# Carry trade and negative policy rates in Switzerland

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**Abstract**

This article investigates the interactions of the Swiss franc carry trade with a set of related financial variables in both periods of positive and negative policy rates in Switzerland. Using a structural vector autoregressive model (SVAR), we examine the behaviour of the carry trade based on five financial variables: nominal exchange rate (USDCHF), interest rate differential between Switzerland and the US, US market sentiment, Swiss stock market index, and US stock market index. There is evidence that while the Swiss franc acted as a target currency during the period of positive policy rates in Switzerland, it reinforced its role funding currency when the policy interest rate turned negative. We conclude that, as long as instability in the International Monetary System is present, the Swiss franc will retain its status of safe haven currency. This paradigm entails far-reaching systemic risks as financial markets are closely intertwined.

*Keywords*: Carry trade; Negative interest rate policy; Market volatility

*JEL Codes*: E43; E44; E52; F31; F37

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## 1 Introduction

This paper aims to investigate the relationships between the Swiss franc (CHF) carry trade and a set of five financial variables, linked to the financial markets of Switzerland and the United States (US). Whereas most of the literature on the currency carry trade focuses on the estimated returns to currency carry portfolios (e.g. Clarida et al. 2009), we opt to analyse the carry trade using weekly data released by the U.S. Commodity Futures Trading Commission (CFTC). As a starting point, it should be pointed out that currency carry trade consists of borrowing money in countries with low interest rates (funding currency) and investing in countries with high interest rates (target or investment currency). Although the uncovered interest rate parity hypothesis rests on the idea that the depreciation of the investment currency should offset the gain in interest rate differential, evidence indicates that it is not always the case (Brunnermeier et al. 2008). However, this has been the case for the Swiss franc whose fluctuations earned it the nickname of "strange animal" (Jochum and Savioz 2005).

The Swiss franc presents us with a twofold interest. First, it is a safe haven currency and a well-known funding currency, depending on the period under consideration. In times of turmoil, the Swiss franc reverts to its core function as a safe haven currency, leading to a rise in the demand in Swiss franc-denominated assets. In this case, the Swiss franc acts as an investment currency (Ranaldo and Söderlind 2010). However, the Swiss franc can also acquire the status of a funding currency by virtue of the long-established Swiss "interest rates bonus" (Kugler and Weder 2002). Historically, such a "bonus" usually kept both short and long real interest rates lower than in other countries. Such a monetary framework incentivizes investors to borrow and to contract debts labelled in Swiss francs. Besides this

Swiss bonus, another contributing factor is the Swiss National Bank's monetary policy of negative interest rates, whose impact resonates far beyond Switzerland.

We examine two aspects related to carry trade behaviour in contexts of positive and negative policy interest rates. Our first task is to identify the key financial factors accounting for the Swiss franc carry trade. Our research scope encompasses the following five financial variables: nominal exchange rate (USDCHF), interest rate differential between Switzerland and the US, US market sentiment, Swiss stock market index, and US stock market index. We explore the extent to which shocks in these financial variables shape trends in carry trade.

Secondly, we do the reverse by examining the impact of changing trends in the Swiss franc carry trade activity on our set of financial variables. Our overarching goal is to determine the relationship between these variables and carry trade shocks.

There are two types of positions in futures contracts: short and long. A short (long) futures position is an obligation to sell (buy) currencies at an agreed rate and at a specified future date. Because it is a funding currency, carry traders tend to take short positions on Swiss francs. Low-yielding currencies, such as the Swiss franc, are used to fund long positions in currencies with a higher yield (i.e. a higher policy interest rate) (Donnelly 2019).

Fig. 1 shows the movements of carry trade, the US policy interest rate, and Switzerland's policy rate in both periods of positive (PI) and of negative interest rates (NI). We obtain a carry trade ratio by dividing the short positions by long positions in Swiss franc. Ratios between zero and one (green shaded area in Fig. 1) indicate that long positions exceed short positions. In this case, in line with Gubler's observations (2014), CHF would be acting as a target currency. Conversely, when the carry trade ratio stands above one, CHF becomes the de facto funding currency in the carry trade strategy.

From around the end of 2016, as shown in Fig. 1, the carry trade ratio helps to reveal the Swiss franc's reinforced role as a funding currency. This behaviour characterizes most of the NI period. By setting negative policy rates in Switzerland, the SNB enhanced Swiss franc carry trade activities. Additionally, such singular monetary policy has resulted in an expansion of the Swiss franc's historical scope as a safe haven currency.

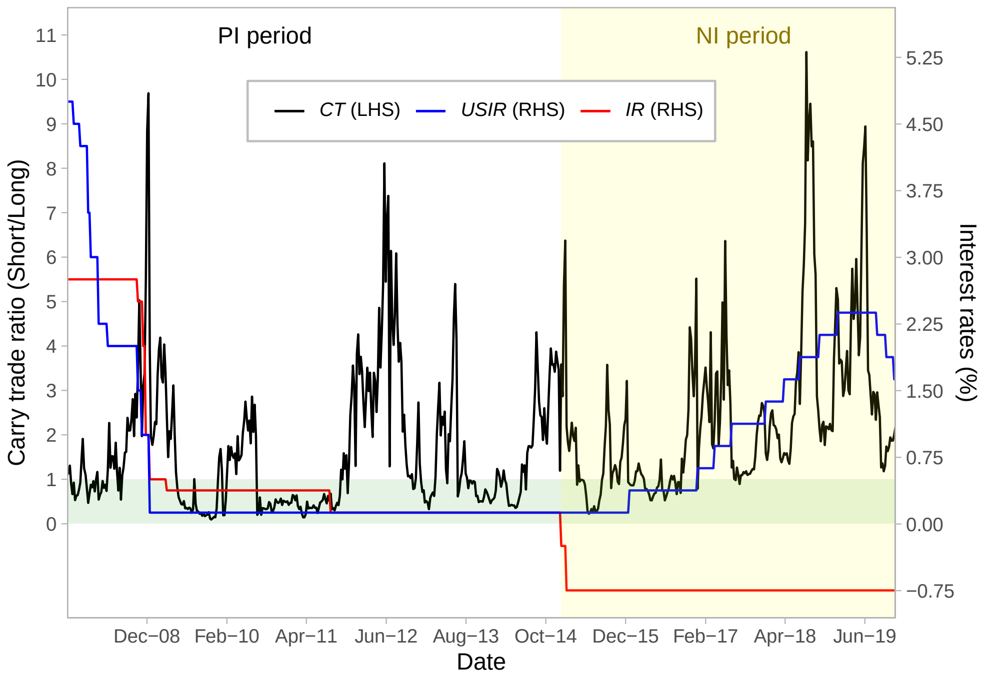


Figure 1: Carry trade ratio ($CT$), United States's policy rate ($USIR$), and Switzerland's policy rate ($IR$), from October 2017 to November 2019
Source: U.S. Commodity Futures Trading Commission; Bank for International Settlements.

By using a structural vector autoregressive model (SVAR), we address two key research questions in this paper: (1) what are the impacts of the financial variables on the carry trade?; (2) what is the impact of the carry trade on the financial variables?

With regard to question (1), we find unprecedented results in the effects of the interest rate differentials on the carry trade. First of all, the contribution of interest rate differentials is more substantial in both short and long-term in the NI (negative interest rate policy) period than in the PI (positive interest rate policy) period. Additionally, an initial positive shock on interest rate differentials has a positive impact on the short-run and a negative in the long-run.

About question (2), evidence of carry trade impact on the financial variables is lacking and inconclusive. More importantly, according to the variance decomposition for NI, the unwinding of the carry trade would impact the market sentiment and both Swiss and US stock markets negatively in the long-run. Moreover, there is evidence of systemic risk in the NI period.

This paper contains four sections. Section 2 provides a review of the literature on our topic of interest. Section 3 contains a description of the data and the estimation methodology of structural vector-autoregressive models (SVAR). Section 4 unveils our empirical results and discusses them. In the final section, we summarize our key findings and suggest some policy implications.

## 2 Literature review

From the investors' perspective, the usual carry trade strategy is to derive profit from country-to-country interest rate differentials. This is only achievable in situations when the hypothesis of uncovered interest rate parity (UIP) does not apply. The UIP holds that the interest rate differential between one specific country and another country invariably matches the currency depreciation forecast for that particular country. Furthermore, as widely documented by the literature, the UIP has repeatedly been proven invalid (see Farhi and Gabaix 2016). The invalidity of the UIP, on which all carry trade-derived profit relies, is referred to as the "forward premium puzzle" (Brunnermeier et al. 2008). In other words, the gaps in the current understanding of international finance theory are what ensures the sustainability of the carry trade.

The literature on carry trade is extensive. A large body of empirical studies of hypothetical portfolios shows evidence of carry trade strategies. Overall, the data used to investigate these portfolios relates to the estimated profitability of carry trade (e.g. Burnside et al. 2007; Clarida et al. 2009; Darvas 2009; Menkhoff et al. 2012; Cenedese et al. 2014; Doskov and Swinkels 2015). However, excessive attention has been paid to carry trade-generated profits, which has hindered research from exploring other aspects of carry trade such as its impact on domestic economies and on the stability of the international financial system. Of particular interest is the side effect of the above-mentioned "forward premium puzzle", which is characterized by dramatic exchange rate fluctuations which disrupt the exchange rate equilibrium. Carry trade no doubt accounts to a large extent for foreign exchange rate puzzles (Spronk et al. 2013). As carry traders constantly seek to evade state regulations affecting their speculative investments, they are incentivized to make their capital as mobile as possible. The likelihood of a crash due to losses in carry trade positions is high, both for investment currencies and for speculators. To that extent, carry trade also increases the global risk (Brunnermeier et al. 2008).

Another strand of research has collected data on broader capital flows to explore the negative impact of carry trade activity (e.g. Dodd and Griffith-Jones 2007; Spronk et al. 2013; Fritz and Prates 2014; Prates and Paula 2017; Goda and Priewe 2019). This is an arduous undertaking, as the balance of payments makes it impossible to distinguish carry trade from other types of flows. Agrippino and Rey (2013) went down a similar path but relied on the Bank of International Settlements for international banking statistics.

In dealing with the data on speculative positions in the US futures market, our approach is indebted to Nishigaki (2007). Our paper explores the impacts of the carry trade using CFTC data, not estimated carry trade returns. There lies the distinctiveness of our undertaking with regard to previous approaches.

To our knowledge, no research has to this day investigated the Swiss franc carry trade in periods of negative policy interest rates using CFTC data. Hameed and Rose (2018) assert that negative interest rates in Switzerland bear no effect on carry trade returns. They find no sufficient evidence that negative interest rates on exchange rate behaviour. This contradicts the view held by the SNB that the effects of a negative interest rate policy would become apparent in the exchange rate channel (Jordan 2016). More in line with our results, Kay (2018) points out that negative policy interest rates encourage carry trade, which may also increase risks with their unpredictable unwind.

# 3 Data and SVAR Methodology

## 3.1 Data specification

We collected two samples consisting of data which illustrate SNB monetary policy. We cross-analyzed them against the backdrop of the structural vector autoregressive (SVAR) framework model devised by Nishigaki (2007). It is a five-variable model, as indicated in

Table 1. The PI period goes from October 2, 2007, to December 16, 2014. Our starting date coincides the beginning of monetary loosening in the US. Meanwhile, on December 18, 2014, the SNB dropped below the symbolical zero lower bound by setting the policy rate at -0.25% per year. Our NI period ranges from December 23, 2014, to November 12, 2019. In an effort to factor in the recent change in monetary policy in the US, a dummy variable (ME2) is created (equal to one from August 6, 2019, through November 12, 2019).

Table 1: Description of variables

| *Variable* | Definition | Source |
|---|---|---|
| *CT* | Ratio of short positions over long positions (Short/Long) | CFTC |
| *ER* | Nominal exchange rates, USDCHF | BIS |
| *IRD* | Difference between the policy interest rate in Switzerland and the policy interest rate in the United States | BIS |
| *VIX* | Market sentiment, CBOE DJIA Volatility Index | FRED |
| *SM* | Swiss Market Index, ^SSMI (Swiss stock market) | Yahoo Finance |
| *SMUS* | S&P 500, ^GSPC (US stock market) | Yahoo Finance |

*Note:* See Table A1 (Appendix) for the descriptive statistics

As a proxy of the carry trade, we use weekly data of Swiss franc futures contracts in the US financial market in which non-commercial traders engage in. According to the Commodity Futures Trading Commission (2020), traders are classified either as commercial or non-commercial. After filling a statement and being verified, a trading entity is classified as commercial if it uses futures contracts for hedging, as defined in the CFTC Regulation 1.3, 17 CFR 1.3(z). This categorization drew criticism on alleged grounds of naivete (Hartzmark 1987, p. 1296), as all other traders that do not qualify as hedgers are classified as non-commercial or speculators. Our study benefits from abundant past literature on the behaviour of speculators, prime among which is the CFTC data (e.g. Houthakker 1957; Chalupa 1982; Goldsteing 1983; Chang et al. 1997; Adrangi and Chatruth 1998; Klitgaard and Weir 2004; Mogford and Pain 2006; Galati et al. 2007; Nishigaki 2007; Brunnermeier et al. 2008; Gubler 2014; Mulligan and Steenkamp 2018; Kang et al. 2020).

In the present study, we use a ratio of short to long positions ($CT$). On day $t$ of a specific week, we divide the given number of contracts for each type of position. This ratio facilitates comparative analysis between countries. In this framework, a higher (lower) $CT$ would indicate an increase (decrease) in Swiss franc carry trade activity. Additionally, the reporting day $t$ of the CFTC data is used as the reference for the other variables.

Nevertheless, any results derived from the use of our proxy of carry trade should be weighed against its own shortcomings, as previously highlighted by Galati et al. (2007), Curcuru et al. (2011), and Bank for International Settlements (2015). The first caveat relates to the restrictiveness of the official definition of trading activity, as contracts classified as a speculator (non-commercial) may not be used in carry trade strategy. Second, over-the-counter contracts, which are not subject to CFTC reporting requirements, are largely used in carry trade activities. Third, only a small fraction of the overall foreign exchange market activity is executed through exchanges, as pointed out by the BIS Triennial Bank Survey of Foreign Exchange and Derivative Market Activity (Galati et al. 2007).

As acknowledged by market participants, CFTC data is a reliable indicator of carry trade trends (Bank for International Settlements 2015). This is, in large part, because it features robust, extensive publicly accessible data on speculative traders.

## 3.2 The SVAR model

In response to Becketti's call for "stronger statements about causation and timing" (2013, p. 372), we design a SVAR model with a view to investigating the impacts of carry trade in Switzerland. Our model follows the equation:

$$y_t = \phi_1 y_{t-1} + \cdots + \phi_p y_{t-p} + A^{-1} B v_t \tag{1}$$

The first element, $y_t$, represents a vector of the endogenous variables in our system of equations. With regard to constants, we exclude its vector for simplicity's sake. The matrices of coefficients are given by $\phi_i$. Matrices $A$ and $B$ are introduced to add structural parameters. In matrix $A$, we introduce additional contemporaneous endogenous variables to each equation. Matrix $B$ simplifies the error structure. In this sense, the matrix of random disturbances is transformed into $v_t$, with uncorrelated elements. The SVAR model follows this specification:

$$A\epsilon_t = Bv_t \tag{2}$$

Alternatively, in line with Nishigaki (2007), we have:

$$\begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 \\ g(VIX,IRD) & 1 & 0 & 0 & 0 & 0 \\ g(CT,IRD) & g(CT,VIX) & 1 & 0 & 0 & 0 \\ g(ER,IRD) & g(ER,VIX) & g(ER,CT) & 1 & 0 & 0 \\ g(SMUS,IRD) & g(SMUS,VIX) & g(SMUS,CT) & g(SMUS,ER) & 1 & 0 \\ g(SM,IRD) & g(SM,VIX) & g(SM,CT) & g(SM,ER) & g(SM,SMUS) & 1 \end{bmatrix} \begin{bmatrix} \epsilon_{IRD,t} \\ \epsilon_{VIX,t} \\ \epsilon_{CT,t} \\ \epsilon_{ER,t} \\ \epsilon_{SM,t} \\ \epsilon_{SMUS,t} \end{bmatrix} = Bv_t \tag{3}$$

Additionally, we follow in the footsteps of Chen et al. (2016) in estimating the SVAR model using the method formulated by Toda and Yamamoto (1995). Amiri and Ventelou (2012) favour this approach because it reduces the risks of a possible misspecification of the models in the presence of non-stationary variables. More importantly, by using this approach, we can capture long-term information with level variables.

The application of this technique is straightforward. First, we apply unit roots tests developed by Clemente et al. (1998). These tests consider one structural break with unknown breakpoints. We choose the innovational outlier (IO) model, which is more relevant to our data (the mean of series shifts gradually). The results are presented in Table 2.

Table 2: Results of unit root test

| | PI period | | | | | | NI period | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *CT* | *ER* | *IRD* | *VIX* | *SM* | *SMUS* | *CT* | *ER* | *IRD* | *VIX* | *SM* | *SMUS* |
| t-stat | -3.92 | -4.54 | -7.86 | -4.1 | -3.94 | -2.34 | -4.94 | -4.16 | -3.03 | -4.6 | -2.74 | -1.75 |
| I($d$) | I(1) | I(0) | I(0) | I(1) | I(1) | I(1) | I(0) | I(1) | I(1) | I(0) | I(1) | I(1) |

*Note:* See Table A2 (Appendix) for more details on these tests.

Moreover, variables that are not stationary in levels must be added as lagged exogenous variables in the SVAR model. The number of lags of these variables is specified by $d$ plus $p$. In doing so, we are proceeding with a modified Wald test (MWald test). Therefore, as asserted by Toda and Yamamoto (1995, p. 226), “it is clearly desirable to have a testing procedure which is robust to the integration and cointegration properties of the process so as to avoid the possible pretest biases."

Second, we require the maximum lag length $p$ of the SVAR model. In order to attain the value of $p$, we first generate tests for the optimal lag length. To that end, we use a combination of one test statistic (likelihood-ratio - LR) with three information criteria (Akaike - AIC, Hannan and Quinn - HQIC, and Schwarz's Bayesian – SBIC). Following these results, we proceeded with the Lagrange-multiplier (LM) test for residual autocorrelation (see Table A3 and Table A4 in Appendix). Whenever the optimal lag length order does not raise autocorrelation problems, we use the stability test (eigenvalue stability condition). Whenever the optimal lag length order fails the autocorrelation test, we choose the lag order with the highest p-value (lowest probability of autocorrelation). Thus, the procedure continues with the stability test at the end. Still, the correct lag order cannot be achieved by merely verifying the optimal lag length. The lag order $p$ may not have autocorrelated residuals. Additionally, the estimated model with the chosen lag must pass in the stability test (i.e. no eigenvalue larger than one).

The structure of the exogenous variables of the final estimated models is provided in Table A5 (Appendix). We explore the results of these models in the next section.

# 4 Empirical results and discussion

By analysing the impulse response functions of the estimated SVAR model, we can assess the relationship between carry trade and financial variables during the periods of positive interest rates (PI) and negative interest rates (NI).

Initially, we seek to determine the extent to which financial variables may account for carry trade fluctuations. By breaking the carry trade variances down into six components, we may isolate the weight of each financial variable. Table 3 shows the results of the variance decomposition for each period.

Table 3: Variance decompositions in PI and NI

| | | PI | | | | | | NI | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Response | | | | | | | | | | | |
| Impulse | *Step* | *IRD* | *VIX* | *CT* | *ER* | *SMUS* | *SM* | *IRD* | *VIX* | *CT* | *ER* | *SMUS* | *SM* |
| *IRD* | 4 | 94.14 | 0.39 | 0.26 | 0.73 | 2.68 | 1.79 | 94.11 | 2.20 | 0.34 | 0.39 | 1.36 | 1.60 |
| | 8 | 84.91 | 0.37 | 1.51 | 3.33 | 5.21 | 4.67 | 86.03 | 3.48 | 1.76 | 1.67 | 5.81 | 1.25 |
| | 12 | 78.01 | 0.30 | 2.43 | 6.83 | 5.79 | 6.65 | 75.65 | 2.85 | 3.15 | 2.45 | 14.02 | 1.88 |
| | 16 | 73.05 | 0.27 | 2.66 | 10.59 | 5.59 | 7.84 | 64.05 | 2.72 | 4.30 | 2.43 | 22.62 | 3.89 |
| | 20 | 69.24 | 0.26 | 2.54 | 14.25 | 5.22 | 8.49 | 53.24 | 3.07 | 5.13 | 2.10 | 29.72 | 6.75 |
| *VIX* | 4 | 0.13 | 93.26 | 0.04 | 0.10 | 5.44 | 1.02 | 1.11 | 95.16 | 0.16 | 2.00 | 1.57 | 0.00 |
| | 8 | 0.50 | 84.58 | 0.82 | 0.57 | 11.31 | 2.22 | 3.58 | 79.68 | 0.31 | 2.69 | 13.48 | 0.25 |
| | 12 | 1.06 | 80.30 | 1.83 | 1.07 | 13.05 | 2.70 | 4.61 | 67.80 | 0.62 | 2.27 | 23.19 | 1.50 |
| | 16 | 1.59 | 78.54 | 2.31 | 1.40 | 13.33 | 2.84 | 4.52 | 59.31 | 1.50 | 1.95 | 29.01 | 3.70 |
| | 20 | 2.02 | 77.84 | 2.43 | 1.57 | 13.28 | 2.85 | 4.15 | 52.65 | 2.35 | 1.70 | 32.83 | 6.32 |
| *CT* | 4 | 2.55 | 3.42 | 90.54 | 1.23 | 2.12 | 0.14 | 4.35 | 0.12 | 87.44 | 6.50 | 1.02 | 0.56 |
| | 8 | 2.08 | 8.45 | 77.54 | 4.98 | 6.29 | 0.66 | 5.51 | 0.28 | 76.28 | 14.60 | 1.48 | 1.86 |
| | 12 | 2.07 | 11.93 | 67.85 | 8.60 | 8.36 | 1.19 | 8.66 | 0.37 | 66.25 | 15.56 | 5.44 | 3.71 |
| | 16 | 2.35 | 13.61 | 62.38 | 11.28 | 8.87 | 1.51 | 10.01 | 0.60 | 57.14 | 13.91 | 12.28 | 6.07 |
| | 20 | 2.75 | 14.30 | 59.36 | 13.13 | 8.82 | 1.64 | 9.70 | 1.13 | 48.96 | 11.79 | 19.71 | 8.71 |
| *ER* | 4 | 0.04 | 2.61 | 6.58 | 90.17 | 0.17 | 0.42 | 2.87 | 3.08 | 0.41 | 93.13 | 0.08 | 0.43 |
| | 8 | 0.24 | 3.61 | 7.04 | 87.70 | 0.35 | 1.06 | 6.31 | 3.00 | 0.49 | 88.47 | 1.02 | 0.71 |
| | 12 | 0.70 | 4.35 | 7.10 | 86.06 | 0.38 | 1.40 | 7.81 | 2.87 | 0.48 | 84.63 | 3.04 | 1.16 |
| | 16 | 1.34 | 4.82 | 7.21 | 84.76 | 0.36 | 1.52 | 8.06 | 2.83 | 0.60 | 80.86 | 5.76 | 1.89 |
| | 20 | 2.06 | 5.11 | 7.39 | 83.60 | 0.32 | 1.52 | 7.86 | 2.94 | 0.84 | 76.80 | 8.63 | 2.91 |
| *SMUS* | 4 | 0.10 | 55.16 | 1.62 | 0.12 | 42.23 | 0.76 | 0.19 | 64.61 | 0.70 | 2.05 | 31.99 | 0.46 |
| | 8 | 0.37 | 50.94 | 5.35 | 0.34 | 41.19 | 1.81 | 1.02 | 60.63 | 3.19 | 3.09 | 30.10 | 1.97 |
| | 12 | 0.73 | 49.17 | 7.69 | 0.60 | 39.44 | 2.37 | 1.55 | 58.56 | 4.28 | 2.99 | 29.19 | 3.43 |
| | 16 | 1.06 | 48.49 | 8.70 | 0.77 | 38.38 | 2.60 | 1.68 | 57.46 | 4.50 | 2.92 | 28.96 | 4.49 |
| | 20 | 1.34 | 48.26 | 9.01 | 0.86 | 37.86 | 2.67 | 1.70 | 56.66 | 4.51 | 2.87 | 29.02 | 5.23 |
| *SM* | 4 | 0.12 | 41.09 | 0.92 | 7.76 | 30.21 | 19.90 | 0.87 | 42.37 | 3.10 | 12.16 | 3.78 | 37.72 |
| | 8 | 0.13 | 40.13 | 4.90 | 6.12 | 37.52 | 11.20 | 2.65 | 33.90 | 5.41 | 11.85 | 7.64 | 38.54 |
| | 12 | 0.25 | 39.12 | 8.70 | 5.28 | 37.84 | 8.80 | 4.47 | 29.32 | 5.37 | 12.48 | 11.57 | 36.79 |
| | 16 | 0.37 | 38.37 | 11.05 | 5.02 | 37.10 | 8.09 | 6.21 | 27.48 | 4.93 | 12.96 | 12.87 | 35.56 |
| | 20 | 0.45 | 37.89 | 12.24 | 5.05 | 36.53 | 7.85 | 7.60 | 26.67 | 4.66 | 13.14 | 12.98 | 34.95 |

In the short-term – within four weeks after the initial shock – the forecast-error variance in carry trade is almost exclusively due to uncertainty in the carry trade equation (90.54% in the PI period; 87.44% in the NI period). Differences are very subtle; results do not differ much from one period to the other. Notably, there are changes in the variables $IRD$, $VIX$, and $ER$ between the two periods. As opposed to the PI period, the examination of the NI period reveals that the error in the $IRD$ and $ER$ equations amplify their impact on the variance of $CT$. Also, $VIX$ appears as a less significant factor.

However, after four weeks, the results of the variance decomposition of the carry trade equation begin to differ sharply. Beyond twenty weeks, in the PI period, 36.25% of the variance is attributed to the error in the $VIX$, $ER$, and $SMUS$ equations (14.30%, 13.13%, and 8.82%, respectively). As for the NI period, $SMUS$, $ER$, $IRD$, and $SM$ contribute approximately to half (49.91%) of carry trade fluctuations (19.71%, 11.79%, 9.70%, and 8.71%, respectively).

By switching from positive policy rates to negative ones, the SNB played a decisive part in effecting change with regard to the relationship between carry trade and financial factors. Notably, during the NI period, the impact of $VIX$ on $CT$ is negligible. Another difference is the substantial impact of Swiss stock prices. Similar to the NI period, factors such as US stock prices and the exchange rate still maintain a meaningful influence on carry trade meaningfully in the PI period.

We follow with the results for the impact of carry trade on the fluctuations in the financial variables. As displayed in Table 3, the error on the carry trade equation bears no significant impact on the forecast-error variance of the financial variables. Interestingly, in the short-term (4 weeks), $CT$ accounts for 6.58% of the $ER$ fluctuations for the PI period. Also, after four weeks ahead, 3.10% of the Swiss stock prices fluctuations are directly tied to carry trade activity during the NI period. Twenty weeks onwards after the initial shock, there is no consistent $CT$ impact on $IRD$ for both periods (2.54% in the PI period; 5.13% in the NI period). Besides, $CT$ effect on $ER$ (7.39%) has been established in the long-term in the PI period, while on the NI period $CT$ has an established effect on $SM$ (4.66%) and $SMUS$ (4.51%).

With Fig. 2 and 3, we assess the impulses response functions graphically. These figures show the impacts of financial variables impulses on carry trade during both PI and NI, respectively.

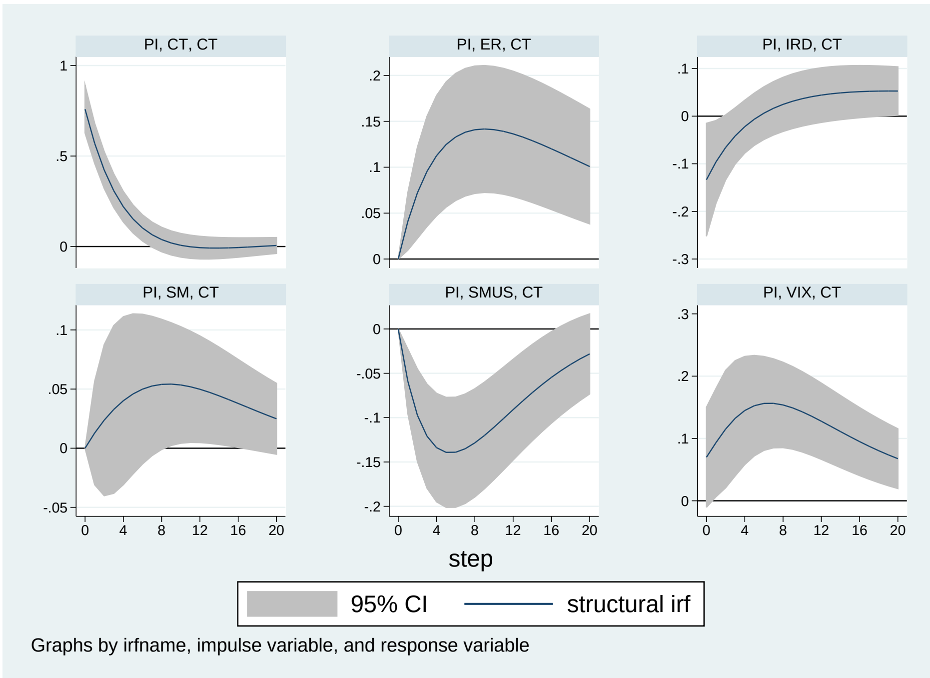


Figure 2: Structural Impulse Responses of $CT$ during PI

Significantly, during the PI period, the Swiss policy rate exceeds the policy rate in the US only for sixteen continuous weeks (over a total of 377 weeks). Moreover, for several weeks, both rates are identical (179 weeks), resulting in an $IRD$ equal to zero. Unsurprisingly, we only find a statistically significant result in the very short-term. Furthermore, the target currency classification is also supported by the number of weeks in which short positions were smaller than in long positions (the green area in Fig. 1). During the PI period, the carry trade ratio presents a value between 0 and 1 for 179 weeks, as opposed to 56 weeks for NI.

We find robust evidence for the effects of $SMUS$ on $CT$ is found. By revealing an inverse relationship, the results show that carry trade activity would increase in a bearish US stock market. However, this substitution effect needs to be interpreted with caution since the presence of diversified portfolios to diminish risk is common practice in the financial market. Results of the $VIX$ shocks on $CT$ are illustrative of this trend. A boost in the market

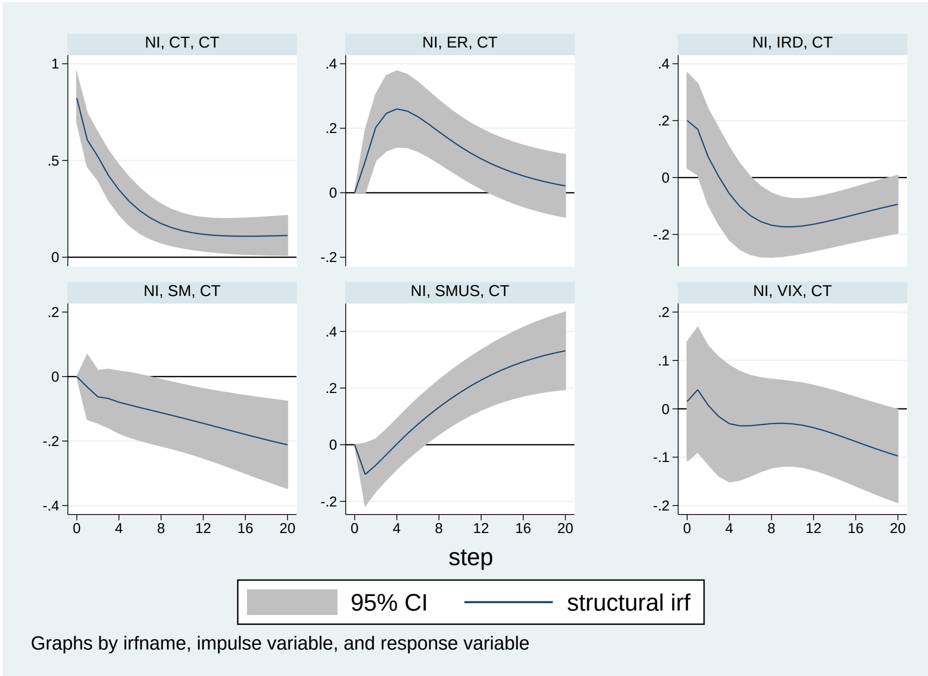


Figure 3: Structural Impulse Responses of $CT$ during NI

sentiment would energize carry trade activity. As for Switzerland's stock market prices shocks, the results highlight a positive relationship with $CT$ within 8 to 16 weeks ahead of the initial shock. This further buttresses our hypothesis of the Swiss franc's role as a target currency in the PI period.

As we learn from Fig. 3, results change drastically in the NI period. Nonetheless, there are some similarities. First of all, concerning the exchange rate shock, results remain the same. A stronger/weaker exchange rate (USDCHF) could increase/decrease Swiss franc carry trade activity. As the Swiss franc depreciates, carry traders intensify their activity, which is what we would expect. Moreover, the SNB explicitly pushes for devaluations of the Swiss franc. Setting negative interest rates increase the likelihood of profits in carry trade operations.

$IRD$ shocks provide significant results in the first two-weeks following the initial shock, as well as past a six week-period. Initially, the increasing interest rate differential has a positive impact on carry trade activity. After two weeks, the trend reversed itself. During NI, Swiss policy rate stays stable at -0.75%.

Consequently, movements in the $IRD$ are due to the Federal Reserve's monetary policy.

In the US, the policy rate remained at 0.125 per cent for 366 weeks. The first hike after this long period occurred on December 14, 2016, when Janet Yellen, Chair of the Federal Reserve, announced a 0.25 percentage point increase. The peak of carry trade ratio in our data is reached after several other hikes (10.61 on July 24, 2018). On July 31, 2019, Yellen's successor Jerome Powell implemented the first cut in the US policy rate since the 2008 crisis with a 25 basis points decrease. This cut precipitated a new monetary easing trend in the US.

The most striking results emerge from the stock markets shocks, both $SM$ and $SMUS$. In the short-term, up to 6-7 weeks ahead of the initial shock, results are not significant in either case. At some later stage, the $SM$ shock begins effecting carry trade negatively, whereas the impact remains positive on $SMUS$ shock.

Hence, bullish markets in Switzerland and the US may have varying impacts on carry trade activity. Nevertheless, data show that both markets are experiencing a long-term upward trend during NI. We might think this result accounts for the rechanneling of financial investments into foreign markets away from domestic stock markets. In that sense, unconventional SNB policy may do more to incentivize speculative financial operations than it does to stimulate productive investments in the Swiss economy. This is consistent with the adverse side effects of NI policy which have been highlighted by a number of authors (see Rossi 2019).

As for the results of the $VIX$ shock on carry trade during NI, they are enclosed by zero (statistically insignificant).

We now turn to the impacts of the franc-denominated carry trade activity on the financial variables (see Fig. 4 and 5). Given the low contributions found in the forecast-error variance analysis, our results need to be interpreted with caution.

During PI, Fig. 4 shows three significant impacts of the carry trade. Firstly, an initial $CT$ shock increases the $ER$ up to five weeks ahead. A similar result is found in Nishigaki (2007). Secondly, from two weeks up to 16 and from four weeks onwards respectively after the initial shock, $SMUS$ and $SM$ increase following a positive shock in $CT$. The dynamic interaction of $ER$, $SM$, and $SMUS$ with carry trade is further proof of the Swiss franc's role as a target

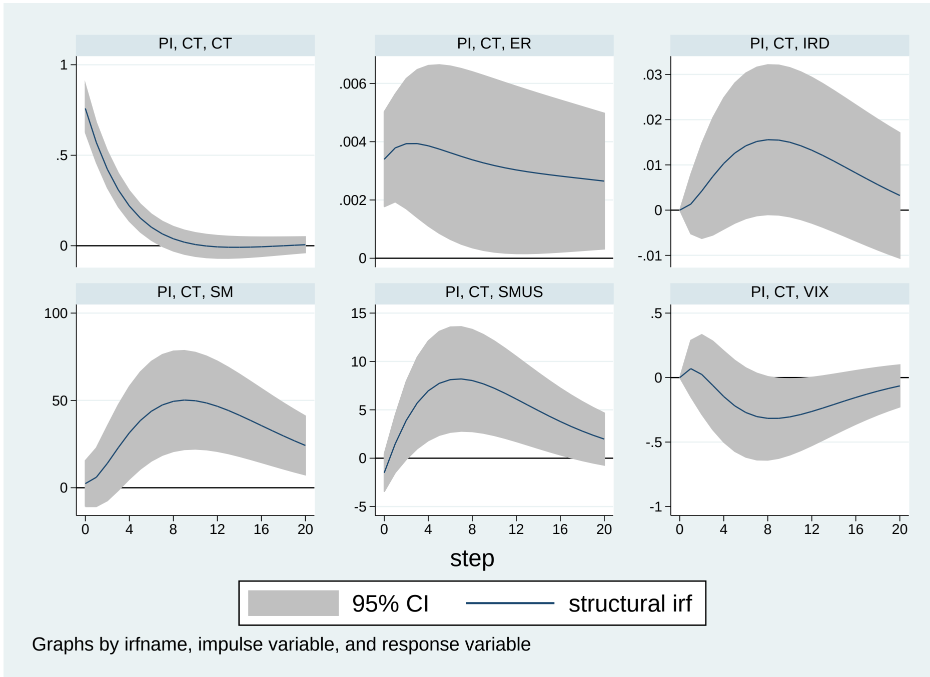


Figure 4: Structural Impulse Responses to the $CT$ shock during PI

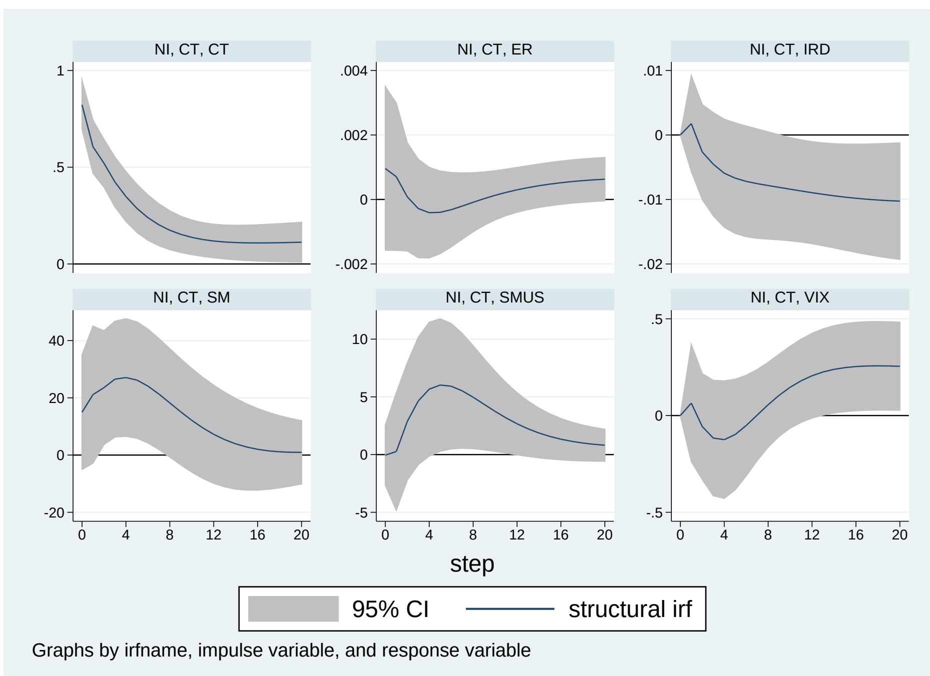


Figure 5: Structural Impulse Responses to the $CT$ shock during NI

currency during PI.

Fig. 5 displays the results pertaining to NI. In the case of $ER$, the lack of statistical evidence makes the results hard to decipher. Contrary to PI, carry trade and interest rate differentials are inversely related. After ten weeks, the negative impact of $CT$ on $IRD$ becomes statistically significant. What is even more striking is the positive impact of carry trade shocks on $SM$, $SMUS$, and $VIX$. Nevertheless, there are only significant results for a short period ahead of the initial shock: 3 to 8 weeks for $SM$, 5 to 12 for $SMUS$, and 13 to 20 for $VIX$. Crucially, the unwinding of the Swiss franc carry trade activity would have negative impacts not only on the domestic market but also on foreign markets.

With regard to the robustness of the results, Fig. A1 (Appendix) shows that both estimated models respect the stability condition (all eigenvalues lie inside the unit circle).

# 5 Main conclusions and policy implications

The present paper takes a novel approach to the study of the Swiss carry trade using data from real positions by speculators in the US futures market. In a complementary way, we explore two different periods of policy interest rates in Switzerland. Notably, we clarify NI with new empirical results.

We initially formulated two key research questions: (1) what are the impacts of the financial variables on the carry trade?; (2) what is the impact of the carry trade on the financial variables? With regard to question (1), we find unprecedented results in the effects of the $IRD$ on the carry trade. First of all, the contribution of $IRD$ is more substantial in both short and long-term in the NI period than in the PI period. Additionally, an initial positive shock on $IRD$ has a positive impact on the short-run and a negative in the long-run. Therefore, the role of a safe haven currency may be reinforced in the near future on the basis of the current downward movement in the US policy rate. Yet, the Swiss franc may still hold its funding currency characteristic with respect to other currencies with positive policy interest rates.

About question (2), evidence of carry trade impact on the financial variables is lacking and inconclusive. More importantly, according to the variance decomposition for NI, the unwinding of the carry trade would impact the market sentiment and both Swiss and US stock markets negatively in the long-run. Moreover, there is evidence of systemic risk in the NI period. Nonetheless, our results need to be interpreted with caution because of the given weight of the forecast in the variance decomposition.

Our findings are consistent with the existing literature stressing the negative impact of carry trade activities on global financial and monetary risk. Specifically, carry trade activities contribute to a negative impact on monetary policies in the sense that they increase exchange rate volatility but reduce the predictability of exchange rate movements. As far as the SNB is concerned, we might suppose that carry trade activities may have played a role in the recent reappreciation of the Swiss franc (Gubler 2014).

Although such an appreciation is not harmful to Switzerland in the long run, it could nevertheless cause disturbances in the short term when some thresholds are crossed, as demonstrated by the 2008 crisis. Presumably, it would be complicated for the SNB to fix the exchange rate floor against the euro a second time. Therefore, the SNB could benefit from announcing exchange rate targets against the USD and the EUR (through crawling pegs), as the Fed would design these targets in conjunction with the ECB. Likewise, this could be very useful to manage carry trade activities, since exchange rate changes seem to predict carry trade activities (Gubler 2014).

Conversely, we should remember that central banks' monetary policies are also more likely to influence carry trade activities when these monetary policies are not coordinated. The SNB's actual negative interest rates policy may have created perverse incentives for more speculation on the Swiss financial market (Rossi, 2019). This finding vindicates the view that the SNB should strengthen its remit over asset price regulation in Switzerland. This entails that the SNB would benefit from consolidating its macro-prudential supervision, by setting up new instruments to respond to changing financial variables, through new types of monetary and financial condition indices for instance (Guillaumin and Vallet 2017).

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# Appendix

Table A1: Descriptive statistics

| | PI | | | | | | NI | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *CT* | *ER* | *IRD* | *VIX* | *SM* | *SMUS* | *CT* | *ER* | *IRD* | *VIX* | *SM* | *SMUS* |
| Observations | 377 | 377 | 377 | 377 | 377 | 377 | 256 | 256 | 256 | 256 | 256 | 256 |
| Mean | 1.60 | 0.99 | 0.09 | 22.39 | 6,896.30 | 1,363.29 | 2.39 | 0.98 | -1.80 | 15.27 | 8,870.29 | 2,431.12 |
| Std. Deviation | 1.48 | 0.09 | 0.46 | 10.19 | 1,093.98 | 314.87 | 1.87 | 0.02 | 0.82 | 4.27 | 587.36 | 343.91 |
| Min. | 0.09 | 0.74 | -2.00 | 10.99 | 4,358.00 | 696.33 | 0.22 | 0.87 | -3.13 | 9.43 | 7,583.27 | 1,852.21 |
| Max. | 9.69 | 1.21 | 1.50 | 67.64 | 9,138.56 | 2,067.03 | 10.62 | 1.03 | -0.38 | 36.02 | 10,314.16 | 3,091.84 |

Table A2: Clemente-Montañés-Reyes unit-root tests, Innovational Outlier Model

| | PI | | | | | | NI | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *CT* | *ER* | *IRD* | *VIX* | *SM* | *SMUS* | *CT* | *ER* | *IRD* | *VIX* | *SM* | *SMUS* |
| $(\rho - 1)$ | -0.12 | -0.07 | -0.10 | -0.07 | -0.04 | -0.02 | -0.25 | -0.18 | -0.03 | -0.17 | -0.07 | -0.02 |
| t-stat | -3.92 | -4.54 | -7.86 | -4.10 | -3.94 | -2.34 | -4.94 | -4.16 | -3.03 | -4.60 | -2.74 | -1.75 |
| Critical value | -4.19 | -4.19 | -4.19 | -4.19 | -4.19 | -4.19 | -4.19 | -4.19 | -4.19 | -4.19 | -4.19 | -4.19 |
| I($d$) | I(1) | I(0) | I(0) | I(1) | I(1) | I(1) | I(0) | I(1) | I(1) | I(0) | I(1) | I(1) |
| T | 339 | 339 | 339 | 339 | 339 | 339 | 230 | 230 | 230 | 230 | 230 | 230 |

*Note:* Critical values are taken from Table 4 (T = $\infty$, 5% sig. level) in Perron and Vogelsang (1992).

Table A3: Optimal lag-order

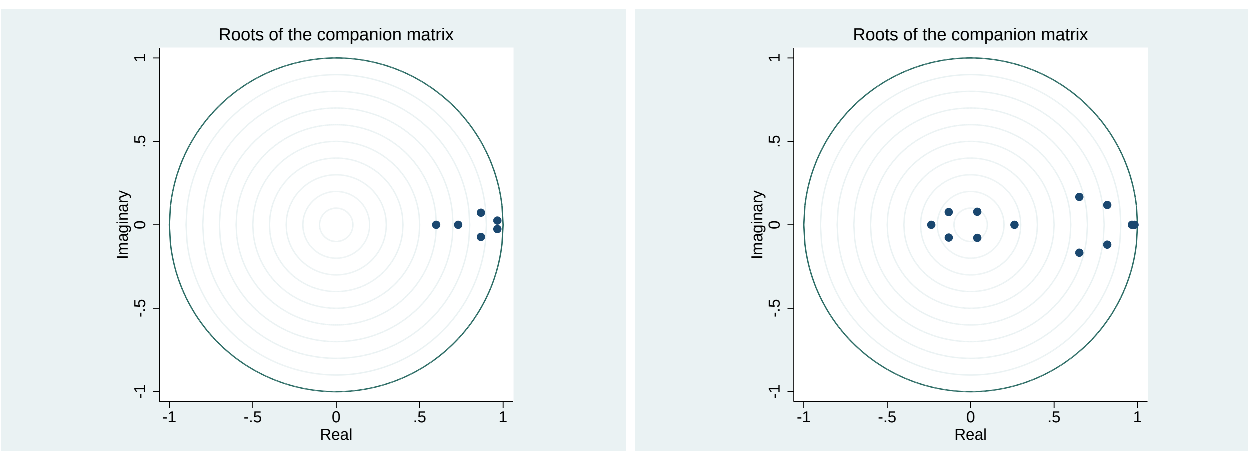
| | PI | | | | NI | | | |
|---|---|---|---|---|---|---|---|---|
| Lags | LR | AIC | HQIC | SBIC | LR | AIC | HQIC | SBIC |
| 0 | | 19.06 | 19.06 | 19.06 | | 16.64 | 16.64 | 16.64 |
| 1 | 5,648.82 | 3.78 | 3.93* | 4.17* | 3,520.98 | 3.17* | 3.37* | 3.67* |
| 2 | 102.46 | 3.70 | 4.00 | 4.47 | 51.00* | 3.25 | 3.65 | 4.25 |
| 3 | 112.05 | 3.59 | 4.05 | 4.74 | 36.43 | 3.39 | 3.99 | 4.89 |
| 4 | 122.02 | 3.45 | 4.06 | 4.99 | 23.17 | 3.58 | 4.38 | 5.58 |
| 5 | 73.89 | 3.45 | 4.21 | 5.37 | 48.64 | 3.67 | 4.68 | 6.17 |
| 6 | 93.31 | 3.39* | 4.30 | 5.69 | 37.45 | 3.81 | 5.01 | 6.80 |
| 7 | 50.10 | 3.45 | 4.52 | 6.14 | 43.43 | 3.92 | 5.32 | 7.41 |
| 8 | 77.84 | 3.43 | 4.65 | 6.51 | 37.77 | 4.05 | 5.66 | 8.04 |
| 9 | 86.72 | 3.39 | 4.77 | 6.85 | 49.19 | 4.14 | 5.95 | 8.63 |
| 10 | 72.78 | 3.39 | 4.92 | 7.23 | 44.75 | 4.25 | 6.25 | 9.23 |
| 11 | 63.67 | 3.41 | 5.09 | 7.64 | 39.35 | 4.38 | 6.58 | 9.86 |
| 12 | 60.64* | 3.44 | 5.28 | 8.06 | 46.21 | 4.48 | 6.88 | 10.46 |

*Note:* The optimal lag-order is marked with an asterisk(*).

Table A4: Lagrange-multiplier (LM) test for residual autocorrelation (p-values)

| Lags | PI | NI |
|---|---|---|
| 1 | 0.1588* | 0.0001 |
| 2 | 0.4483 | 0.7308* |
| 3 | 0.0004 | 0.0004 |
| 4 | 0.1631 | 0.0744 |
| 5 | 0.2863 | 0.0001 |
| 6 | 0.0003 | 0.3796 |
| 7 | 0.0201 | 0.3083 |
| 8 | 0.0465 | 0.0655 |
| 9 | 0.0103 | 0.1161 |
| 10 | 0.2001 | 0.0548 |
| 11 | 0.1675 | 0.0053 |
| 12 | 0.7308 | 0.7314 |

*Note:* The number of lags used in the estimated models is marked with an asterisk(*).




(a) PI (b) NI

Figure A1: Eigenvalue stability condition

Table A5: Exogenous variables for each model

| Sample | VAR lag length ($p$) | Exogenous variables |
|---|---|---|
| PI | 1 | $CT_{t-2}$, $VIX_{t-2}$, $SM_{t-2}$, $SMUS_{t-2}$ |
| NI | 2 | $ME2$, $ER_{t-3}$, $IRD_{t-3}$, $SM_{t-3}$, $SMUS_{t-3}$ |