The role of carry trades on the effectiveness of Japan's quantitative easing

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Abstract

This paper investigates how carry trades altered the efficiency of the Japanese quantitative easing policy between March 1995 and September 2010. Monetary policy shocks are identified by means of a data-driven Structural VAR approach. Accordingly, our results rely exclusively on the statistical properties of the data through non-Gaussian identification. We show that carry trades, by altering the portfolio re-balancing channel, hampered the impact of the Japanese quantitative easing policy on growth.

Index terms— Carry trades, Unconventional monetary policy, Data-driven structural VAR, Japan
JEL classification: C32; C54; E5; E52; E58

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1 Introduction

In 2001, the Bank of Japan (BoJ) began implementing unconventional monetary policies (UMP). Since large economies massively resorted to Quantitative Easing (QE) after the 2008 crisis, such measures took a central place in the economic debate. Injection of liquidity into the financial system coupled with the zero lower bound in large economies gives investors in the foreign exchange (FX) market an incentive to exploit interest differentials. The literature acknowledges that part of the liquidity moves into emerging economies.[1]

This article investigates whether capital outflows driven by interest differential (so-called carry trades) affected QE effectiveness in Japan though a structural VAR model. The impulse response functions (IRFs) provide evidence of the channels through which the policy influences the economy. Finally, examining the results with and without carry trades allows us to conclude whether and how such speculative investments altered QE effectiveness in Japan.

In the early 1990s, the housing market crashed in Japan. Banking and housing markets are closely linked. To support the economy, the Bank of Japan lowered its policy rate to 0.5% in 1995 and zero in 1999. However, this was not sufficient to secure the recovery of the real economy. The policy rate remained close to zero and the Bank of Japan started to implement its QE program in March 2001. The monetary policy instrument was changed to current account balances held by commercial banks with the BOJ, influencing the economy through two channels: the portfolio-rebalancing channel of Meltzer (1995) and the expectation channel of Eggertsson and Woodford (2003). On the one hand, the QE policy aims at purchasing long-term securities in order to reduce their yields and push investors to hold other assets related to the corporate sector. In the end, it is designed to make borrowing cheaper for corporations, promot-

[1] See e.g. Morgan (2011), Anya et al. (2017), and Fratzscher et al. (2017).

ing investment and growth. This is what is termed the portfolio-rebalancing channel. On the other hand, the central bank tries to lower short and long-run interest rate expectations to boost growth (expectation channel). Our study of the effectiveness of the QE-policy in Japan sheds light on the instabilities carry trades could induce in the transmission mechanisms of monetary policy. A good understanding of what happened in Japan can help to explain how QE might contribute to global economic recovery. This topic is relevant for other central banks facing the liquidity trap. The case of the US economy is somewhat similar: the 2007 financial crisis started with the bursting of the housing bubble, the FED decreased its interest rate and began to implement QE by mean of a massive injection of liquidity (Joyce et al. 2012). This monetary policy has been studied intensely by researchers in the last decade.

This article investigates the effectiveness of the QE policy in Japan between 1995 and 2010. The novelty is the integration of capital flows allowing us to consider carry trades in a structural VAR (SVAR) model. Intuitively, when a QE episode occurs, carry trades make part of the injected liquidity move abroad, which could alter QE in Japan. Such investments aim at borrowing a low-return currency in order to invest it in a high-return one. QE policies are naturally favorable to carry trades since the interest rate remains close to zero and there are massive liquidity injections. These two ingredients are highly favorable to carry trades. However, capital outflows also lead to a depreciation of the Japanese Yen (JPY). Therefore a dilemma arises; on the one hand, QE should boost the economy through the portfolio re-balancing channel which could be broken by carry trades. On the other hand, capital outflows depreciate the JPY (see e.g. Svensson 2003 and Kurihara 2006), which benefits the Japanese economy. Our intuition is in line with Michaelis and Watzka (2017) who find that the impact of QE is time varying. The amount of carry trades is time varying depending on the interest rate differential. The above mentioned link between QE and carry trades is central to our paper. The main question is: what would happen if we did not omit carry trades from a monetary policy model? Would the effect of the QE shock be the same in this new environment? As far as we know, there is no study of the global effect of carry trades on QE policies. Part of the injected liquidity moves out of the country which might prevent the portfolio rebalancing channel from operating and hamper credit growth. First, this article contributes to the literature on the success of QE by allowing capital outflows to have an impact on the model. Secondly, following Lanne et al. (2017), the impulse response functions for a QE shock on the Japanese economy are statically identified. We find that, accounting for positions on the foreign exchange (FX) market, a QE shock does not significantly affect industrial production. Carry trades exported liquidity abroad, blocking the portfolio re-balancing channel and affecting industrial production. In other words, speculative positions in the FX market hampered QE effectiveness by preventing credit and growth from rising.

Section 2 presents the relevant literature and shows how carry trades are linked to quantitative easing policies. In Section 3, we introduce our SVAR model. Sections 4 and 5 respectively present the results and robustness checks and section 6 concludes.

2 Literature review

2.1 Quantitative easing

After the global financial crisis, the United States implemented unconventional monetary policies. A few years later, the European Central Bank also resorted to QE, raising the issue of the effectiveness of such policies. The Japanese economy provides a case study since the Bank of Japan (BoJ) was the first to massively resorted to QE. In September 1995, the BoJ reduced the uncollateralized overnight call rate to 0.5%. Unfortunately, it was not enough to boost growth and the Japanese economy deteriorated again in 1998. In 1999, the BoJ set the interest rate to zero and announced that it would keep it constant until deflation ended. In March 2001, Japan resorted to QE by increasing the current account balance. To reach the quantitative target, the BoJ bought mainly long-term government bonds between 2001 and 2005. Thereafter, it expanded its buying to cover assets held by private banks. Increasing the monetary base in excess should lead the private sector to adjust its portfolio by buying financial assets (portfolio-rebalancing channel). Indeed, the increasing money supply should raise the private sector's incentive to hold illiquid assets. That was the aim of the BoJ which massively used this kind of policy until 2011.[2] Gauging the effects of unconventional measures is a trending topic. In the last decade, Cecioni et al. (2011) show evidence that unconventional measures have been effective in influencing financial and macroeconomic variables, however there is still uncertainty surrounding the quantification of those effects. Morgan (2011) investigates the impact of the different Quantitative Easing (QE) episodes in the United States. His results reveal that QE episodes exported liquidity to emerging economies. In the same vein, Anya et al. (2017) showed that an expansionary policy shock significantly increases portfolio flows from the United States to emerging economies. On the same issue, Fratzscher et al. (2017) consider flows induced by QE episodes in the United States. They find an heterogeneous response of capital flows: both MBS and maturity extension programs triggered rebalancing outside the United States. This result is mainly explained by variation in macro-financial uncertainty.

[2] See Ueda (2012) for the timing and exhaustive details of the different QE episodes initiated by the BoJ.

The empirical studies usually focus on the effect of QE on financial market variables. Oda and Ueda (2007) use a no-arbitrage model of the term structure to asses the effectiveness of the BoJ's policies. By means of a risk-averse arbitrageurs model, Hamilton and Wu (2012) show that the maturity structure of debt held by the public might affect the interest rate structure. They show that when the economy is at the zero lower bound, the long-run yield is decreased without increasing the short-run yield. Thus, there is still considerable uncertainty around the quantification of the QE effects on macroeconomic variables as pointed out by Joyce et al. (2012). Recently, several authors (see e.g. Meinusch and Tillmann (2016), Weale and Wieladek (2016), Boeckx et al. (2017), and Schenkelberg and Watzka (2013)) have investigated how an unconventional monetary policy (UMP) shock affects macroeconomic variables in large economies in the context of a liquidity trap. These latter mostly use vector autoregression models (VAR). Reduced-form VARs are convenient for modeling the joint dynamics of numerous time series. However, SVAR model is more appropriate for dealing with macroeconomic issues. Impulse response functions (IRFs) can be derived to analyze the dynamics in SVAR models. Weale and Wieladek (2016) analyze the effects of asset purchases using monthly data when the zero lower bound was binding in the United Kingdom and the United States. Using the sign restrictions method like Uhlig (2005), they show that asset purchases had significant effects on output and inflation in both countries. In addition, they find that asset purchases reduce long-term interest rates and household uncertainty. Boeckx et al. (2017) estimate the effects of a shock to the balance sheet of the European Central Bank within a structural VAR framework identified by zero and sign restrictions. According to their results, a rising balance sheet stimulates bank lending, reduces interest-rate spreads, depreciates the Euro, and raises economic activity and inflation. Finally, Schenkelberg and

Watzka (2013) focus on QE in Japan with an SVAR model identified by sign restrictions. They require the UMP shock to have a non-negative effect on inflation. However, imposing such a restriction is quite a powerful move and rests on arbitrary assumptions. The recent literature is able to go further in the identification of macroeconomic shocks. Puonti (2019) uses a novel method recently put forward by Lanne et al. (2017) to test the plausibility of the restrictions imposed in the previous studies. In this approach, the identification is achieved under a non-Gaussian assumption and the independence of the error processes. This method leads to a statistical identification and the resulting IRFs are not economically labeled. Therefore, the model is uniquely identified, the so-called model identification problem (see e.g. Fry and Pagan 2011) disappears, and it becomes straightforward to report the impulse response functions.

2.2 Carry trade strategy

Carry trades are investments in the FX market in which investors bet against Uncovered Interest Parity (UIP). Indeed as long as UIP holds, the gain of investing in a high-interest rate country is canceled by the depreciation of the same currency. However, the seminal paper of Fama (1984) acknowledged that UIP does not hold in the short term. Accordingly, investors in the FX market are willing to exploit interest differentials by borrowing in low-yield currencies to invest in high-yield currencies. As Japan implemented QE, at a zero interest rate for several years, the JPY was the main funding currency in the past decade. Ranaldo and Söderlind (2010) and Habib and Stracca (2012) show that in crisis times the Japanese Yen acts as a safe haven currency against the US Dollar. Thus, such strategies could be used to hedge the risk. MacDonald and Nagayasu (2015) highlight that the decision to invest in a carry trade portfolio is motivated by the BoJ's willingness to maintain a low interest rate rather than exchange rate volatility. Formally, the return of a carry trade R_t (in log) with the JPY as the source currency is:

$$R_t = i_t^* - i_t + (E_t s_{t+1} - s_t), \tag{1}$$

with i_t the Japanese interest rate, i_t^* the foreign interest rate and $E_t s_{t+1} - s_t$ expected changes in the exchange rate. An increase in s_t refers to a JPY depreciation. After the 1999 announcement of the BoJ, FX market investors were informed that the Japanese interest rate would remain equal to zero until deflation ended. Hence, the interest differential between high interest rate countries and Japan would remain high. In this context, borrowing in JPY to invest in high-yield currencies implied a high profit (all else equal). Moreover, QE policy could be a signal for investors in the FX market that it is the moment to bet against UIP. As shown by Figure 2, speculators increased their appetite for such positions between 2000 and 2007 (QE episodes). Over this period, excess returns of carry trades, constructed with a portofolio of 10 currencies, were positive on average. Moreover, focusing on net future positions in the JPY, we observe that they are mainly negative over this period, reflecting capital outflows. The economic intuition underlying this paper is that the central bank injects liquidity into the banking sector in order to boost credit and growth. However, part of this liquidity goes abroad (high interest rates in SOEs) through carry trades. In Japan, Kurihara (2006) showed that capital outflows were accompanied by substantial depreciation of the JPY which benefited the Japanese economy. As a matter of fact, the JPY's depreciation is positively correlated with Japanese stock price indexes. By improving profits of Japanese exporting companies, the JPY's depreciation enhanced substantial capital gains for Japanese companies with large external assets. Svensson (2003) supports these findings and goes further by acknowledging that the depreciation channel is the main driver of

QE efficiency. However, Fang and Miller (2007) shows that the exchange rate volatility prevents the positive impact of a depreciation on exports in Singapore. Therefore, if the depreciation does not lead to more exports, capital outflows would only have a negative effect on the economy.

3 Structural VAR for the Japanese economy

3.1 The model

It is clear now that countries implementing unconventional monetary policies would be the source countries for carry trades. Given that investors borrow in the domestic currency (JPY) to invest in foreign currencies, such investments could alter the way the monetary policy acts on the economy. To analyze the effects of carry trades on the effectiveness of Japanese monetary policy, we estimate a simple reduced-form VAR model:

$$Y_t = C + \sum_{i=1}^{p} A_i Y_{t-i} + u_t \tag{2}$$

where C is a vector of intercepts, Y_t is a vector of n endogenous variables, A_i is an $n \times n$ matrix of autoregressive coefficients of Y_{t-i}, and u_t is a vector of residuals. We consider the following macroeconomic variables in the VAR system:

$$Y_t = [\mathrm{CPI}_t; \mathrm{IP}_t; \mathrm{RES}_t; \mathrm{LTY}_t; \mathrm{REER}_t; \mathrm{CT}_t]' \tag{3}$$

where CPI_t denotes the core consumer price index, IP_t the Japanese industrial production index, RES_t the bank reserves held at the Bank of Japan, LTY_t the 10-year yield of Japanese government bonds, REER_t the real effective exchange rate of the Yen against other currencies, and CT_t the proxy for carry trade activity.[3] In this model, the reduced-form error terms are related to the uncorrelated structural errors ε_t according to:

$$\varepsilon_t = B^{-1}u_t. \tag{4}$$

The $n \times n$ matrix B contains the contemporaneous relations of the structural vector ε_t. If the process y_t satisfies the stability condition

$$det(I_n - \sum_{i=1}^{p} A_i z) \neq 0, |z| \leq 1(z \in C) \tag{5}$$

then the model represented by equation (2) has a moving average representation

$$y_t = \mu + \sum_{i=0}^{\infty} \Psi_i B \varepsilon_{t-j}. \tag{6}$$

μ is the unconditional mean of y_t and Ψ_i is an $n \times n$ impulse response matrix. In line with Schenkelberg and Watzka (2013), the VAR model is estimated by Bayesian methods using monthly data. The sample starts in July 1995 and finishes in March 2010. We choose this period for two main reasons. First, the BoJ began to have an interest rate close to zero in 1995. During this period and for the whole sample, we consider that Japan was at the zero lower bound. The Japanese call rate reached 0.5% around 1995. Accordingly, the monetary policy tools during our sample period are a short-run interest rate close and equal to zero and the bank reserves held at the BoJ. Second, in 2010, other carry trades funding currencies emerge, such as the US Dollar. Indeed, all major central banks registered low interest rates in this period leading speculators to borrow in other currencies and no longer in JPY only while making carry trades. We use the same number of lags, $p = 6$ as Schenkelberg and Watzka (2013). It

[3] We have made Granger causality and Fisher tests on the reduced form model to be sure that the carry trade variable has an impact on the other. Results are available on request.

seems to be sufficient to capture the dynamics of the model. Autocorrelation tests do not reject the null of no remaining autocorrelation up to 10 lags for all the variables.[4] Finally, we seasonally adjust and de-trend the variables.

3.2 Non-Gaussian identification

We apply here the method of identification developed by Lanne et al. (2017) which rests exclusively on the statistical properties of the data. This approach has many advantages and few drawbacks compared to the approach of sign restrictions. If numerous models fit the data well, the latter method may fail to identify a unique model (Fry and Pagan 2011). Moreover, IRFs are driven by an implicit prior as shown by Baumeister and Hamilton (2015). The method used in this paper yields to a unique identification. In equation (4), matrix $\mathbf{B}$ contains the contemporaneous relations of the structural errors ε_t. This matrix is assumed to be nonsingular. Moreover, each component is independent in time with zero mean and a finite variance. In other words, we assume that each error term is a sequence of stationary random vectors independently distributed and one of them at most has a Gaussian marginal distribution. Furthermore, they follow a Student distribution with their own degree of freedom λ_i, $i = 1, \times, n$. Lanne et al. (2017) show that under the non-Gaussian assumption of the structural error term, matrix $\mathbf{B}$ is uniquely identified.[5]

With this identification, we can compute the n structural shocks and their impulse responses but they are not labeled and do not have economic meanings. We use the same restrictions as Schenkelberg and Watzka (2013) which have been validated by Puonti (2019). Then, to determine which shock is the QE one, we compute the conditional probability to satisfy these restrictions. This method was introduced by Lanne and Luoto (2016). Those satisfying the sign

[4]Results are available from the authors on request.
[5]See Puonti (2019) for more details on this identification method.

restrictions are expected to have high posterior probabilities. The interpretation of the impulse responses of that shock is straightforward. Such an identification method is used by Puonti (2019) who studies the impact of an UMP shock on the United States, Japan, and the Euro area but does not focus on the impact of carry trades activity. Turnip (2017) uses it to test identifying restrictions commonly used in small open economy SVAR models.

3.3 Data and statistics

The time series used in this paper are presented in Figure 2. Our data come from four main sources. First, we take the average outstanding current account balances (CABs) held by financial institutions at the BoJ and the 10-year government bond yield on the BoJ website. The main objective of the BoJ is the CABs target which is mainly made up of central bank reserves.

We proxy inflation with the core consumer price index obtained from the Statistical Bureau of Japan. This indicator measures the development of consumer prices excluding energy and food. From the Trade and Industry Ministry of Japan, we obtain a measure of Japanese industrial production. We use this index as a proxy for Japanese economic activity.The real effective exchange rate of the JPY against a basket of currencies is computed by the Bank of International Settlements and is available on their website. When this index increases, it represents an appreciation in the JPY. Lastly, like Brunnermeier et al. (2009), we use net positions in the FX market to proxy carry trades. These data are taken from the Chicago Mercantile Exchange. More precisely, we use positions of non-commercial (speculative) traders in exchange rate futures. Still, what matters in our study are net future positions. We construct them by taking the difference between long and short positions ($long - short$). Negative net positions mean that investors sell JPY (reflecting capital outflows) and vice versa.

Figure 2 shows that this indicator is mainly negative and presents a structural break after the introduction of QE. This could be interpreted as intense activity in Japanese-sourced carry trades.

4 Results

4.1 Non-Gaussian assumption and shock identification

Table 1 reports the estimates of the scale (σ_i) and the degree of freedom (λ_i) parameters corresponding to the errors of each equation i. It suggests clear deviations from normality, which is what is required for identification.

To disentangle the unconventional monetary policy shock among the n statistically identified ones, we check which shock satisfies the sign restrictions of Schenkelberg and Watzka (2013) among the n statistically identified ones. This procedure is explained in Lanne and Luoto (2016). The monetary policy shock should have a non-negative impact on prices and reserves. The IRF with the highest probability of satisfying these restrictions is labeled as a QE shock. We compute the posterior probability of each structural shock satisfying the restrictions on the first six and twelve lags ($h = 0$, $h = 0, \ldots, 6$ and $h = 0, \ldots, 12$). The results are reported in Table 1. We consider the shock with the highest posterior probability as the candidate for the QE shock. This shock supports the sign restriction with a probability around 0.30 and 0.34 depending on the lag structure.

4.2 Impulse Response analysis

The aim of this paper is to investigate whether carry-trade activity affected Japan's unconventional monetary policy. To answer this question, we estimate a model represented by Equations (2), (3), and (4) and compute the IRF of a

QE shock. The results are reported in figure 5.

Regarding the IRF, the QE shock affects inflation slightly (approximately 0.01%). This positive impact lasts 10 months and is not significant in each period. Overall, our result suggests that the QE shock does not raise inflation sufficiently to stop deflation, leading to the conclusion that the Japanese unconventional monetary policy has been unable to reach its objective. This finding is in line with Schenkelberg and Watzka (2013) and Ono (2017) who show that the inflation rate does not increase to a statistically significant level different from zero. It is worth noting that carry trades make the impact of the shock on inflation even lower, suggesting that these investments do matter in terms of QE efficiency. However, the difference is small which prevents us from concluding that there is a perverse effect of carry trades on QE in Japan.

The literature acknowledges that unconventional policies reduce activity initially and increase it after a delay (see among others, Lenza and Reichlin 2010). We obtain this increase in growth with a delay in the model without carry trades. However, in the presence of investments in the FX market, the impact on growth is not significant at all. This lack of efficiency of the policy in the presence of carry trades is explained by the portfolio re-balancing channel. By increasing liquidity, the QE policy should boost the flow of credit to the economy,[6] raising output. However, carry trades export part of the liquidity injected by the central bank abroad, offsetting the positive effect on credit and growth. Accordingly, carry trades hamper the impact of QE on growth through the credit channel. After the shock, positions in the FX market diminish and become negative. Therefore, our results show that the QE shock leads to capital outflows by altering positions in the FX market.

The real exchange rate represents an important channel of transmission: carry trades are affected by this variable and they in turn affect it. As shown in

[6] See Bowman et al. (2015) for an in-depth analysis of the credit channel.

Figure 5, the domestic currency depreciates after the shock for a few months, then it appreciates. The correlation between the REER and positions in the FX market is striking. As long as capital goes abroad (short > long positions), the Japanese Yen depreciates. Investigating the impact of this depreciation on output is beyond the scope of the paper, however, some authors have shown that it is positively correlated with the stock index and increases in exports, growth, and inflation.

One of the theoretical effects of a quantitative easing policy is the way it might change investors' expectations. With such a policy, central banks want investors to expect lower future interest rate in order to boost growth. According to our results this has not been the case in Japan in the sense that the QE shock does not significantly affect the long-term yield. The IRFs have revealed that accounting for carry trades or not in an SVAR model of the Japanese economy leads to different results. In the following section, we discuss how these effects of carry trades adversely affected the Japanese QE policy.

4.3 Discussion

Our analysis shows that, beside the positive effect of the JPY depreciation (see e.g. Svensson (2003) and Kurihara (2006)), carry trades have affected effectiveness of QE in Japan. According to our results, by exporting liquidity, carry trades canceled out the portfolio re-balancing channel, hampering the impact of the policy on growth.

As a matter of fact, the Japanese Yen depreciates more in the presence of carry trades. Comparing the IRF of net future positions and the real exchange rate highlights their close connection. Indeed the exchange rate depreciates as long as capital moves from Japan to foreign countries. In this paper, we argue that the capital flight is induced by carry trades, accordingly capital should move to small open economies with high interest rates.

The main result of our paper is that carry trades have altered the portfolio re-balancing channel. While implementing QE, a central bank buys long-term securities to reduce their yields and increase investors' incentive to buy assets benefiting the private sector. Therefore, borrowing becomes cheaper, raising investments and growth. However, our results suggests that investors in the FX market invested abroad. Accordingly, the policy did not increase the incentive to buy corporate assets but foreign assets, canceling the positive effect of the policy on growth.

Overall our results reveal that carry trades have hampered quantitative easing effectiveness in Japan by reducing the impact of the policy on growth. In addition, in line with Svensson (2003) and Kurihara (2006) among others, we state that the expectation channel is not a source of growth. Indeed, agents do not expect a lower interest rate in the future. Therefore, over the period studied, the BoJ was unable to anchor interest rate expectations. We do not find any positive effect of the depreciation of the Yen enhanced by capital outflows on growth. There is two possible explanations of this phenomena. First, the positive effect of capital outflows on international trade is coupled with a negative effect enhanced by moving liquidity, by addition there is no significant effect. Accordingly, unconventional monetary policies would not benefit non exporting countries. Second, Fang and Miller (2007) acknowledged that the expectation channel is reduced when investors grant too much importance to risk on the exchange rate market. Andersen et al. (2003), Watanabe and Yabu (2013), and Hashimoto and Ito (2010) have all shown that QE announcements and macroeconomic surprises have an impact on the JPY exchange rate.

5 Robustness checks

In this section, we use an alternative proxy for carry trades, carry excess returns. Then, we consider two different portfolios and re-estimate our SVAR model.

5.1 Proxying carry trades with their returns

To compute the excess returns of the carry trade portfolio, we follow the methodology of Lustig and Verdelhan (2007) and Husted et al. (2017) among others. We use daily data on spot exchange rates and three-month interest rates for the following countries: Australia, Canada, the Euro-Zone, Japan, New Zealand, Norway, Sweden, Switzerland, the United Kingdom, and the United States of America. All data are from Thomson Reuters Eikon database. For all currencies, except the Euro, the sample period begins in April 1995 and ends in March 2010. In our main portfolio, all currencies are equally weighted. We calculate daily excess returns, in JPY, over corresponding-maturity Japan interest rates on these portfolios. Then, we compute the unconditional mean of the excess returns at monthly frequency. More specifically, we compute the "Hold One Quarter" excess returns R_t as

$$z_t = (m - 0.25)i_{t+65} - mi_t - [(m - 0.25)i^{\star}_{t+65} - mi^{\star}_t] - (s_{t+65} - s_t). \qquad (7)$$

i_t and $i^{\star}_t$ represent the three-month Japanese and foreign interest rates respectively. s_t is the nominal exchange rate between the Yen and foreign currencies. Since we use the three-month interest rate, $m = 0.25$, we have

$$z_t = 0.25(i^{\star}_t - i_t) + (s_{t+65} - s_t). \qquad (8)$$

Figure 2 exhibits the monthly time series of the portfolio excess returns. In section 5.1.1, we use an alternative portfolio composed of 10 currencies. However, section 5.1.2 we construct a smaller portfolio composed of the three most attractive currencies in terms of carry trades.

5.1.1 The 10-currency portfolio

The IRFs from a QE shock with the return of a 10-currency portfolio are presented in Figure (4). Importantly, with an alternative proxy for carry trades, the economy responds similarly to the QE shock. Inflation rises slightly (still close to 0.01), industrial production first falls before recovering. The JPY depreciates right after the shock and appreciates further while the long-term yield does not respond significantly to the shock. These results clearly highlight the robustness of our methodology in the sense that our IRFs are similar with different proxies.

However, with this new proxy, in the presence of carry trades, the output widens significantly which was not the case with the previous proxy. Still, the output widens less with than without carry trades, suggesting again that carry trades negatively affect the portfolio re-balancing channel. This difference between our two proxies is due solely to the fact that net positions account for the volume while returns do not. Therefore, when quantifying the impact of FX investments, volume matters.

Also, with this proxy, the exchange rate depreciation is smaller in the presence of carry trades. Compared to the results with net positions, it is still induced by the volume of investments. Interestingly, comparing the red and black lines in Figure (4) corroborates the story that the depreciation of the currency affects growth through trade. Indeed, in the presence of carry trades (without accounting for the volume), depreciation is reduced, making the positive impact of international trade on growth slighter.

5.1.2 The 3-currency portfolio

Re-estimating the model with a smaller portfolio clearly reveals that our results are robust to different carry trade portfolios. In addition, while considering the three main currencies, we observe that industrial production still increases significantly but a little less than with 10 currencies. These are intensively used for carry trades, making the impact of FX investments on the portfolio re-balancing channel greater than with the previous portfolio. Our robustness checks argue in favor of a robust model. Indeed, using an alternative proxy and two different portfolios leads to the same economic conclusions. Carry trades prevented the portfolio re-balancing channel in Japan from operating by exporting liquidity to high interest rate countries.

6 Conclusions

The main objective of this paper is to provide a plausible explanation for the ineffective monetary policy in Japan during the last decade. Speculative positions in the FX markets have altered the QE measures adopted by Japan. In this paper, we argue that carry trade activity, which was very intensive during the 2000s, is able to explain part of this inefficiency. By means of a recent Bayesian SVAR identification method introduced by Lanne et al. (2017), we estimate the macroeconomic effects of Japan's unconventional monetary policy. This procedure exploits non-Gaussianity and independence of the structural error terms to uniquely identify the shocks. Then, we simulate a QE shock both with and without carry trades and compare the IRFs obtained. We find that an unconventional monetary policy shock produces different macroeconomic effects with carry trades: the timing, persistence, and statistical significance of responses to the shock are quite different.

The main result of this paper is that carry trades cancel out the portfolio rebalancing channel. Indeed, carry trades exported part of the liquidity injected by the BoJ. Therefore, according to our results, massive purchases of long-term securities led investors to invest in other currencies in the FX market. As a result, the policy did not increase the investors' incentive to buy corporate assets enough to increase credit and growth. Accordingly, our results show that investments in the FX market hampered the effect of the QE policy on Japanese growth. Our robustness analysis shows that the volume of carry trades is crucial when it comes to quantifying their impact on the economy. Indeed, we find similar results while accounting for excess returns instead of positions in the FX market. The difference is that, with net positions in the FX market, production does not rise significantly after the QE shock, while it does with excess returns. Still, even with excess returns as a carry trade proxy, production rises less after the QE shock than without carry trades. Such a result suggests that the non significance of industrial production for the QE policy is induced by the volume of carry trades.

A natural extension of this work would be to investigate whether and how central banks could implement unconventional policies and evict the negative effects of carry trades at the same time. Given that carry trades are performed in the FX markets, further research could focus on policies in these markets (including taxation and macroprudential measures).

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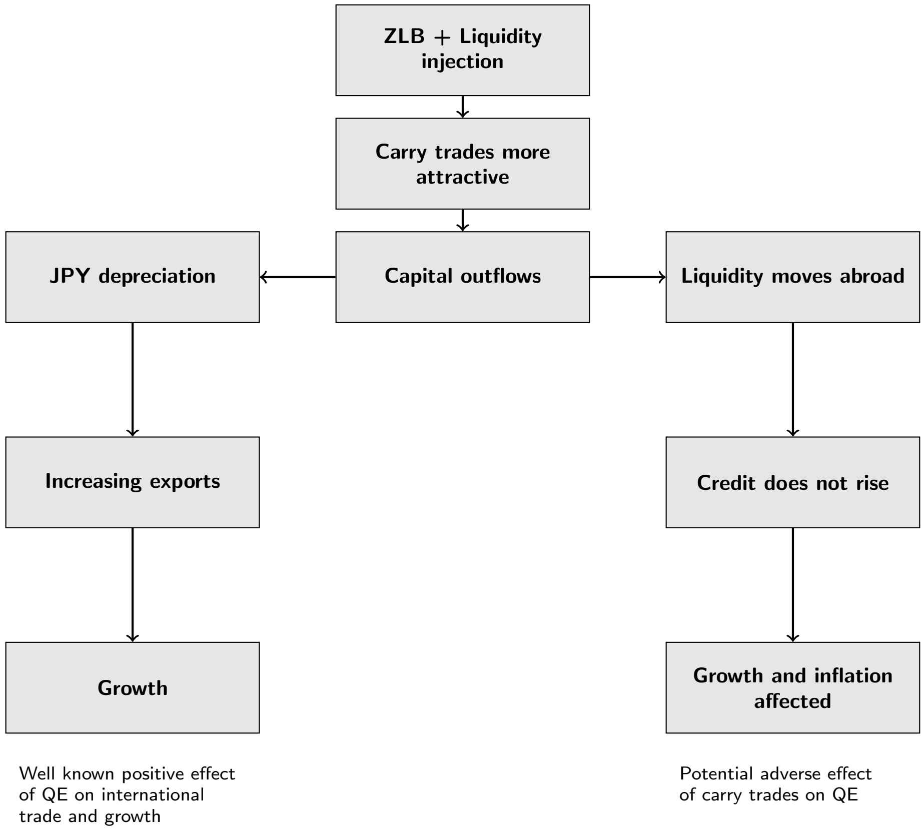

Figure 1: Quantitative Easing and Capital Outflows

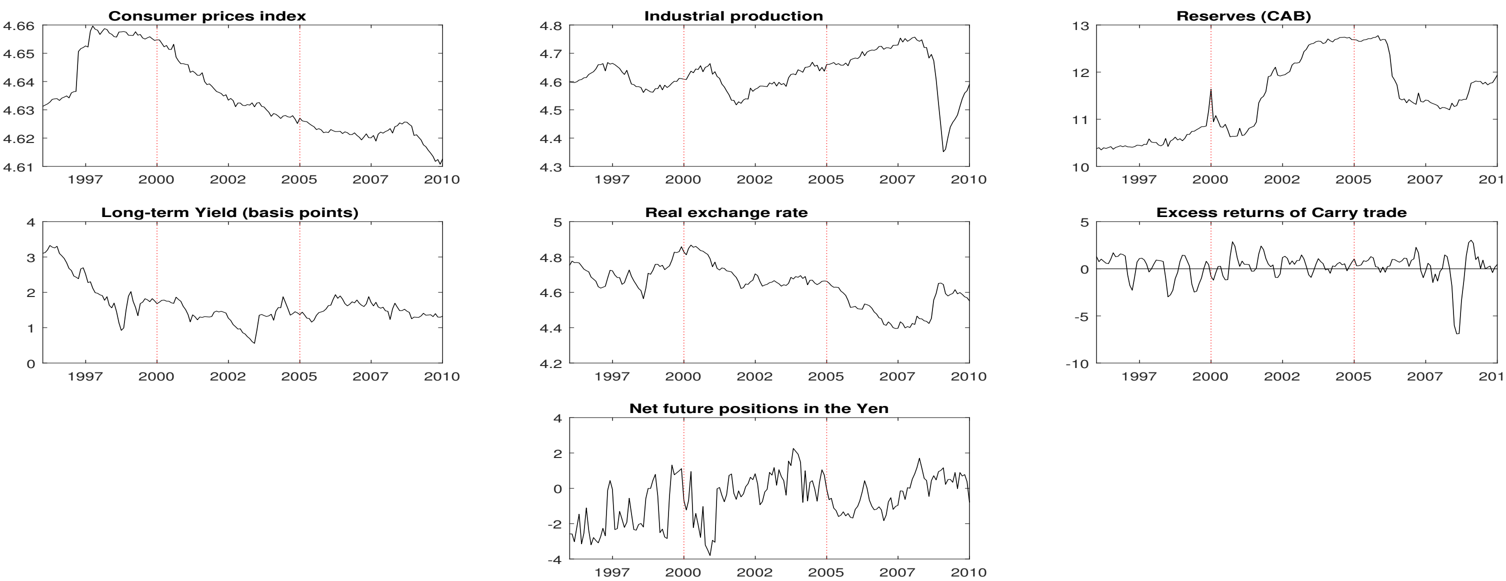

Figure 2: Actual evolution of the variables. The figure displays the evolution of CPI, industrial production, reserves, long-term yield, real exchange rate of the yen, excess returns of carry trades, and net positions in the futures market. The red vertical lines indicate the QEP period 2001:032006:03.

	CPI	IP	RES	LTY	REER	CT
Estimation of the scales and degrees of freedom						
σ	0.00	0.00	0.01	0.01	0.00	0.42
λ	3.82	2.34	2.27	2.66	5.05	5.89
Posterior probabilities						
h = 0	0.07	0.00	**0.12**	0.01	0.01	0.01
h = (0,. . . 6)	0.20	0.00	**0.30**	0.02	0.01	0.02
h = (0,. . . ,12)	0.22	0.00	**0.34**	0.01	0.01	0.01

Table 1 Scales and degrees of freedom of SVAR model estimation and posterior probabilities to satisfy the QE-shock at different horizons
Note: σ represents the scale of the error terms and λ the degree of freedom of the Student distribution. The posterior probabilities represents the probabilities to satisfy the sign restrictions that the reserves be positive and consumer prices be non-negative.

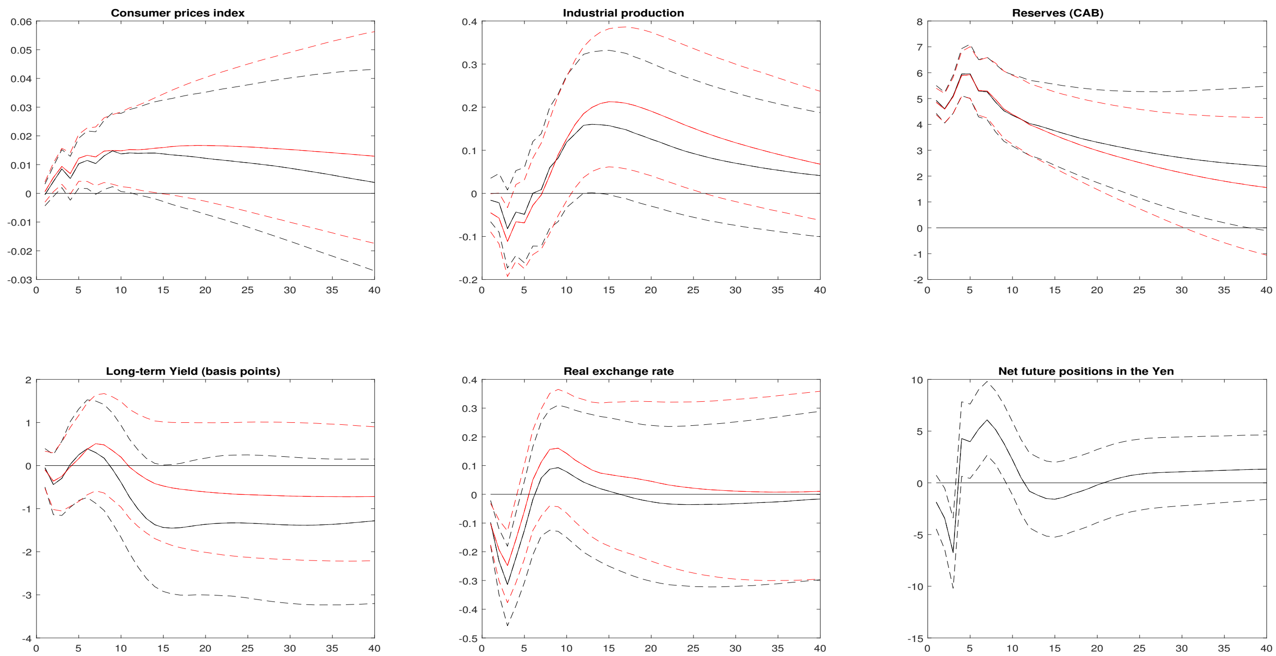

Figure 3: Impulse responses to an expansionary QE-Shock with net positions as a proxy of capital outflows.
Note: Red lines are the response from a model without the carry trade variable. Black lines are the response with the carry trade variable. Responses over an x-month horizon to a QE-shock as identified though non-Gaussian errors. Solid lines denote the median impulse responses from a BVAR (1000 draws), dashed lines indicate the 16% and 84% percentiles of the posterior distribution of the responses.

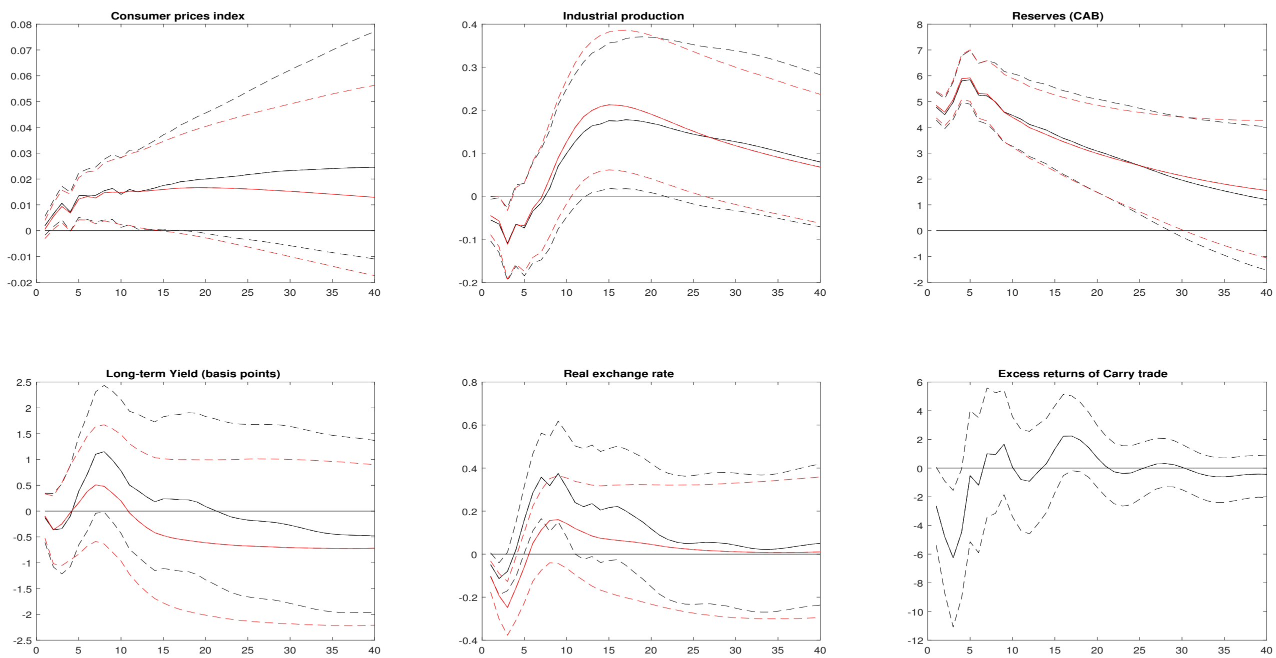

Figure 4: Impulse responses to an expansionary QE-shock: Excess return with a 10-currency portfolio.
Note: See figure 3.

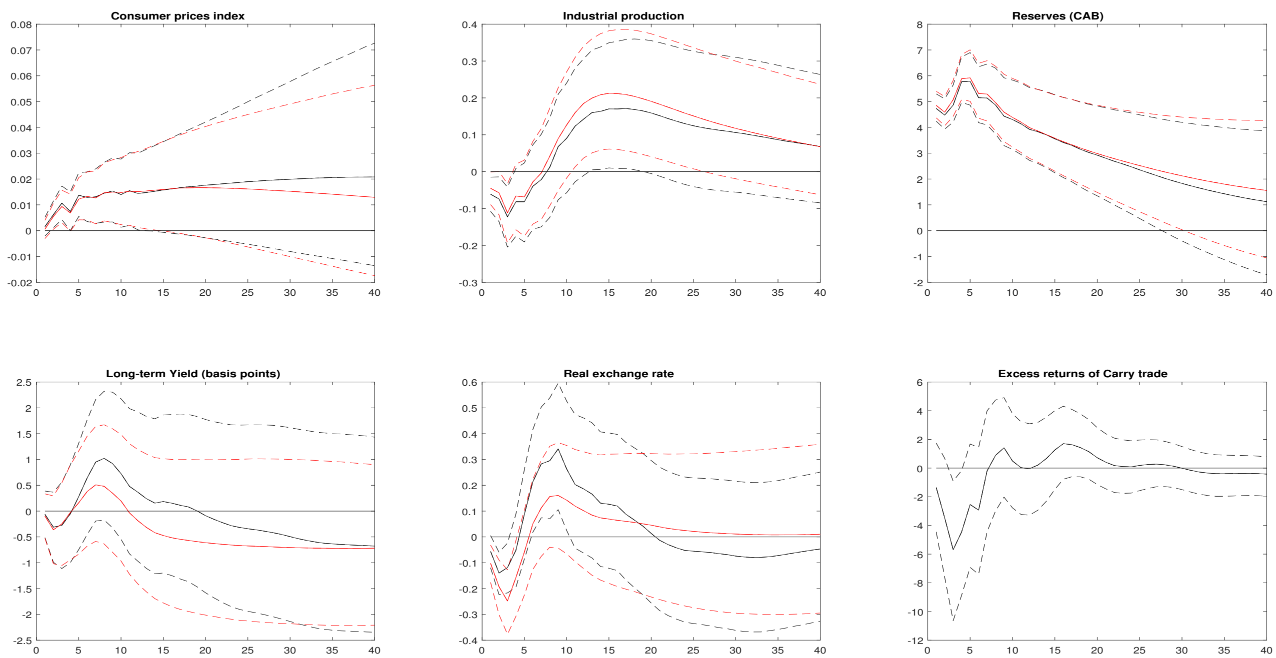

Figure 5: Impulse responses to an expansionary QE-shock: Excess return with a three-currency portfolio.
Note: See figure 3.