeks in quarter) and applied a random walk Christiano and Fitzgerald (2003) band pass filter which effectively interpolated the quarterly data into weekly. Then, similarly, to quarterly cycles, we cumulated the filtered growth rates and estimated aggregated weekly financial cycles for each country. Despite the larger number of observations, macroeconomic changes occur gradually and in longer term. Hence, the obtained high frequency data should be interpreted cautiously as these variables are not observable in the real economy, and we only use these cycles as a robustness check.

3.2.2 Hodrick and Prescott (1997) filter

In addition to the band pass filter developed by Christiano and Fitzgerald (2003), we also used Hodrick and Prescott (1997) (HP) filter for the other robustness checks. Originally, HP frequency based filter was used to smoothen quarterly data by isolating fluctuations of business cycle frequency. General formula for Hodrick and Prescott filter is provided in Appendix A. The filtering frequency in this filter is set using a smooth parameter lambda which determines the extent to which the data is smoothened. The suggested smooth parameter lambda for business cycle is 1600 and the business cycle frequency is from 8 to 32 quarters while the financial cycle frequency is four times smaller (32 to 120 quarters) (Hodrick & Prescott, 1997). As we also used quarterly data, we did not need to adjust the lambda parameter for different periodicity but we had to account for a change from business cycle to financial cycle frequency.

In order to determine the lambda parameter, Ravn and Uhlig (2002) suggested an adjustment formula $1600q^4$, where q stands for a number of observations per quarter. It adjusts the parameter in a way that higher frequency data (usually monthly or weekly) can be used, but the time series is still smoothened at the same periodicity as the quarterly data. Therefore, as we also intended to lower the frequency and increase the smoothening, we used the Ravn and Uhlig (2002) formula and the smoothening parameter of $1600\times4^4 = 409600$, which effectively allowed us to 4 times reduce the frequency and isolate medium-term financial cycle fluctuations.

Kaiser et al. (1999) noted that HP filter is imprecise at both period ends, and suggested possible adjustments using forecasts. Therefore, we applied an autoregressive integrated moving average (ARIMA) model in order to obtain data on financial cycle variables for additional 12 quarters. In this way we intended to improve the HP filtered cycles. ARIMA model estimates the current value using past values of the variable or its differences (if non-stationary) and past estimation errors calculated as the difference between the actual and estimated value. Therefore, the model requires the following specification: number of lagged values used (noted as p), order of integration (noted as d), and number of past estimation errors used (noted as q). We used Akaike information criteria to choose the best ARIMA model specification for each variable by altering the p and q values from 0 to 3.

3.3. Model for testing relation between CIP violations and financial cycle

Finally, we determined the relationship between the financial cycle and the deviations from CIP accounted for transaction costs.

3.3.1 Vector Autoregressive (VAR) Model

As it is not intuitive which variable is the exogenous and which is the endogenous, the Vector Autoregressive Model (VAR) was chosen, which allows both variables to be treated as endogenous (Johnston & DiNardo, 1997). First of all, VAR requires data to be integrated to I(0) degree of integration meaning that the variables should be stationary in levels. If the data is not stationary, the two variables with an upward or downward trend will yield significant results, although, the regression is spurious. Therefore, we applied Dickey-Fuller tests to check the stationarity of the deviations from CIP. As the financial cycle was already detrended using filters, it only contains cyclical component. Augmented Dickey-Fuller test is a unit-root test, which has a null hypothesis that the series is non-stationary. If one can reject the null hypothesis, the series is assumed to be stationary in levels (the mean is constant). Furthermore, as VAR is an autoregressive model including a set of lagged variables, the appropriate number of lags had to be chosen, for which we used Akaike information criteria (AIC) (Johnston & DiNardo, 1997).

High frequency data of deviations from CIP is less comparable with the quarterly data of financial cycle measures. Therefore, in addition to nominal quarterly observations of CIP violations we also used variables derived from weekly CIP violations. For our regressions we determined four CIP variables accounted for transaction costs on quarterly basis: [1] nominal CIP violations measured quarterly, [2] average of weekly CIP violations over a quarter (13 weeks) measured by taking arithmetic average of 6 lagged, the current, and 6 lead observations; and [3] cumulated covered carry trade return over a quarter measured by cumulating 6 lagged, the current, and 6 lead values of weekly deviations from CIP to test *hypothesis 1*; and [4] CIP violations volatility over a quarter measured by standard deviation in a sample of 6 lagged, the current and 6 lead values of weekly deviations from CIP to test *hypothesis 2*. Then, we linked these CIP violations variables with the aggregated domestic and foreign financial cycles measured in first difference using the following VAR(p) models, where *p* stands for the number of lags:

$$\begin{cases} Dev_t = \beta_{2,0} + \beta_{2,1}Dev_{t-1} + \beta_{2,2}FC_{t-1}^D + \cdots + \beta_{2,2p-1}Dev_{t-p} + \beta_{2,2p}FC_{t-p}^D + \varepsilon_t^{Dev} \\ FC_t^D = \beta_{1,0} + \beta_{1,1}FC_{t-1}^D + \beta_{1,2}Dev_{t-1} + \cdots + \beta_{1,2p-1}FC_{t-p}^D + \beta_{1,2p}Dev_{t-p} + \varepsilon_t^{FC^D} \end{cases} \quad (7)$$

$$\begin{cases} Dev_t = \beta_{2,0} + \beta_{2,1}Dev_{t-1} + \beta_{2,2}FC_{t-1}^F + \cdots + \beta_{2,2p-1}Dev_{t-p} + \beta_{2,2p}FC_{t-p}^F + \varepsilon_t^{Dev} \\ FC_t^F = \beta_{1,0} + \beta_{1,1}FC_{t-1}^F + \beta_{1,2}Dev_{t-1} + \cdots + \beta_{1,2p-1}FC_{t-p}^F + \beta_{1,2p}Dev_{t-p} + \varepsilon_t^{FC^F} \end{cases} \quad (8)$$

$$\begin{cases} Vol_t = \beta_{2,0} + \beta_{2,1}Vol_{t-1} + \beta_{2,2}FC_{t-1}^D + \cdots + \beta_{2,2p-1}Vol_{t-p} + \beta_{2,2p}FC_{t-p}^D + \varepsilon_t^{Vol} \\ FC_t^D = \beta_{1,0} + \beta_{1,1}FC_{t-1}^D + \beta_{1,2}Vol_{t-1} + \cdots + \beta_{1,2p-1}FC_{t-p}^D + \beta_{1,2p}Vol_{t-p} + \varepsilon_t^{FC^D} \end{cases} \quad (9)$$

$$\begin{cases} Vol_t = \beta_{2,0} + \beta_{2,1}Vol_{t-1} + \beta_{2,2}FC_{t-1}^F + \cdots + \beta_{2,2p-1}Vol_{t-p} + \beta_{2,2p}FC_{t-p}^F + \varepsilon_t^{Vol} \\ FC_t^F = \beta_{1,0} + \beta_{1,1}FC_{t-1}^F + \beta_{1,2}Vol_{t-1} + \cdots + \beta_{1,2p-1}FC_{t-p}^F + \beta_{1,2p}Vol_{t-p} + \varepsilon_t^{FC^F} \end{cases} \quad (10)$$

In the Eq. 7 – 10, FC_t^D and FC_t^F denote the growth of an aggregated domestic and foreign financial cycle measures, respectively, observed at time *t*; Dev_t denotes deviations from CIP observed at time *t*; Vol_t denotes volatility of deviations from CIP observed at time *t*; and ε_t^X is the residual value at time *t* of each model *x*.

Eq. 7 and Eq. 8 were used in models testing *hypothesis 1*, and Eq. 9 and Eq. 10 were used in models testing *hypothesis 2*. The conducted robustness checks were testing *hypothesis 1* and followed the form of Eq. 7 and Eq. 8.

We note that we did not include common explanations for the CIP violations as control variables. First of all, the financial cycle is meant to capture an aggregated effect of these factors and in this way explain CIP violations. Secondly, factors such as credit risk, funding liquidity, and market uncertainty are directly related with the financial cycle, and thus would not be exogenous and lead to multicollinearity.

3.3.2. Granger causality

Direct interpretation of VAR model coefficients of lagged values is difficult and in most cases of limited use due to contradicting findings, for instance when different lags of the same variable have opposite signs. Therefore, we used Granger causality and impulse response functions (IRFs) to interpret the causal effects. Granger causality tests estimate whether all lagged coefficients of an independent variable are jointly non-zero, and thus "Granger causes" the dependent variable. The null hypothesis is that the independent variable does not "Granger-cause" the dependent variable. The null hypothesis is rejected when Chi^2 statistics exceeds the threshold value of a selected significance level: 5%, 1% and 0.1%. The p-value of Granger causality test denotes the probability for the Chi^2 statistics to be higher than the estimated, and thus can be used to interpret the significance level at which an independent variable "Granger causes" the dependent variable. If the null hypothesis cannot be rejected, then the independent variable does not "Granger-cause" the dependent variable (Johnston & DiNardo, 1997).

3.3.3 Impulse response functions

The main limitation of the Granger causality test is that it does not provide information on how the variables are linked, namely, positively or negatively. Therefore, for that we applied impulse response functions. An impulse response function estimates an exogenous effect of an impulse variable to a response variable over time by aggregating the obtained VAR model coefficients (Green, 1997). We specified our IRFs using commonly applied specification of one standard deviation shock over a period length of 8 steps, which in our case corresponds to 8 quarters. We estimated the IRFs within a 95% confidence interval and used the obtained IRF shapes for the interpretation of the relationship between the CIP violations and the growth of financial cycle.

4. Data description

Data can be divided into two parts: cross country data on exchange rates and interest rates for obtaining CIP violations, and country level data for the determination of the financial cycle. The choice of countries used in this research is based on data availability as well as on how well the countries satisfy the underlying assumptions behind CIP: low credit risk, high liquidity of risk free assets that ensures perfect substitutability.

Taking into account these criteria, the following currencies were selected for testing against the Euro: the Norwegian Krone (NOK), the Swedish Krone (SEK), the Danish Krone (DKK), the Swiss Franc (CHF), the Canadian Dollar (CAD), the Australian Dollar (AUD), and the New Zealand Dollar (NZD). These currencies are commonly used in other studies to form currency pairs (Fletcher & Taylor, 1994; Cho, 2015; Linnemann & Schabert, 2015; Liao, 2016; Borio et al., 2016).

Even though the USD is more commonly used in the academic literature, we chose the euro as an anchor currency as it is less affected by the exogenous effects. More than 80% of all international trade is carried out using the USD, including the oil trade. (Auboin, 2012). This, naturally, creates additional factors affecting the demand and supply of USD, and thus influences its exchange rate. The adverse effects of USD exchange rate may not allow us to capture the actual relationship between the financial cycle and CIP violations. Although the euro is also one of the major currencies of international trade, unlike USD, it is used by the Eurozone itself to much greater extent, which limits the exogenous effects.

4.1. Covered interest rate parity

For obtaining CIP short term violations we gathered 1m, 3m, 6m, and 12m interbank rates, bid/ask and last spot rates, as well as bid/ask and last quotes on 1m, 3m, 6m, 12m forward rates expressed in forward points.

We used interbank rates instead of usually used government bond yields that are more accessible to general investors because of several reasons. Firstly, CIP violations are low. In order to exploit the profit opportunities substantial capital is required which is only available to very large financial institutions and banks. This point is also evident from the research by Borio et al. (2016) which finds that upon the imposition of tighter restrictions on banks after the financial crisis of 2008, less arbitrage opportunities were exploited and they were allowed to persist, meaning that banks are one of the main parties in these investments. Secondly, as CIP relies on cross country interest differential, which can be obtained from the interbank rates without causing significant bias. Lastly, the interbank data is more widely available and is more comparable across countries.

Necessary data with weekly frequency was obtained from Bloomberg Terminal (Appendix B). It is also important to note that we took the reciprocal of spot and forward rates so they are expressed as euros per one unit of foreign currency to proceed with further analysis as Eurozone is considered as a domestic market.

4.2. Data for financial cycle construction

As financial cycles tend to have periodicity of 16 years on average, long time span of data is required to determine the individual cycles for Eurozone and each non-Eurozone country. In addition, filtered data is less precise at the both ends of filtered period and detrending short timespan data of financial cycle variables may not properly capture the cyclical component. Therefore, filtering data over long timespan improves the precision (Baxter, & King, 1999; Christiano & Fitzgerald, 2003).

In line with previous literature, quarterly data of credit to non-financial institutions, credit to GDP ratio, and residential property prices were used of the 7 advanced and open economies from 1977 Q1 to 2016 Q3 (Drehmann et al, 2012). Due to the fact that Eurozone was established in 1999, aggregated data to construct Eurozone financial cycle is available only for the timespan starting from 1999Q1 (Appendix C).

In addition to the three variables used in financial cycle determination, we also gathered Consumer Price Index (CPI) data which is required to adjust financial cycles for inflation. Quarterly data for these variables was collected from Bank of International Settlements using Thomson Reuters Datastream.

5. *Results*

5.1. CIP violations

Firstly, we tested the general CIP model of the Euro against a sample of seven advanced economies: Norway, Sweden, Denmark, Switzerland, Canada, Australia, and New Zealand. Initially we disregarded the transaction costs and only examined whether in the CIP holds in the long run in our sample as explained in methodology section (Eq.5)

According to the null hypothesis, when CIP holds, intercept should be equal to zero and the coefficient of the interest differential equal to one. We found violations to be the largest when engaging into one year contracts and the lowest when using the three month contracts. The Newey-West regression results for 12 month contracts are summarised in Table 2. Results for 1, 3 and 6 month contracts are reported in Appendix D.

Table 2. Newey-West regression results with 12 month contracts.

	β_0	β_1	R^2	Total observations
Norway (12m)	.0000961	.9497141***	0.9750	781
Sweden (12m)	-.0001721	1.052707***	0.9053	735
Denmark (12m)	.0008305**	.5899489***	0.5067	936
Switzerland (12m)	.0003911	.9225935***	0.8405	935
Canada (12m)	-.0047927***	.6743115***	0.7489	747
Australia (12m)	.0009452**	1.014459***	0.9525	747
New Zealand (12m)	-.0077054***	.6976449***	0.2896	500

*, **, and *** denote 5%, 1% and 0.1% significance level, respectively. Appropriate lag operator is chosen using Stock-Watson (2007) truncation parameter m=0.75T^(1/3)

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Even though some of the β_0 coefficients are statistically significant even at 0.1% significance level, the coefficients are approaching zero. Therefore, the null hypothesis cannot be rejected in all sample countries. Moreover, β_1 coefficient is close to one in Norway, Sweden, Switzerland, and Australia providing positive evidence that CIP holds well in these markets. R-squared for these countries was also found to be very high: 0.975 for Norway, 0.905 for Sweden, and 0.953 for Australia. The opposite can be observed in the regressions for Denmark, Canada, and New Zealand where the coefficients highly deviate from the null hypothesis and the explanatory power of regressions is significantly lower. Denmark was found to have β_1 coefficient of 0.59, Canada – 0.67, and New Zealand – 0.70.

The data is highly sensitive to individual outliers as they might highly affect the estimated slope and R-squared of these regressions. As a result, the null hypothesis of CIP cannot be strongly rejected. However, the weak explanatory power of the interest differential provides strong positive evidence that there are some significant deviations from CIP during the period analysed.

To obtain CIP violations used in further regressions, we subtracted the interest differential from the forward premium, as it was noted in the methodology section (Eq. 5). Table 3 summarises the obtained CIP violations with transaction costs.

Table 3. Descriptive statistics of CIP violations.

	No. of obs.	Mean (%)	St. deviation (%)	Min (%)	Max (%)
EUR/NOK	777	.04647	.08193	-.48747	.35446
EUR/SEK	735	-.03393	.14437	-.72003	.44412
EUR/DKK	932	.16201	.20681	-.18148	1.3772
EUR/CHF	935	-.04373	.1561	-1.03573	.20184
EUR/CAD	747	-.40202	.48565	-2.83683	.03798
EUR/AUD	746	.01556	.15348	-.80794	1.76084
EUR/NZD	500	.01605	.59046	-1.91194	8.41261

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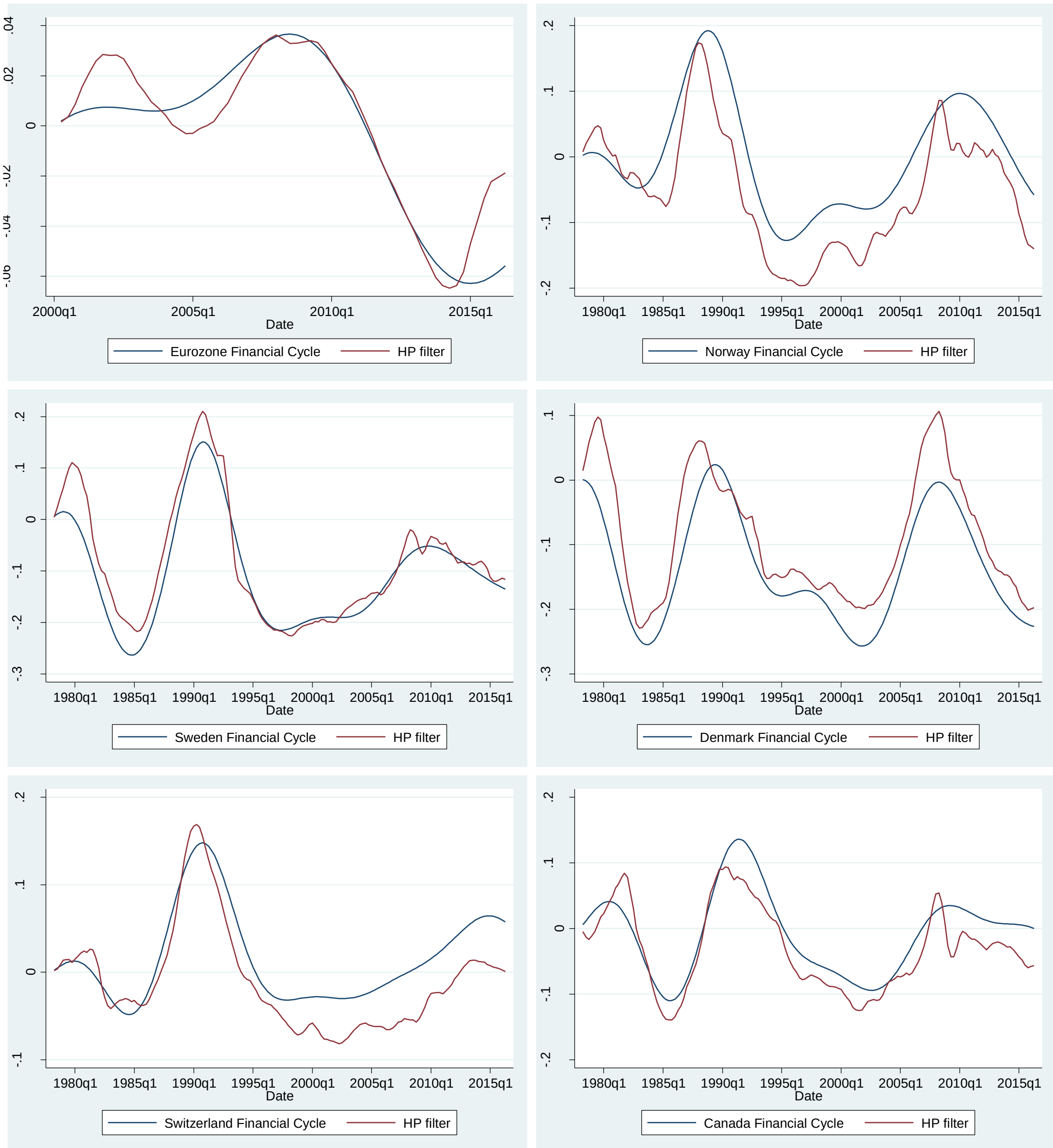
CIP violations can be interpreted as follows: 1% annualised deviation from CIP means that exchange rate fixed at prevailing forward rate undercompensates for the current interest differential by 1%; thus borrowing domestically and depositing abroad would yield a profit of 1% in one year. Looking at the mean, the most severe violations were found for the EUR/CAD exchange rate, where the average violations were 0.47% on average, the smallest violations of 0.03% were observed for EUR/SEK exchange rate. EUR/CAD exchange rate also had the highest volatility (St. dev = 0.52%), while the lowest volatility of 0.17% was for the EUR/NOK rate. It is important to note that EUR/NOK, EUR/DKK, EUR/AUD, and EUR/NZD have on average positive violations, meaning that it is more often profitable to borrow the Euro and deposit in the foreign markets. However, EUR/SEK, EUR/CHF, and EUR/CAD have mostly negative violations which means that it is more often profitable to borrow at the foreign market and deposit at the Eurozone rates. Graphic representations of deviations from CIP across countries over time are provided in Appendix E.

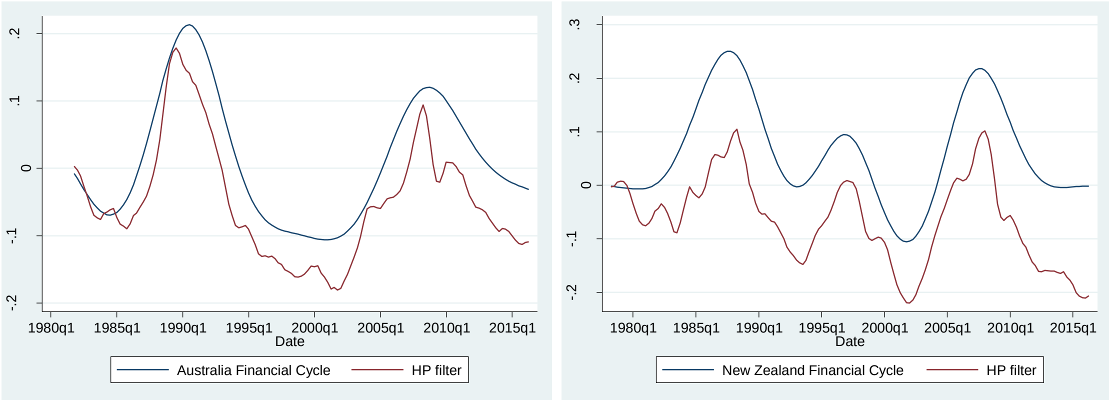
5.2. Financial cycle

The next step involved construction of the financial cycles using the Christiano and Fitzgerald (2003) band pass filter to separate the cyclical component of the financial cycles for frequencies between 32 and 120 quarters or 416 an 1560 weeks. Following variables were used: residential real estate prices, credit to non-financial institutions, and credit to GDP ratios

The band pass filter of Christiano and Fitzgerald (2003) assumes that the input values are non-stationary. As a result, we tested the stationarity of these variables using augmented Dickey-Fuller test and adjusted the filtering methods respectively. Results of stationarity tests are reported in Appendix F. Obtained financial cycles are presented in Figure 3.

Figure 3. Graphic representation of quarterly financial cycles across countries using Christiano and Fitzgerald (2003) filter and Hodrick and Prescott (1997) HP filter.





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As the financial cycles are cumulated growth rates from zero at the start year, the y-axis values indicate the accumulated change from the starting date. As the cycles start at different dates, the nominal values of the financial cycles do not provide a basis for meaningful interpretation. Therefore, they are only used in the regressions to establish a link or to analyse the amplitude of fluctuations.

Nevertheless, certain patterns can be observed by analysing the shapes of obtained financial cycles. Countries have seemingly independent financial cycles; however, for countries with long time series, there are two prominent booms: around 1990 and 2008 with lower amplitude intermediate fluctuations between these dates. The boom and the following recession in 2008 is common to all countries. The important difference is the range of financial cycles, which can be observed in minimum and maximum values during the period analysed: Eurozone and Switzerland seem to have lower fluctuations while Sweden, Denmark and Australia have the highest amplitude of fluctuations.

In addition to the quarterly cycles, we also obtained weekly cycles using interpolation. These weekly cycles were necessary for weekly regressions in the robustness checks where more observations of CIP violations were used. As the interpolation was conducted at the initial steps of the financial cycle determination, it is necessary to test whether the filtered and cumulated values of weekly cycles correspond the quarterly ones. In line with our expectations, the obtained weekly cycles resemble well the quarterly ones and thus are suitable for further regressions. Descriptive statistics of all financial cycles is provided in Appendix G. In addition, weekly financial cycles together with CIP violations are presented in Appendix E.

Finally, for the robustness checks, we also obtained the alternative quarterly cycles using Hodrick and Prescott (1997) filter by smoothening the data to medium term frequencies. As noted in the methodology (3.2), we used ARIMA model to forecast data on financial cycle variables for 3 years in order to obtain a better approximation for the HP filter. ARIMA model specifications obtained by minimising AIC are reported in Appendix H. The HP financial cycles are presented in Figure 3 together with cycles obtained using Christiano and Fitzgerald (2003) band pass filter. It is important to note that cycles obtained using HP filter are not that smooth as the HP filter is high-pass filter.

5.3. VAR model

In this section we present results obtained from VAR model that was applied to investigate the relationship between CIP violations and the financial cycles. Firstly, augmented Dickey-Fuller test was used to examine whether the following variables are stationary: nominal deviations from CIP, average of weekly CIP violations over one quarter, cumulated profit of a carry trade over one quarter, and volatility of weekly CIP deviations over a quarter. The results of stationarity tests are summarised in Appendix F. We found that unit-root (null hypothesis of the stationarity test) could only be rejected for the volatility of CIP deviations at 5% significance level. Nevertheless, neither of the other quarterly or weekly variables were found to be stationary across the whole sample of countries.

Secondly, we determined the order of integration for non-stationary variables. Our results show that all of them are integrated to the first order; thus, the first difference is stationary. To ensure accurate estimation of regression coefficients, we used first difference of non-stationary CIP variables and the growth of domestic and foreign financial cycles in VAR model.

In all the other VAR models, we regressed nominal values of stationary CIP variables with the growth of financial cycle where the number of lags was chosen using AIC. In most cases we found that the value of AIC is minimized when 3 lagged values are included. Lags higher than three were excluded as too high number of them may affect the representativeness of the model.

Regression results of VAR model with three lags of nominal CIP violations and the growth of financial cycle are presented in Table 4, where *Dom Fin Cycle* refers to domestic or Eurozone financial cycle; *For Fin Cycle* - to foreign financial cycle; and *CIP Violation* - to the abnormal return from borrowing domestically (abroad) and investing abroad (domestically) when the value of CIP is positive (negative). In Table 4, R-squared notes the goodness of the model's fit; Granger causality results indicate p-values of a test that the impulse variable "Granger-causes" the response variable; IRF slope indicates the shock effect of a one standard deviation increase in an impulse variable on a response variable. *Upward* slope of an IRF can be interpreted as a direct (positive) effect; *Downward* as an inverse (negative) effect; *(fl)* or *flat* indicates that the effect is not continuously increasing, but rather constant over the first steps; *Down/Upward* or *Up/Downward* indicates that the initial shock is short term and after initially causing a direct or opposite effect the later steps are insignificant; *Insignificant* shows that the zero value is within 95% confidence interval, and thus the shock effect cannot be rejected to be non-zero.

Table 4. VAR model results using quarterly CIP violations with transaction costs.

Currency	**Response Variable**	**Impulse Variable**	**VAR Model R-squared**	**Granger P > Chi²**	**IRF slope (step 8)**
EUR/NOK	CIP Violation	Δ(Dom Fin Cycle)	0.2973	0.227	Insignificant
	Δ(Dom Fin Cycle)	CIP Violation	1.0000	0.000	Upward
	CIP Violation	Δ(For Fin Cycle)	0.4252	0.024	Upward (fl)
	Δ(For Fin Cycle)	CIP Violation	1.0000	0.066	Upward
EUR/SEK	CIP Violation	Δ(Dom Fin Cycle)	0.6215	0.025	Upward
	Δ(Dom Fin Cycle)	CIP Violation	1.0000	0.026	Upward
	CIP Violation	Δ(For Fin Cycle)	0.5784	0.288	Insignificant
	Δ(For Fin Cycle)	CIP Violation	1.0000	0.000	Upward
EUR/DKK	CIP Violation	Δ(Dom Fin Cycle)	0.5288	0.019	Downward (fl)
	Δ(Dom Fin Cycle)	CIP Violation	1.0000	0.000	Upward
	CIP Violation	Δ(For Fin Cycle)	0.5104	0.065	Downward
	Δ(For Fin Cycle)	CIP Violation	1.0000	0.310	Insignificant
EUR/CHF	CIP Violation	Δ(Dom Fin Cycle)	0.6474	0.063	Insignificant
	Δ(Dom Fin Cycle)	CIP Violation	1.0000	0.098	Upward
	CIP Violation	Δ(For Fin Cycle)	0.6239	0.276	Insignificant
	Δ(For Fin Cycle)	CIP Violation	1.0000	0.135	Upward
EUR/CAD	**Δ(CIP Violation)**	Δ(Dom Fin Cycle)	0.0795	0.571	Insignificant
	Δ(Dom Fin Cycle)	**Δ(CIP Violation)**	1.0000	0.642	Insignificant
	Δ(CIP Violation)	Δ(For Fin Cycle)	0.0707	0.626	Insignificant
	Δ(For Fin Cycle)	**Δ(CIP Violation)**	1.0000	0.941	Insignificant
EUR/AUD	CIP Violation	Δ(Dom Fin Cycle)	0.5430	0.065	Insignificant
	Δ(Dom Fin Cycle)	CIP Violation	1.0000	0.784	Insignificant
	CIP Violation	Δ(For Fin Cycle)	0.5170	0.114	Insignificant
	Δ(For Fin Cycle)	CIP Violation	1.0000	0.016	Upward
EUR/NZD	CIP Violation	Δ(Dom Fin Cycle)	0.7482	0.009	Insignificant
	Δ(Dom Fin Cycle)	CIP Violation	1.0000	0.008	Insignificant
	CIP Violation	Δ(For Fin Cycle)	0.7475	0.010	Insignificant
	Δ(For Fin Cycle)	CIP Violation	1.0000	0.071	Insignificant

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Results suggest that the effect is highly country specific when nominal deviations from CIP and growth of financial cycle are tested as endogenous variables.

R-squared values of the VAR model are ranging from 0.08 in EUR/CAD rate, when the growth of CIP violations was tested, to 0.75 in EUR/NZD rate. All regressions, where the financial cycle was used as the dependent variable, yield R-squared values of 1.000. It is due to the filter used to obtain this series as the lagged values of financial cycle are highly significant in predicting current financial cycle. As a result of this issue, the reverse causality regressions (where the financial cycle is a response variable) should be interpreted with scrutiny. This situation is further addressed in robustness checks using alternative HP filter and higher order of VAR model lags.

Granger causality probability values vary between 0.000 where causal effect is significant at 0.1% significance level and 0.784 where causal effect is insignificant. It is important to note that some of the reverse causality effects were found to be significant at 5% significance level. In this case, CIP violation shocks have a significant causal effect on the financial cycle for following currency pairs: EUR/NOK, EUR/SEK, EUR/DKK, EUR/CHF, and EUR/AUD rates. Although the reverse causality effect seems counterintuitive, it only means that the changes in CIP violations occurred prior to significant changes in the financial cycle as the direction of causality tests use VAR model lagged values.

We used IRFs to compare findings across countries as they provide useful interpretation not only about the direction of causality, but also estimate whether the effect is direct or opposite. Twelve out of 28 IRF pairs indicated significant causal effects Domestic or Eurozone financial cycle growth was found to be a significant impulse variable causing CIP violations in EUR/SEK and EUR/DKK rates. Foreign financial cycle growth was found to be a significant determinant of CIP violations in EUR/NOK and EUR/DKK exchange rates. The effect for EUR/DKK was found to be negative in both cases

Considering the reverse causality, CIP violations are significant impulse variables causing changes in the growth of domestic financial cycle for EUR/NOK, EUR/SEK, EUR/DKK and EUR/CHF. They all have positive sign or upward sloping IRFs. CIP violations are also significant impulse variables causing changes in the growth of foreign financial cycle for EUR/NOK, EUR/SEK, EUR/CHF, and EUR/AUD rates, which all have upward sloping IRFs. We found that the reverse causality is significant in more countries than the direct causality. It indicates that significant CIP violations occur prior to significant changes in the growth of financial cycle.

In sum, we found sufficient evidence to accept *hypothesis 1*: there is a significant relationship between the financial cycle growth and CIP violations; however, the effect depends on each country.

We also used average of weekly CIP violations and cumulated profit from weekly investments in carry trade to test *hypothesis 1* and volatility of CIP violations to test *hypothesis 2*. Detailed findings of these models are reported in Appendix I. When *hypothesis 1* was tested, both average CIP violations and the cumulated profit models had higher R-squared values. Most of the results are in line with the findings obtained from the nominal CIP violations model. In addition, EUR/SEK and EUR/DKK average and cumulative variables of CIP violations are non-stationary in levels in contrast to the nominal CIP violations model. Therefore, the regressions were conducted with first differences resulting in lower R-squared values for these exchange rates. Overall, we found sufficient evidence from the two other models testing *hypothesis 1* to accept that the relationship between CIP violations and the financial cycle is significant.

Regarding *hypothesis 2*, R-squared values in the model with volatility of CIP violations are lower than in the nominal CIP model as they fluctuate from 0.12 in EUR/NZD rate to 0.47 in EUR/NOK rate. In this case all variables are stationary, therefore, the first differences were not used in the regressions with CIP violations volatility.

We found that growth of domestic financial cycle is a significant impulse variable that negatively affects the volatility of CIP violations in EUR/SEK, EUR/DKK, EUR/CHF, EUR/CAD and EUR/AUD exchange rates. Moreover, the results suggest that volatility of CIP violations is also significantly affected by foreign financial cycle as an impulse variable for EUR/CHF and EUR/AUD rates, where EUR/CHF has upward sloping and EUR/AUD downward sloping IRFs. From the reverse causality results, we also found evidence that volatility of CIP violations is positively affecting the domestic financial cycle growth for EUR/NOK and EUR/DKK rates. Two exchange rates were also found to be significant for the foreign financial cycle, where EUR/SEK and EUR/NZD CIP violations are causing the changes in cycle growth. The effect is negative for the former and positive for the latter.

Although some of the findings are in line with *hypothesis 2*, there is also strong support for the *alternative hypothesis 2*, that the relationship is inverse and an increase in volatility of CIP violations is associated with a slowdown of the financial cycle growth. All findings and respective hypotheses are summarised in Table 5 where *R* in brackets denotes reverse causality.

Table 5. Summary of accepted and rejected hypotheses across models.

Hypothesis	**Nominal CIP violations** (*Hypothesis 1*)	**Average CIP violations** (*Hypothesis 1*)	**Cumulated carry trade profit** (*Hypothesis 1*)	**Volatility of CIP violations** *(Hypothesis 2)*
Domestic Financial Cycle				
Accepted	EUR/NOK(R), EUR/SEK, EUR/DKK, EUR/CHF(R)	EUR/NOK(R), EUR/SEK(R), EUR/CHF	EUR/NOK(R), EUR/SEK(R), EUR/CHF(R)	EUR/NOK(R), EUR/DKK(R)
Alternative (opposite) accepted				EUR/SEK, EUR/DKK, EUR/CHF, EUR/CAD, EUR/AUD
Rejected	EUR/CAD, EUR/AUD, EUR/NZD	EUR/DKK, EUR/CAD, EUR/AUD, EUR/NZD	EUR/DKK, EUR/CAD, EUR/AUD, EUR/NZD	EUR/NZD
Foreign Financial Cycle				
Accepted	EUR/NOK, EUR/SEK(R), EUR/DKK, EUR/CHF(R), EUR/AUD(R)	EUR/NOK, EUR/CHF, EUR/AUD(R)	EUR/NOK, EUR/CHF, EUR/AUD(R)	EUR/CHF, EUR/NZD(R)
Alternative (opposite) accepted				EUR/SEK(R), EUR/AUD
Rejected	EUR/CAD, EUR/NZD	EUR/SEK, EUR/DKK, EUR/CAD, EUR/NZD	EUR/SEK, EUR/DKK, EUR/CAD, EUR/NZD	EUR/NOK, EUR/DKK, EUR/CAD

(Created by authors)

In Table 5, we clearly reject *hypothesis 1* for EUR/CAD and EUR/NZD rates while it is approved for the remaining sample currency pairs: EUR/SEK, EUR/DKK, EUR/NOK, EUR/CHF and EUR/AUD. Furthermore, regarding *hypothesis 2*, all exchange rates have significant relationships with the volatility of domestic or foreign financial cycles except for the EUR/DKK findings that are contradicting and assumed inconclusive. Although we found some positive evidence to accept the hypothesis, the alternative for *hypothesis 2* is accepted in more cases, meaning that increase in volatility of CIP violations is associated with a decrease in growth of financial cycle.

If the reverse causality findings were disregarded, less exchange rates would exhibit significant results. Hence, there would be less of positive evidence that our hypotheses hold. Nevertheless, financial cycle was found to be a significant determinant of CIP violations for at least two exchange rates in every direct causality model. Therefore, regardless of the treatment of reverse causality findings, the results suggest that there is strong evidence that the CIP violations are significantly related with the financial cycle.

6. Discussion of results

In summary, we found strong positive evidence in favour of our *hypothesis 1*, that there is a statistically significant link between the financial cycle and CIP violations; as well as strong evidence to accept the alternative of *hypothesis 2*, suggesting that the volatility of CIP violations is inversely related with the financial cycle. The findings regarding *hypothesis 2* contradict our initial expectations. In addition, there is no clear pattern whether the domestic (Eurozone) or the foreign financial cycles tend to be more significant in explaining CIP violations for the sample of exchange rates.

6.1. Market frictions and financial cycle

The rejection of *hypothesis 2* can be explained using economic reasoning. The market frictions, which lead to increased volatility, only occur when the rapid growth of the financial cycle starts to slow down, and continue throughout the transition stage until the economy turns into recession.

Although there was no research testing the relationship between the financial cycle and CIP violations directly, our findings are closely related to the research on CIP violations and market frictions. We argue that market frictions are directly related and captured by the financial cycle. According to Cornett et al. (2011) and Linnemann and Schabert (2015), recessions are associated with higher credit risk, lower liquidity and market uncertainty, which are one of the main factors leading to CIP violations (Aliber, 1973; Brunnermeier et al. 2008; Cho, 2015; Fong et al., 2010; Skinner and Mason, 2011). In addition, periods of turbulence are associated with lower funding liquidity, meaning that it is highly likely that large capital necessary to exploit relatively small CIP arbitrage opportunities is unavailable at the time, and thus short-term deviations are more prone to persist (Brunnermeier, 2009; Brunnermeier & Pedersen, 2009; Rösch & Kaserer, 2014; Baba & Packer, 2009).

Our results are in line with the findings stated above as the financial cycle is significantly related with the CIP deviations. Since the start of transition stage and during the recession stage we observe higher volatility of these deviations in most of the sample countries. On the other hand, it was unexpected to find highly country and exchange rate specific effects which not only differ by their significance, but also by their direction. In the following subsection we propose several possible reasons for such findings and in this way provide directions for further research in this area.

6.2. Possible explanations

We search for possible explanations for the unique results of each analysed exchange rate from two perspectives: differences in currency regimes from the monetary policy and differences in trade patterns from the macroeconomic perspective.

From the analysed seven exchange rates, EUR/NOK, EUR/SEK, EUR/CAD, and EUR/AUD rates are freely floating during our sample period while EUR/DKK, EUR/CHF, and EUR/NZD have different arrangements (International Monetary Fund, 2014). Neither of these currencies has any foreign exchange trading restrictions. EUR/DKK is described to a have a conventional peg since the introduction of the euro, which means that the amplitude within which the exchange rate is allowed to float is managed; EUR/CHF had had pegged rate to the Euro with 2% allowed fluctuations until 2015 when it was allowed to float; and EUR/NZD has a floating exchange rate with monetary policy intervention and inflation targeting (International Monetary Fund, 2014). In our sample, no common pattern can be established from the results when comparing the findings across countries grouped by the exchange rate regime. Therefore, although exchange rate regime may explain some of the differences, the effect is not directly observable in our rather small sample and is worth further investigation.

In addition to currency regimes, a possible explanation for cross country differences could be different trade patterns and the extent to which sample countries are dependent on the trade with the Eurozone. When the trade between the two countries is limited, domestic and foreign financial cycles may be less related. In addition, the exchange rate itself may be less frequently used and might have lower liquidity due to the lack of trade. Thus, there might bigger constraints to directly exploit the profit opportunities. We determined the trade patterns between the Eurozone and the seven analysed countries using monthly trade data from the OECD Statistics Database (OECD, 2017).

Naturally, the strongest trade links are between the European countries as more than 40% of Norwegian, Swedish, and Swiss and more than 30% of Danish trade (export plus imports) is with the Eurozone while the Eurozone constitutes less than 25% of New Zealander and less than 10% of Canadian and Australian trade. Our findings are in favour of the difference in trade patterns explanation, as in most cases EUR/CAD, EUR/AUD and EUR/NZD findings are less significant than results of other currencies. On the other, hand EUR/AUD rate was found to be more significant that the EUR/NZD rate while the latter has much greater exposure to the Eurozone. Therefore, this theory also requires further investigation and it serves as one of the potential directions to expand this research.

6.3. Robustness checks

Although we have provided possible explanations for our results it is also important to test how robust and how sensitive are these findings to model adjustments. In order to do so, we altered the original model using nominal CIP violations with transaction costs and performed four tests: [1] replaced 12 month CIP violations with 6 month ones; [2] re-filter financial cycle data using HP frequency based filter; [3] ran quarterly regressions with nominal CIP violations using VAR model with 9 lags; and [4] ran weekly regressions with interpolated financial cycles. The results of robustness checks are reported in Appendix J.

The obtained CIP violations using 6 month contracts in comparison to CIP violations using 12 month contracts are much smaller, and thus we expect less significant relationship. On the other hand, this robustness check allows us to investigate to what extent our findings can be generalised with respect to duration of forward contracts and interest rates. As in this case the many observations of CIP violations were equal zero, the obtained R-squared values were lower than in the original model and fluctuate from 0.14 to 0.60. Findings for EUR/NOK, EUR/SEK, EUR/DKK, and EUR/CHF are significant and highly similar to the ones obtained in the model with 12 month contracts while EUR/AUD findings are even more significant. However, EUR/CAD and EUR/NZD results remain insignificant. There is sufficient evidence to accept the *hypothesis 1.* Nevertheless, the effect is country specific which is in line with the original findings.

Furthermore, we reconstructed domestic and foreign quarterly financial cycles using the alternative HP filter. From the graphical comparison of Christiano and Fitzgerald (2003) financial cycles with the Hodrick and Prescott (1997) filtered cycles, it is clear that overall shape as well as peaks and troughs correspond in both models. However, as HP filter eliminates only high frequency violations, the obtained financial cycle variables are more volatile. R-squared values are similar when Christiano and Fitzgeral (2003) and HP filtered models are used, but in the latter the obtained Granger causality Chi^2 values as well as significance of IRFs are lower. On the other hand, each exchange rate have at least one significant model with either the domestic or foreign financial cycle. Although it may seem that this test indicates that the results are highly sensitive to the filtering technique chosen, HP filter has its own limitations. It is shown to be less precise at the end periods and less efficient compared to the band pass filter (Christiano & Fitzgerald, 2003, Kaiser, 1999). Therefore, the recent studies focusing on the financial cycles use the latter one (Comin & Gertler, 2006; Drehmann et al., 2012; Stremmel, 2015). In summary, findings using the HP filter are slightly less robust but still support *hypothesis 1*.

In order to address the issue of high autocorrelation of the financial cycle variables in the reverse causality regressions, besides the HP filter, we also alter our VAR model to include up to 9 lags of each variable. In this setting, the R-squared values in most models are higher as well as the results of Granger causality test are more statistically significant. From the IRF analysis, we also find a significant link between the financial cycle and CIP violations of EUR/CAD, EUR/AUD, and EUR/NZD exchange rates. These exchange rates were also significant in the original model. On the other hand, we find lower significance in EUR/SEK, EUR/DKK, and EUR/CHF exchange rates, but the direct causality effect in all of these rates remains significant. In addition, the shape of IRF curves changes for EUR/NOK rate from continuously upward to short term downward effect. Overall, this model is in favour of *hypothesis 1.*

Considering the model with interpolated weekly financial cycles, the number of observations increased thirteen times (13 weeks per quarter). Obtained VAR model R-squared values were higher than in the original model due to higher significance of CIP violations lagged values. Findings for EUR/NOK, EUR/SEK, EUR/CHF, EUR/AUD, and EUR/NZD are in line with the quarterly model, but the direction of causality obtained from IRFs in most cases differs. In addition, EUR/CAD deviations from CIP were found to have no significant link with the domestic and foreign financial cycles which is also observed in the quarterly model. Overall, weekly regressions support the *hypothesis 1*.

In our robustness checks we addressed several issues regarding our model setup: variable chosen for the CIP violations, filtering method, lag order of the VAR model, and frequency of observations. Despite several misalignments with the findings from the original model, robustness checks support *hypothesis 1* that there is a significant link between the CIP violations and the financial cycle. In addition, robustness checks also confirm that the relationship is unique for each exchange rate and cycle.

6.4. Limitations

This paper has several limitations which might be addressed in future research: firstly, relatively short time span since the introduction of the Euro. The sample period between 1999 and 2016 limits the number of quarterly observations and the sample period captures the maximum of two financial cycle peaks. Secondly, we use band pass filters to obtain financial cycle measures which means that the obtained data is not directly observable in the real economy. Thus, the p-values of vector autoregressive model may be subject to higher errors depending on the filtering method. In addition, data for the Eurozone financial cycle is only available since 1999, which may affect the shape of the filtered cycle. Thirdly, smoothened financial cycle series also yield very high R-squared values in reverse causality model where the financial cycle is a response variable, which may lead to additional errors in the interpretation of these results. Finally, due to high probability of multicollinearity and adverse effects, we use only two variable VAR model without exogenous variables.

Furthermore, monetary policy and exchange rate regimes were not tested. Moreover, the hourly misalignments of the interest rate and exchange rate quoting times were not accounted for. Including these factors may explain the observed cross country differences better.

6.5. Implications of the findings

This paper has several implications. Firstly, the law of one price is one of the most fundamental laws in finance and economics. Numerous researches have investigated why it does not hold, and several explanations have been suggested. Our findings propose that the overall state in financial markets and economy captured by the fluctuations of financial cycle may explain why CIP violations persist. Hence, findings can be used by academic community to further explore failures of the law one price.

Secondly, our results might be valuable for arbitrage seekers. Relationship between financial cycle and CIP violations suggests that CIP deviations follow financial cycle pattern over the sample period. Therefore, in specific stages of financial cycle money market investors have a higher probability to gain profit. However, amplified market frictions may restrict access to financing.

Thirdly, due to increase of mispricing in financial markets that results in violations of CIP, cost of hedging might rise. Hence, relationship between financial cycles and CIP deviations might have implications for hedgers.

Lastly, the aim of monetary policy makers is to ensure financial stability. During financial crisis periods, turbulence in the markets significantly increases. The evidence show that CIP violations are the highest during turbulences in the markets. This might be a concern of monetary policy makers as there might be higher pressure for financial stability because higher mispricing in FOREX markets might lead to larger speculations as the investors are willing to eliminate arbitrage opportunities.

7. Conclusions

7.1. Conclusions

The aim of this paper was to identify the relationship between the deviations from covered interest parity and composite financial cycle measure using the Euro as an anchor currency for the sample period of 1999-2016.

Our results suggest that the link between CIP deviations and a composite financial cycle measure exists. Firstly, we find positive evidence that there is a significant relationship between the CIP violations and the growth of financial cycle for five currency pairs out of seven tested. Secondly, we find that the increase in volatility of CIP violations is associated with the increased growth of financial cycle for two currency pairs. In addition, our results show that for four currency pairs the increased volatility is associated with the decrease in either domestic or foreign financial cycle growth. One of the explanations of such relation is that the volatility only starts to increase when the growth of financial cycle decreases reaching the peak of financial cycle, and volatility remains relatively high during the recession. However, the results are unique for each sample exchange rate and are also not consistent across domestic and foreign financial cycles.

Our findings contribute to already existing literature in several ways. Firstly, we expand on explanatory capabilities of financial cycle as a macro variable. As the financial cycle theory came into prominence relatively recently, the research regarding in this area is rather limited. Secondly, we propose another explanation for CIP violations that accounts for overall changes in the financial market and the economy.

7.2. Suggestions for further research

Country specific findings note the importance of further cross country and individual exchange rate studies. For this, we propose conducting a detailed research on each currency pair taking into account prevailing monetary policy and currency regimes. These steps would increase the accuracy of country specific model. Moreover, it might provide additional insights into the actual channels through which financial cycle may affect the CIP violations. Furthermore, specific channels could also be used to alter the model to directly test the relationship between the CIP violations, the financial cycle, and specific variables through which the two are linked. This setup of the model could more precisely capture the direction of causality than the Granger causality and impulse response functions used in our research. In addition, analysis of alternative currency pairs by using other anchor currencies than the euro would estimate the extent to which these findings can be generalised. Moreover, it would provide additional insight into how the effect may differ comparing the more widely traded currency pairs with the less traded ones. Finally, we propose investigating the relationship using alternative rates: bond yields as well as swap rates.

8. References

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9. Appendices

Appendix A. Algorithm for data filtering using frequency based filters.

The aim of a time series filter is to divide it into trend and cyclical components which can be expressed in Eq. 11.

$$f_t = c_t + g_t \tag{11}$$

In Eq. 11 f_t represents for an unfiltered time series, c_t denotes cyclical component, and g_t denotes a trend component (Hodrick and Prescott, 1997).

The frequency based filters isolate a cyclical component by estimating such adjusted time series that for predefined interval of frequencies. A cyclical component contributes to both covariance and auto covariance of the series while it contributes nothing outside of this interval. These filters can be divided into one sided filters and band pass filters. The former isolates frequencies lower or higher than certain level and the latter isolates the frequencies within a closed interval (Hodrick and Prescott, 1997; Christiano and Fitzgerald, 2003; Comin and Gertler, 2006).

Christiano and Fitgerald (2003) band pass filter

Optimal Christiano and Fitzgerald (2003) filter is based on a random walk assumption and is obtained by minimised the squared error between the finite series filter and an ideal filter where the time series is indefinite ($T \rightarrow \infty$). The ideal filter can be expressed as follows:

$$c_t = \sum_{j=-\infty}^{\infty} (B_j f_{t-j}) \tag{12}$$

Where,

$$B_j = \begin{cases} \pi^{-1}\left(\frac{2\pi}{p_u} - \frac{2\pi}{p_l}\right) & ,j = 0 \\ (j\pi)^{-1}\left[\sin\left(j\frac{2\pi}{p_u}\right) - \sin\left(j\frac{2\pi}{p_l}\right)\right] & ,j \neq 0 \end{cases} \tag{13}$$

In Eq. 13 p_u denotes a maximum period or upper band, and p_l denotes a minimum period or lower band.

The optimal filter of a finite time series was derived by Christiano and Fitzgerald (2003) to be as follows:

$$c_t = B_0 f_t + \sum_{j=1}^{T-t-1}\left(B_j f_{t+j}\right) + \hat{B}_{T-t} f_T + \sum_{j=1}^{t-2}\left(B_j f_{t-j}\right) + \hat{B}_{t-1} f_1 \quad ,t \,\epsilon\, (1,T) \tag{14}$$

Where,

$$\hat{B}_{T-t} = -\frac{1}{2}B_0 - \sum_{j=1}^{T-t-1} B_j \qquad and \qquad \hat{B}_{t-1} = -\frac{1}{2}B_0 - \sum_{j=1}^{t-2} B_j \tag{15}$$

The Eq. 14 is applied if $1 < t < T$, otherwise, namely when $t = 1$ or $t = T$, the following is applied:

$$c_1 = \frac{1}{2} B_0 f_1 + \sum_{j=1}^{T-2} (B_j f_{j+1}) + \hat{B}_{T-1} f_T \quad (16)$$

$$c_1 = \frac{1}{2} B_0 f_T + \sum_{j=1}^{T-2} (B_j f_{T-1}) + \hat{B}_{T-1} f_1 \quad (17)$$

It is important to note that the default case considered by Christiano and Fitzgerald (2003) is a non-stationary time series. Therefore, if it is stationary, adjustments to the formulas have to be made. In this case, $\hat{B}_j = B_j$.

Hodrick and Prescott (1997) filter

Hodrick and Prescott (1997) filter obtains a trend component g_t which in turn is used to estimate a cyclical component c_t by subtracting the trend from a time series. The trend component is estimated by minimising the following equation with respect to g_t:

$$\min_{g_t} \left[\sum_{t=1}^{T} (f_t - g_t)^2 + \lambda \sum_{t=2}^{T-1} \left((g_{t+1} - g_t) - (g_t - g_{t-1}) \right)^2 \right] \quad (18)$$

In Eq. 18 λ is a smooth parameter noting to which extent or to which frequency the cycles are filtered.

Appendix B. Data used for obtaining CIP violations

Table 6. Data description for variables to assess deviations from CIP.

	Variable	Description	Time span
Eurozone	Interbank rates	1m, 3m, 6m, 12m interest rate	January 1, 1999 – December 30, 2016
Sweden	Forward rates	Bid/ask and last EUR/SEK 1m, 3m, 6m, 12m forward points	January 8,1999- December 30, 2016
	Spot rates	Bid/ask and last EUR/SEK spot rates	January 1, 1999 – December 30, 2016
	Interbank rates	1m, 3m, 6m, 12m interest rate	January 9, 1987 – December 30, 2016
Norway	Forward rates	Bid/ask and last EUR/NOK 1m, 3m, 6m, 12m forward points	January 8, 1999- December 30, 2016
	Spot rates	Bid/ask and last EUR/NOK spot rates	January 1, 1999- December 30, 2016
	Interbank rates	1m, 3m, 6m, 12m interest rate	October 1, 1986 – December 30, 2016
Denmark	Forward rates	Bid/ask and last EUR/DKK 1m, 3m, 6m, 12m forward points	January 8, 1999- December 30, 2016
	Spot rates	Bid/ask and last EUR/DKK spot rates	January 1, 1999- December 30, 2016
	Interbank rates	1m, 3m, 6m, 12m interest rate	June 10, 1988 - December 30, 2016
Switzerland	Forward rates	Bid/ask and last EUR/CHF 1m, 3m, 6m, 12m forward points	January 8, 1999- December 30, 2016

	Spot rates	Bid/ask and last EUR/CHF spot rates	January 1, 1999- December 30, 2016
	Interbank rates	1m, 3m, 6m, 12m interest rate	October 10, 1998 - December 30, 2016
Canada	Forward rates	Bid/ask and last EUR/CAD 1m, 3m, 6m, 12m forward points	January 8, 1999- December 30, 2016
	Spot rates	Bid/ask and last EUR/CAD spot rates	January 1, 1999- December 30, 2016
	Interbank rates	1m, 3m, 6m, 12m interest rate	November 14, 1997 - December 30, 2016
Australia	Forward rates	Bid/ask and last EUR/AUD 1m, 3m, 6m, 12m forward points	January 8, 1999- December 30, 2016
	Spot rates	Bid/ask and last EUR/AUD spot rates	January 1, 1999- December 30, 2016
	Interbank rates	1m, 3m, 6m, 12m interest rate	January 13, 1995- December 30, 2016
New Zealand	Forward rates	Bid/ask and last EUR/NZD 1m, 3m, 6m, 12m forward points	January 8, 1999- December 30, 2016
	Spot rates	Bid/ask and last EUR/NZD spot rates	January 1, 1999- December 30, 2016
	Interbank rates	1m, 3m, 6m, 12m interest rate	June 27, 2003 - December 30, 2016

(Created by authors)

Appendix C. Data used for constructing financial cycle

Table 7. Data description for financial cycle variables. All data is reported quarterly.

	Variable	Description	Time span
Eurozone	Residential property prices	Residential property prices (long series)	1980Q1- 2016Q2
	Credit to non-financial institutions	Credit to non-financial corporations from all sectors	1997Q4- 2016Q2
	Credit to GDP ratio	Credit to private non-financial institutions from all sectors (%GDP)	1999Q1- 2016Q2
	CPI	Consumer Price Index monthly growth aggregated	1999Q1- 2016Q2
Norway Canada Australia	Residential property prices	Residential property prices (long series)	1977Q1- 2016Q3
	Credit to non-financial institutions	Credit to non-financial corporations from all sectors	1977Q1- 2016Q2
	Credit to GDP ratio	Credit to private non-financial institutions from all sectors (%GDP)	1977Q1- 2016Q2
	CPI	Consumer Price Index aggregated	1977Q1- 2016Q2
Sweden Denmark Switzerland New Zealand	Residential property prices	Residential property prices (long series)	1977Q1- 2016Q3
	Credit to non-financial institutions	Credit to private non-financial institutions from all sectors	1977Q1- 2016Q2
	Credit to GDP ratio	Credit to private non-financial institutions from all sectors (%GDP)	1977Q1- 2016Q2
	CPI	Consumer Price Index aggregated	1977Q1- 2016Q2

(Created by the authors)

Appendix D. OLS regression results of CIP testing

Table 8. Newey-West regression results of CIP testing using 1 month rates.

	β_0	β_1	R^2	Total observations
Norway (1m)	.0000876***	1.061306***	0.9399	935
Sweden (1m)	.0000204*	1.113978***	0.9203	932
Denmark (1m)	.0000958***	.9044328***	0.6747	936
Switzerland (1m)	.0000379*	.9983127***	0.9119	935
Canada (1m)	-.0003222***	.8422789***	0.6911	797
Australia (1m)	.0001866**	1.136027***	0.8186	746
New Zealand (1m)	-.0004846**	.8690341***	0.4769	506

*, **, and *** denote 5%, 1% and 0.1% significance level, respectively. Appropriate lag operator is chosen using Stock-Watson (2007) truncation parameter m=0.75T^(1/3)

(Created by authors)

Table 9. Newey-West regression results of CIP testing using 3 month rates.

	β_0	β_1	R^2	Total observations
Norway (3m)	.000112***	1.034761***	0.9767	934
Sweden (3m)	.0000262	1.078162***	0.9557	932
Denmark (3m)	.0003082***	.7652507***	0.6938	936
Switzerland (3m)	-.0000343	1.007492***	0.9202	935
Canada (3m)	-.0010527***	.7626247***	0.8171	743
Australia (3m)	.0005356***	1.141113***	0.9168	747
New Zealand (3m)	-.0015985***	.8726523***	0.8111	495

*, **, and *** denote 5%, 1% and 0.1% significance level, respectively. Appropriate lag operator is chosen using Stock-Watson (2007) truncation parameter m=0.75T^(1/3)

(Created by authors)

Table 10. Newey-West regression results of CIP testing using 6 month rates.

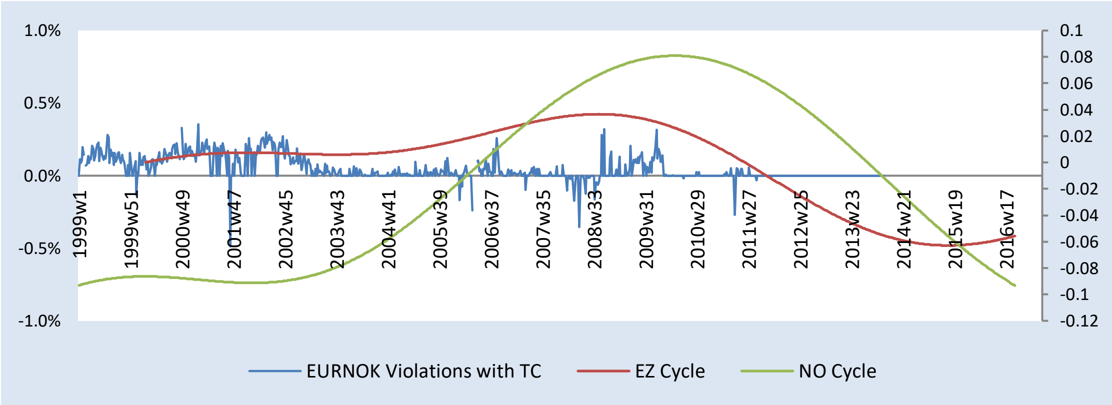
	β_0	β_1	R^2	Total observations
Norway (6m)	.0001768***	1.010339***	0.9902	934
Sweden (6m)	.0000676	1.085118***	0.9345	932
Denmark (6m)	.0005503***	.6606438***	0.5766	936
Switzerland (6m)	-.0001628	.9915301***	0.8740	935
Canada (6m)	-.002122***	.7552996***	0.7745	744
Australia (6m)	.0013038***	1.126945***	0.8230	749
New Zealand (6m)	-.0033501***	.7962771***	0.4252	500

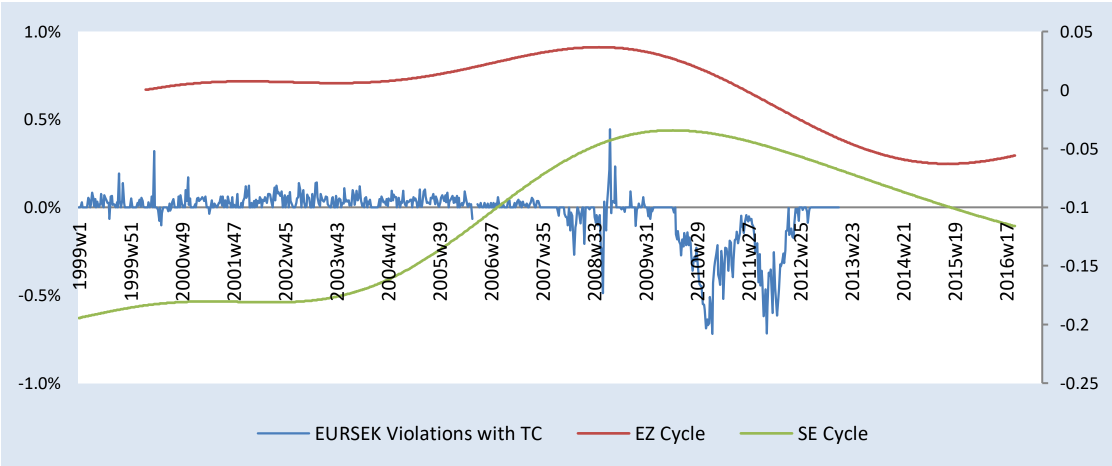
*, **, and *** denote 5%, 1% and 0.1% significance level, respectively. Appropriate lag operator is chosen using Stock-Watson (2007) truncation parameter m=0.75T^(1/3)

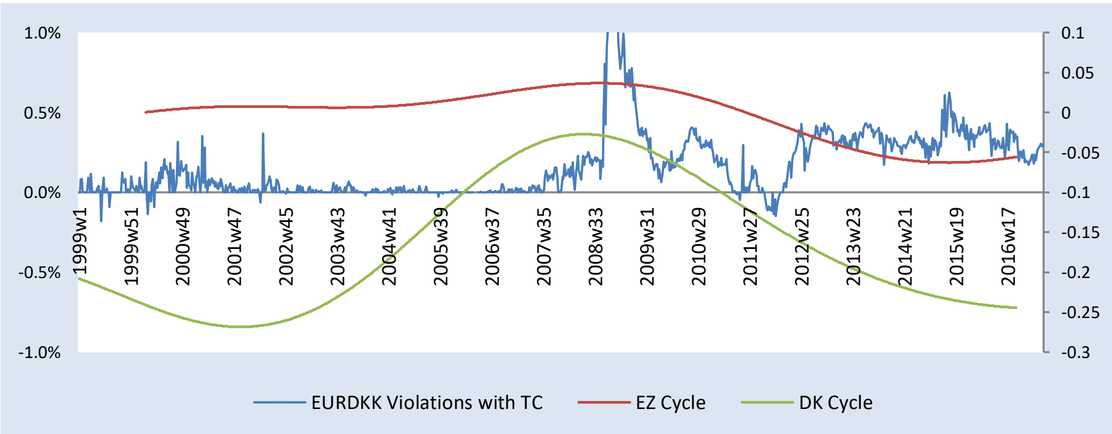
(Created by authors)

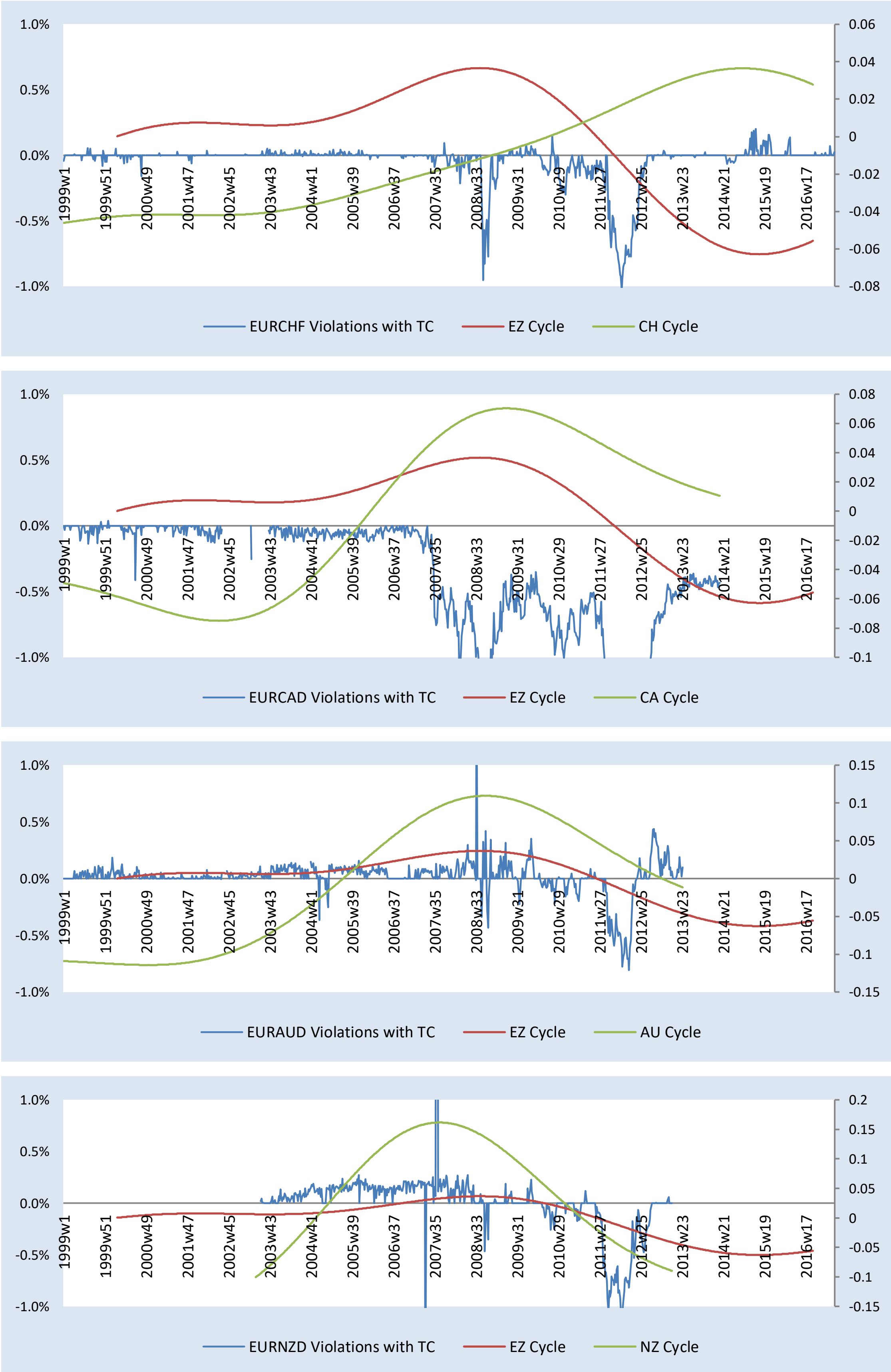
Appendix E. Graphic representation of CIP violations and the respective weekly financial cycles across countries.

Figure 4. Weekly financial cycles with CIP violations accounted for transaction costs.









(Created by the authors)

Appendix F. Stationarity checks using augmented Dickey – Fuller test

Table 11. Stationarity checks of financial cycle variables using augmented Dickey – Fuller test

Dickey-Fuller	Credit to GDP growth		Credit growth		Real Estate Price growth	
	p-value	Conclusion	p-value	Conclusion	p-value	Conclusion
Weekly						
Eurozone (w)	0.5563	Non-stationary	0.4106	Non-stationary	0.7703	Non-stationary
Norway (w)	0.0529	Non-stationary	0.0043	Stationary	0.1171	Non-stationary
Sweden (w)	0.1840	Non-stationary	0.0045	Stationary	0.3181	Non-stationary
Denmark (w)	0.1168	Non-stationary	0.0139	Stationary	0.1289	Non-stationary
Switzerland (w)	0.0073	Stationary	0.0609	Non-stationary	0.1973	Non-stationary
Canada (w)	0.0894	Non-stationary	0.0026	Stationary	0.0213	Stationary
Australia (w)	0.1594	Non-stationary	0.0032	Stationary	0.0648	Non-stationary
New Zealand (w)	0.0024	Stationary	0.0023	Stationary	0.0814	Non-stationary
Quarterly						
Eurozone (q)	0.5545	Non-stationary	0.4091	Non-stationary	0.7729	Non-stationary
Norway (q)	0.0469	Stationary	0.0026	Stationary	0.1110	Non-stationary
Sweden (q)	0.1772	Non-stationary	0.0029	Stationary	0.3151	Non-stationary
Denmark (q)	0.1102	Non-stationary	0.0107	Stationary	0.1227	Non-stationary
Switzerland (q)	0.0051	Stationary	0.0550	Non-stationary	0.1926	Non-stationary
Canada (q)	0.0821	Non-stationary	0.0015	Stationary	0.0165	Stationary
Australia (q)	0.1534	Non-stationary	0.0018	Stationary	0.0582	Non-stationary
New Zealand (q)	0.0014	Stationary	0.0013	Stationary	0.0728	Non-stationary

(Created by the authors)

Table 12. Stationarity test results using augmented Dickey – Fuller test for quarterly CIP violations variables at 5% significance level.

Dickey-Fuller	Simple CIP violations	One quarter average of CIP violations	One quarter cumulated return from carry trade	One quarter volatility of CIP violations
EUR/NOK	Stationary	Stationary	Stationary	Stationary
EUR/SEK	Stationary	I(1)	I(1)	Stationary
EUR/DKK	Stationary	I(1)	I(1)	Stationary
EUR/CHF	Stationary	Stationary	Stationary	Stationary
EUR/CAD	I(1)	I(1)	I(1)	Stationary
EUR/AUD	Stationary	Stationary	Stationary	Stationary
EUR/NZD	Stationary	Stationary	Stationary	Stationary

(Created by the authors)

Table 13. Stationarity tests results using augmented Dickey – Fuller test for nominal weekly CIP violations with transaction costs at 5% significance level.

	EUR/NOK	EUR/SEK	EUR/DKK	EUR/CHF	EUR/CAD	EUR/AUD	EUR/NZD
Dickey-Fuller test results	Stationary	Stationary	Stationary	Stationary	I(1)	Stationary	Stationary

(Created by the authors)

Appendix G. Descriptive statistics of obtained financial cycles

Table 14. Descriptive statistics of obtained quarterly financial cycles.

Fin Cycles	No. of obs.	Mean	St. deviation	Min	Max
Eurozone	65	-.0030713	.0324209	-.0629302	.0366573
Norway	153	.0021474	.0844117	-.1276203	.1925921
Sweden	153	-.1056958	.1033173	-.263837	.1506619

Denmark	153	-.1349103	.0865019	-.257134	.0239754
Switzerland	153	.0160163	.0519588	-.0483614	.1478946
Canada	153	-.0074969	.0626659	-.109947	.1360326
Australia	139	.0118786	.0920289	-.106346	.2133682
New Zealand	153	.0620607	.0935121	-.1056137	.2504755

(Created by the authors)

Table 15. Descriptive statistics of obtained weekly financial cycles.

Fin Cycles	No. of obs.	Mean	St. deviation	Min	Max
Eurozone	845	-.0026544	.0318567	-.0628545	.0366304
Norway	1989	-.017533	.0807353	-.1472095	.1589032
Sweden	1989	-.1050723	.1030648	-.2634479	.1507555
Denmark	1989	-.1341789	.0863235	-.2569564	.0240732
Switzerland	1989	.0157432	.0517067	-.0484789	.1476113
Canada	1989	-.0074179	.0624079	-.1098086	.1361578
Australia	1807	.0120071	.0916032	-.1062941	.2131484
New Zealand	1989	.0616431	.0930544	-.1056738	.2500303

(Created by the authors)

Appendix H. ARIMA model specifications

Table 16. ARIMA model specifications obtained by minimising Akaike information criteria.

ARIMA Specification (p,d,q)	**Credit to GDP growth**	**Credit growth**	**Real Estate price growth**
Eurozone	(1,1,3)	(0,1,3)	(2,1,3)
Norway	(3,0,3)	(2,0,3)	(2,1,3)
Sweden	(3,1,3)	(1,0,3)	(2,1,3)
Denmark	(2,1,3)	(3,0,3)	(2,1,3)
Switzerland	(2,0,3)	(2,1,3)	(3,1,3)
Canada	(1,1,3)	(1,0,3)	(3,0,3)
Australia	(3,1,3)	(2,0,3)	(1,1,3)
New Zealand	(3,0,3)	(1,0,3)	(2,1,3)

d values are obtained from the results of stationarity tests presented in Appendix F, Table 11.

(Created by the authors)

Appendix I. VAR regression results

Table 17. VAR model results using one quarter average of weekly CIP violations with transaction costs.

Currency	**Response Variable**	**Impulse Variable**	**VAR Model R-squared**	**Granger P > Chi^2**	**IRF slope (step 8)**
EUR/NOK	CIP Violation	Δ(Dom Fin Cycle)	0.6939	0.412	Insignificant
	Δ(Dom Fin Cycle)	CIP Violation	1.0000	0.000	Upward
	CIP Violation	Δ(For Fin Cycle)	0.7809	0.000	Upward (fl)
	Δ(For Fin Cycle)	CIP Violation	1.0000	0.575	Insignificant
EUR/SEK	**Δ(CIP Violation)**	Δ(Dom Fin Cycle)	0.2895	0.157	Insignificant
	Δ(Dom Fin Cycle)	**Δ(CIP Violation)**	1.0000	0.037	Upward
	Δ(CIP Violation)	Δ(For Fin Cycle)	0.2879	0.118	Insignificant
	Δ(For Fin Cycle)	**Δ(CIP Violation)**	1.0000	0.945	Insignificant

EUR/DKK	**Δ(CIP Violation)**	Δ(Dom Fin Cycle)	0.0947	0.855	Insignificant
	Δ(Dom Fin Cycle)	**Δ(CIP Violation)**	1.0000	0.833	Insignificant
	Δ(CIP Violation)	Δ(For Fin Cycle)	0.1084	0.599	Insignificant
	Δ(For Fin Cycle)	**Δ(CIP Violation)**	1.0000	0.213	Insignificant
EUR/CHF	CIP Violation	Δ(Dom Fin Cycle)	0.6753	0.050	Upward (fl)
	Δ(Dom Fin Cycle)	CIP Violation	1.0000	0.080	Upward
	CIP Violation	Δ(For Fin Cycle)	0.6651	0.114	Downward (fl)
	Δ(For Fin Cycle)	CIP Violation	1.0000	0.154	Insignificant
EUR/CAD	**Δ(CIP Violation)**	Δ(Dom Fin Cycle)	0.0793	0.649	Insignificant
	Δ(Dom Fin Cycle)	**Δ(CIP Violation)**	1.0000	0.257	Insignificant
	Δ(CIP Violation)	Δ(For Fin Cycle)	0.0713	0.701	Insignificant
	Δ(For Fin Cycle)	**Δ(CIP Violation)**	1.0000	0.940	Insignificant
EUR/AUD	CIP Violation	Δ(Dom Fin Cycle)	0.6512	0.058	Insignificant
	Δ(Dom Fin Cycle)	CIP Violation	1.0000	0.107	Insignificant
	CIP Violation	Δ(For Fin Cycle)	0.6313	0.098	Insignificant
	Δ(For Fin Cycle)	CIP Violation	1.0000	0.017	Upward
EUR/NZD	CIP Violation	Δ(Dom Fin Cycle)	0.4377	0.010	Insignificant
	Δ(Dom Fin Cycle)	CIP Violation	1.0000	0.084	Insignificant
	CIP Violation	Δ(For Fin Cycle)	0.4301	0.014	Insignificant
	Δ(For Fin Cycle)	CIP Violation	1.0000	0.922	Insignificant

(Created by the authors)

Table 18. VAR model results using one quarter cumulated profit from weekly investments in carry trade.

Currency	**Response Variable**	**Impulse Variable**	**VAR Model R-squared**	**Granger P > Chi²**	**IRF slope (step 8)**
EUR/NOK	CIP Violation	Δ(Dom Fin Cycle)	0.6937	0.410	Insignificant
	Δ(Dom Fin Cycle)	CIP Violation	1.0000	0.000	Upward
	CIP Violation	Δ(For Fin Cycle)	0.7808	0.000	Upward (fl)
	Δ(For Fin Cycle)	CIP Violation	1.0000	0.575	Insignificant
EUR/SEK	**Δ(CIP Violation)**	Δ(Dom Fin Cycle)	0.3317	0.126	Insignificant
	Δ(Dom Fin Cycle)	**Δ(CIP Violation)**	1.0000	0.041	Upward
	Δ(CIP Violation)	Δ(For Fin Cycle)	0.3362	0.075	Insignificant
	Δ(For Fin Cycle)	**Δ(CIP Violation)**	1.0000	0.929	Insignificant
EUR/DKK	**Δ(CIP Violation)**	Δ(Dom Fin Cycle)	0.0947	0.854	Insignificant
	Δ(Dom Fin Cycle)	**Δ(CIP Violation)**	1.0000	0.833	Insignificant
	Δ(CIP Violation)	Δ(For Fin Cycle)	0.1085	0.598	Insignificant
	Δ(For Fin Cycle)	**Δ(CIP Violation)**	1.0000	0.213	Insignificant
EUR/CHF	CIP Violation	Δ(Dom Fin Cycle)	0.6752	0.050	Insignificant
	Δ(Dom Fin Cycle)	CIP Violation	1.0000	0.080	Upward
	CIP Violation	Δ(For Fin Cycle)	0.6650	0.114	Downward (fl)
	Δ(For Fin Cycle)	CIP Violation	1.0000	0.154	Insignificant
EUR/CAD	**Δ(CIP Violation)**	Δ(Dom Fin Cycle)	0.0792	0.650	Insignificant
	Δ(Dom Fin Cycle)	**Δ(CIP Violation)**	1.0000	0.258	Insignificant
	Δ(CIP Violation)	Δ(For Fin Cycle)	0.0712	0.703	Insignificant
	Δ(For Fin Cycle)	**Δ(CIP Violation)**	1.0000	0.941	Insignificant
EUR/AUD	CIP Violation	Δ(Dom Fin Cycle)	0.6520	0.058	Insignificant
	Δ(Dom Fin Cycle)	CIP Violation	1.0000	0.107	Insignificant
	CIP Violation	Δ(For Fin Cycle)	0.6322	0.099	Insignificant
	Δ(For Fin Cycle)	CIP Violation	1.0000	0.017	Upward
EUR/NZD	CIP Violation	Δ(Dom Fin Cycle)	0.4482	0.010	Insignificant
	Δ(Dom Fin Cycle)	CIP Violation	1.0000	0.074	Insignificant
	CIP Violation	Δ(For Fin Cycle)	0.4402	0.014	Insignificant
	Δ(For Fin Cycle)	CIP Violation	1.0000	0.894	Insignificant

(Created by the authors)

Table 19. VAR model results using one quarter volatility of CIP violations with transaction costs.

Currency	Response Variable	Impulse Variable	VAR Model R-squared	Granger P > Chi^2	IRF slope (step 8)
EUR/NOK	σ(CIP Violation)	Δ(Dom Fin Cycle)	0.4707	0.009	Insignificant
	Δ(Dom Fin Cycle)	σ(CIP Violation)	1.0000	0.000	Upward
	σ(CIP Violation)	Δ(For Fin Cycle)	0.4549	0.015	Insignificant
	Δ(For Fin Cycle)	σ(CIP Violation)	1.0000	0.181	Insignificant
EUR/SEK	σ(CIP Violation)	Δ(Dom Fin Cycle)	0.4000	0.047	Downward (fl)
	Δ(Dom Fin Cycle)	σ(CIP Violation)	1.0000	0.465	Insignificant
	σ(CIP Violation)	Δ(For Fin Cycle)	0.2825	0.215	Insignificant
	Δ(For Fin Cycle)	σ(CIP Violation)	1.0000	0.015	Downward
EUR/DKK	σ(CIP Violation)	Δ(Dom Fin Cycle)	0.4329	0.010	Downward (fl)
	Δ(Dom Fin Cycle)	σ(CIP Violation)	1.0000	0.007	Upward
	σ(CIP Violation)	Δ(For Fin Cycle)	0.4243	0.009	Insignificant
	Δ(For Fin Cycle)	σ(CIP Violation)	1.0000	0.172	Insignificant
EUR/CHF	σ(CIP Violation)	Δ(Dom Fin Cycle)	0.3497	0.039	Downward (fl)
	Δ(Dom Fin Cycle)	σ(CIP Violation)	1.0000	1.000	Insignificant
	σ(CIP Violation)	Δ(For Fin Cycle)	0.3368	0.063	Upward (fl)
	Δ(For Fin Cycle)	σ(CIP Violation)	1.0000	0.787	Insignificant
EUR/CAD	σ(CIP Violation)	Δ(Dom Fin Cycle)	0.4410	0.084	Downward (fl)
	Δ(Dom Fin Cycle)	σ(CIP Violation)	1.0000	0.989	Insignificant
	σ(CIP Violation)	Δ(For Fin Cycle)	0.4297	0.091	Insignificant
	Δ(For Fin Cycle)	σ(CIP Violation)	1.0000	0.173	Insignificant
EUR/AUD	σ(CIP Violation)	Δ(Dom Fin Cycle)	0.2350	0.112	Downward (fl)
	Δ(Dom Fin Cycle)	σ(CIP Violation)	1.0000	0.957	Insignificant
	σ(CIP Violation)	Δ(For Fin Cycle)	0.2517	0.066	Downward (fl)
	Δ(For Fin Cycle)	σ(CIP Violation)	1.0000	0.981	Insignificant
EUR/NZD	σ(CIP Violation)	Δ(Dom Fin Cycle)	0.1162	0.308	Insignificant
	Δ(Dom Fin Cycle)	σ(CIP Violation)	1.0000	0.928	Insignificant
	σ(CIP Violation)	Δ(For Fin Cycle)	0.1447	0.183	Insignificant
	Δ(For Fin Cycle)	σ(CIP Violation)	1.0000	0.006	Upward

(Created by the authors)

Appendix J. Robustness checks

Table 20. VAR model results using nominal 6 months quarterly CIP violations with transaction costs and financial cycles.

Currency	Response Variable	Impulse Variable	VAR Model R-squared	Granger P > Chi^2	IRF slope (step 8)
EUR/NOK	CIP Violation	Δ(Dom Fin Cycle)	0.1356	0.067	Upward
	Δ(Dom Fin Cycle)	CIP Violation	1.0000	0.069	Upward
	CIP Violation	Δ(For Fin Cycle)	0.0550	0.449	Insignificant
	Δ(For Fin Cycle)	CIP Violation	1.0000	0.977	Insignificant
EUR/SEK	CIP Violation	Δ(Dom Fin Cycle)	0.3551	0.127	Upward
	Δ(Dom Fin Cycle)	CIP Violation	1.0000	0.057	Upward
	CIP Violation	Δ(For Fin Cycle)	0.3123	0.442	Insignificant
	Δ(For Fin Cycle)	CIP Violation	1.0000	0.000	Upward
EUR/DKK	CIP Violation	Δ(Dom Fin Cycle)	0.5959	0.005	Downward (fl)
	Δ(Dom Fin Cycle)	CIP Violation	1.0000	0.000	Upward
	CIP Violation	Δ(For Fin Cycle)	0.5814	0.016	Downward
	Δ(For Fin Cycle)	CIP Violation	1.0000	0.606	Insignificant

EUR/CHF	CIP Violation	Δ(Dom Fin Cycle)	0.5510	0.012	Upward
	Δ(Dom Fin Cycle)	CIP Violation	1.0000	0.315	Insignificant
	CIP Violation	Δ(For Fin Cycle)	0.5147	0.120	Downward (fl)
	Δ(For Fin Cycle)	CIP Violation	1.0000	0.078	Upward
EUR/CAD	**Δ(CIP Violation)**	Δ(Dom Fin Cycle)	0.1418	0.568	Insignificant
	Δ(Dom Fin Cycle)	**Δ(CIP Violation)**	1.0000	0.740	Insignificant
	Δ(CIP Violation)	Δ(For Fin Cycle)	0.1380	0.565	Insignificant
	Δ(For Fin Cycle)	**Δ(CIP Violation)**	1.0000	0.968	Insignificant
EUR/AUD	CIP Violation	Δ(Dom Fin Cycle)	0.5099	0.024	Upward
	Δ(Dom Fin Cycle)	CIP Violation	1.0000	0.014	Upward
	CIP Violation	Δ(For Fin Cycle)	0.4941	0.062	Insignificant
	Δ(For Fin Cycle)	CIP Violation	1.0000	0.000	Upward
EUR/NZD	**Δ(CIP Violation)**	Δ(Dom Fin Cycle)	0.2429	0.227	Insignificant
	Δ(Dom Fin Cycle)	**Δ(CIP Violation)**	1.0000	0.158	Insignificant
	Δ(CIP Violation)	Δ(For Fin Cycle)	0.1803	0.721	Insignificant
	Δ(For Fin Cycle)	**Δ(CIP Violation)**	1.0000	0.660	Insignificant

(Created by the authors)

Table 21. VAR model results using nominal CIP violations with transaction costs and financial cycles obtained by employing a Hodrick and Prescott (1997) frequency based filter.

Currency	**Response Variable**	**Impulse Variable**	**VAR Model R-squared**	**Granger P > Chi^2**	**IRF slope (step 8)**
EUR/NOK	CIP Violation	Δ(Dom Fin Cycle)	0.2576	0.711	Insignificant
	Δ(Dom Fin Cycle)	CIP Violation	0.8965	0.092	Downward (fl)
	CIP Violation	Δ(For Fin Cycle)	0.3611	0.414	Insignificant
	Δ(For Fin Cycle)	CIP Violation	0.6639	0.924	Insignificant
EUR/SEK	CIP Violation	Δ(Dom Fin Cycle)	0.5702	0.455	Insignificant
	Δ(Dom Fin Cycle)	CIP Violation	0.8777	0.482	Insignificant
	CIP Violation	Δ(For Fin Cycle)	0.6139	0.031	Insignificant
	Δ(For Fin Cycle)	CIP Violation	0.6101	0.118	Up/Downward
EUR/DKK	CIP Violation	Δ(Dom Fin Cycle)	0.5134	0.052	Insignificant
	Δ(Dom Fin Cycle)	CIP Violation	0.8674	0.603	Insignificant
	CIP Violation	Δ(For Fin Cycle)	0.4856	0.294	Insignificant
	Δ(For Fin Cycle)	CIP Violation	0.8283	0.007	Downward
EUR/CHF	CIP Violation	Δ(Dom Fin Cycle)	0.6261	0.336	Insignificant
	Δ(Dom Fin Cycle)	CIP Violation	0.8662	0.732	Insignificant
	CIP Violation	Δ(For Fin Cycle)	0.6370	0.094	Insignificant
	Δ(For Fin Cycle)	CIP Violation	0.6513	0.078	Down/Upward
EUR/CAD	**Δ(CIP Violation)**	Δ(Dom Fin Cycle)	0.1927	0.037	Insignificant
	Δ(Dom Fin Cycle)	**Δ(CIP Violation)**	0.8951	0.896	Insignificant
	Δ(CIP Violation)	Δ(For Fin Cycle)	0.1522	0.085	Downward
	Δ(For Fin Cycle)	**Δ(CIP Violation)**	0.8320	0.600	Insignificant
EUR/AUD	CIP Violation	Δ(Dom Fin Cycle)	0.5510	0.043	Upward
	Δ(Dom Fin Cycle)	CIP Violation	0.8942	0.600	Insignificant
	CIP Violation	Δ(For Fin Cycle)	0.4691	0.824	Insignificant
	Δ(For Fin Cycle)	CIP Violation	0.7220	0.494	Insignificant
EUR/NZD	CIP Violation	Δ(Dom Fin Cycle)	0.7372	0.023	Upward
	Δ(Dom Fin Cycle)	CIP Violation	0.9014	0.286	Insignificant
	CIP Violation	Δ(For Fin Cycle)	0.6875	0.479	Insignificant
	Δ(For Fin Cycle)	CIP Violation	0.8370	0.953	Insignificant

(Created by the authors)

Table 22. Results of a VAR model with 9 lags using nominal CIP violations with transaction costs.

Currency	Response Variable	Impulse Variable	VAR Model R-squared	Granger P > Chi^2	IRF slope (step 8)
EUR/NOK	CIP Violation	Δ(Dom Fin Cycle)	0.5117	0.000	Upward
	Δ(Dom Fin Cycle)	CIP Violation	1.0000	0.043	Insignificant
	CIP Violation	Δ(For Fin Cycle)	0.6140	0.000	Down/Upward
	Δ(For Fin Cycle)	CIP Violation	1.0000	0.018	Upward
EUR/SEK	CIP Violation	Δ(Dom Fin Cycle)	0.8235	0.000	Insignificant
	Δ(Dom Fin Cycle)	CIP Violation	1.0000	0.000	Insignificant
	CIP Violation	Δ(For Fin Cycle)	0.8472	0.000	Upward
	Δ(For Fin Cycle)	CIP Violation	1.0000	0.000	Upward
EUR/DKK	CIP Violation	Δ(Dom Fin Cycle)	0.6170	0.006	Insignificant
	Δ(Dom Fin Cycle)	CIP Violation	1.0000	0.002	Insignificant
	CIP Violation	Δ(For Fin Cycle)	0.7156	0.000	Downward
	Δ(For Fin Cycle)	CIP Violation	1.0000	0.489	Insignificant
EUR/CHF	CIP Violation	Δ(Dom Fin Cycle)	0.7727	0.000	Upward
	Δ(Dom Fin Cycle)	CIP Violation	1.0000	0.001	Insignificant
	CIP Violation	Δ(For Fin Cycle)	0.7803	0.000	Insignificant
	Δ(For Fin Cycle)	CIP Violation	1.0000	0.238	Insignificant
EUR/CAD	**Δ(CIP Violation)**	Δ(Dom Fin Cycle)	0.4510	0.000	Upward
	Δ(Dom Fin Cycle)	**Δ(CIP Violation)**	1.0000	0.220	Insignificant
	Δ(CIP Violation)	Δ(For Fin Cycle)	0.3885	0.005	Downward
	Δ(For Fin Cycle)	**Δ(CIP Violation)**	1.0000	0.011	Insignificant
EUR/AUD	CIP Violation	Δ(Dom Fin Cycle)	0.8204	0.000	Upward
	Δ(Dom Fin Cycle)	CIP Violation	1.0000	0.000	Downward
	CIP Violation	Δ(For Fin Cycle)	0.8058	0.000	Down/Upward
	Δ(For Fin Cycle)	CIP Violation	1.0000	0.000	Upward
EUR/NZD	CIP Violation	Δ(Dom Fin Cycle)	0.8895	0.000	Insignificant
	Δ(Dom Fin Cycle)	CIP Violation	1.0000	0.000	Downward
	CIP Violation	Δ(For Fin Cycle)	0.9162	0.000	Up/Downward
	Δ(For Fin Cycle)	CIP Violation	1.0000	0.000	Downward

(Created by the authors)

Table 23. VAR model results using interpolated weekly data of nominal CIP violations with foreign and domestic financial cycles.

Currency	Response Variable	Impulse Variable	VAR Model R-squared	Granger P > Chi^2	IRF slope (step 104)
EUR/NOK	CIP Violation	Δ(Dom Fin Cycle)	0.4753	0.226	Insignificant
	Δ(Dom Fin Cycle)	CIP Violation	1.0000	0.021	Upward
	CIP Violation	Δ(For Fin Cycle)	0.4854	0.745	Insignificant
	Δ(For Fin Cycle)	CIP Violation	1.0000	0.000	Upward
EUR/SEK	CIP Violation	Δ(Dom Fin Cycle)	0.8360	0.008	Upward
	Δ(Dom Fin Cycle)	CIP Violation	1.0000	0.843	Insignificant
	CIP Violation	Δ(For Fin Cycle)	0.8301	0.172	Upward
	Δ(For Fin Cycle)	CIP Violation	1.0000	0.483	Insignificant
EUR/DKK	CIP Violation	Δ(Dom Fin Cycle)	0.9189	0.985	Insignificant
	Δ(Dom Fin Cycle)	CIP Violation	1.0000	0.046	Downward
	CIP Violation	Δ(For Fin Cycle)	0.9163	0.427	Insignificant
	Δ(For Fin Cycle)	CIP Violation	1.0000	0.160	Insignificant
EUR/CHF	CIP Violation	Δ(Dom Fin Cycle)	0.8984	0.080	Upward
	Δ(Dom Fin Cycle)	CIP Violation	1.0000	0.790	Insignificant
	CIP Violation	Δ(For Fin Cycle)	0.8969	0.094	Insignificant
	Δ(For Fin Cycle)	CIP Violation	1.0000	0.546	Insignificant

EUR/CAD	**Δ(CIP Violation)**	Δ(Dom Fin Cycle)	0.0808	0.868	Insignificant
	Δ(Dom Fin Cycle)	**Δ(CIP Violation)**	1.0000	0.775	Insignificant
	Δ(CIP Violation)	Δ(For Fin Cycle)	0.0872	0.102	Insignificant
	Δ(For Fin Cycle)	**Δ(CIP Violation)**	1.0000	0.003	Insignificant
EUR/AUD	CIP Violation	Δ(Dom Fin Cycle)	0.5738	0.272	Insignificant
	Δ(Dom Fin Cycle)	CIP Violation	1.0000	0.966	Insignificant
	CIP Violation	Δ(For Fin Cycle)	0.5726	0.069	Insignificant
	Δ(For Fin Cycle)	CIP Violation	1.0000	0.018	Insignificant
EUR/NZD	CIP Violation	Δ(Dom Fin Cycle)	0.4292	0.000	Upward
	Δ(Dom Fin Cycle)	CIP Violation	1.0000	0.590	Insignificant
	CIP Violation	Δ(For Fin Cycle)	0.4290	0.000	Insignificant
	Δ(For Fin Cycle)	CIP Violation	1.0000	0.152	Insignificant

(Created by the authors)