Carry trade and its relationship with the Stock Market: Evidence from New Zealand

By: **Dacheng Jin (Mike)**

Faculty of Business, Economics and Law

A dissertation submitted Auckland University of Technology in partial fulfilment of the requirements of Master of Business (Finance)

January 2018

Abstract

This study investigates the New Zealand dollar carry trade and its effect on the New Zealand stock market. Using a Vector Autoregression (VAR) model, the Granger causality relationship is from carry trade to stock market. The US dollar, Euro and Swiss Franc dominate carry trade as funding currencies and the New Zealand Dollar as investment currency. There is no evidence of Japanese Yen and New Zealand Dollar carry trade during the sample period of 2007 to 2017. Carry trade returns' effect on New Zealand stock market sector returns are generally attributed with various degree and preference. The basic materials sector is the only exception, where there is no Granger causality relationship in either direction. It also indicates carry trade returns positively affect the New Zealand stock market in both periods of crisis and post crisis. However, the Granger causality relationship is stronger in crisis period than it is in post crisis period.

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Attestation of Authorship

I hereby declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person except that which appears in the citations and acknowledgements. Nor does it contain material which to a substantial extent I have submitted for the qualification for any other degree of another university or other institution of higher learning.

Signature of the candidate:

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Acknowledgements

This work would not have been possible without support from the Finance department of Auckland University of Technology. I am very grateful to those I have had the pleasure of working with during this project. My first thanks go to Jun Chen, my primary supervisor. He has been there for me the whole time. I want to thank Professor Alireza Tourani-Rad, my secondary supervisor: he was very helpful at the beginning stage of this project. Professor Bart Frijns and Dr Alexandre Garel have been unstintingly generous in providing information and knowledge as well.

I also want to thank Dr Andy Godfrey, Min Milosavljevic, Tania Ang and Carol Young from the Postgraduate department of the Faculty of Business, Economics and Law. They provided me with extensive personal and professional guidance.

Last, I want to thank my family and friends whose love and support are with me all the time.

1. Introduction

Carry trade is a strategy of currency investment that explores the failure of Uncovered Interest Rate Parity (UIP). In its simplest form, the carry trader buys currencies of countries with high interest rates and sells currencies of countries with low interest rates. The high interest rate currency tends to appreciate, and low interest rate currencies tend to depreciate. Under the conditions of uncovered interest rate parity, changes of exchange rate should eliminate the gain generated from the difference of interest rates across the two countries. However, there is already plentiful empirical evidence that rejects the hypothesis of Uncovered Interest Rate Parity (UIP), two of the earliest and most famous works being from Fama (1984) and Engel (1996).

Carry trade has been one of the most popular speculative strategies among both global investment managers and individual currency investors for seeking yield and diversification benefits. For almost half a century, globalisation has substantially increased the integration of people through various channels. The global financial system does not make an exception, and international money flow has never been this easy. In addition, the Fed and major central banks have been widely lowering interest rates since the beginning of the new millennium and interest rates became even lower after the Global Financial Crisis in 2008. Cheap money and the easy flow of capital created a hotbed for such currency carry trade activities to form a multi trillion-dollar market.

Yield-seeking capital does carry trade, and it causes excess demand of investment currency. Such excess demand brings appreciation of investment currency against funding currency (Jylhä et al, 2008). Then appreciation of the currency attracts more capital into carry trade. The continuous capital inflow will influence the stock market. Because carry trade strategy does not merely hold a long position of the target currency, this strategy includes holding a long position in other asset classes denominated by the target currency for the purpose of both seeking extra yield returns and diversification benefit. Equity is a favourable asset class due to its liquidity. In the recipient country, carry trade capital inflow tends to be invested in the stock market. It is likely to push up asset prices. When there is too much capital inflow caused by carry trade, it may create irrational prosperity in the target financial market.

Contrariwise, when the performance of the stock market is good, it may also attract more global capital into the target currency stock market in the form of carry trade strategy. The increasing position of carry trade strategy consequentially brings excess demand for the investment currency. It causes appreciation of the investment currency against the funding currency (Jylhä et al, 2008), such exchange rate appreciation bringing more carry trade profitability in addition to stock market returns. Under this mechanism, it generates more interest in initiating carry trade. When the stock

market does not perform well in a bear market, carry traders may unwind their position in carry trade to minimise their risk exposure. Such unwinding activities may cause selling activities of equity assets and worsen the performance of the stock market. This situation then causes reverse in the balance between the investment currency and the funding currency, and depreciation of the investment currency against the funding currency. It affects carry trade return. It is supported by Katechos (2011) who suggests that equity market returns are correlated to international interest rate arbitrage returns. In bad times, risk and loss aversion may result in unwinding carry trade positions to cover losses in the stock market which causes the exchange rate to swing as well as carry trade return. Further, such a relationship depends on relative currencies and the degree of relationship is stronger when interest rate differentials are larger.

There were previous studies suggesting that there are Granger causality relationships between carry trade and the stock market. Cheung et al (2012) found that Japanese Yen carry trades positively cause stock market returns. Fung et al (2013) also empirically suggest there are Granger causality relationships between carry trade and stock markets in Australia, Japan and India. Lee et al (2013) suggest there are positive spill-lovers of currency carry trade returns and corresponding stock market returns of the investment currency. Nevertheless, Tse and Zhao (2012) provide opposing empirical evidence that there is no Granger causality relationship between carry trade and the US stock market. Overall, such a relationship is not very clear and the mechanism behind it Is relatively less studied.

Following the prior literature, this study looks into the mechanism of such a relationship between two asset classes of New Zealand Dollar carry trade and the New Zealand stock market. It is primarily motivated to contribute further supportive evidence explaining the relationship between carry trade and the stock market in the context of New Zealand. The study applies the Vector AutoRegression (VAR) model to study in depth the dynamic between carry trade and the stock market. It is significant that such bidirectional interaction gives important implications for asset pricing and portfolio management. In a more practical setting, this study investigates the lead-lag relationship in both directions between carry trade with the New Zealand Dollar as the target currency and the New Zealand stock market. More specifically, it examines whether a change in the currency carry trade return is predictable from past movements of the stock market, and vice versa.

In this study we will focus on New Zealand Dollar carry trade and its relationship between it and the New Zealand stock market, since New Zealand has been commonly considered to be one of the most popular investment (target) currency countries. As one of the most advanced economies with an open, mature and regulated financial market, the New Zealand Dollar is a highly liquid currency: it is one of the highest interest rate countries among OECD countries. Galati et al (2007)

initiated a few tracking measurements of currency flows in the international banking system and net open opposition in the foreign exchange futures market, which showed evidence that New Zealand is one of the most-used target currencies. Curcuru et al (2010) attempt to explain carry trade activity, collecting data from various source such as BIS and the Triennial Central Bank Survey for foreign currency positions. Likewise, it shows clear evidence that the New Zealand Dollar is a target currency for carry trade activities. Fong (2010) measured Yen carry trade activities covering the period from 2001 to 2009, and the cumulative return of carry trade paring of the Japanese Yen and the New Zealand Dollar tops the group, among others including the Australia Dollar and the United Kingdom Pound. Similarly, in Neely and Weller (2013), New Zealand and Australia are within the group of top performers of investment currencies in carry trade transactions in their sample period. Bansal and Dahlquist (2000) elaborate that Uncovered Interest Rate Parity (UIP) is more significant in developed countries than emerging markets. The New Zealand stock market is likely to be more affected by carry trade. The impact can be even more pronounced given the popularity of the New Zealand Dollar as an investment currency and the relatively small size of capitalisation of the New Zealand stock market.

This study contributes to the literature in three ways. It attempts to offer a much more comprehensive way of studying the New Zealand Dollar carry trade both in the most up-to-date timeframe and given the inadequate focus hitherto on New Zealand Dollar carry trade and its impact on the New Zealand stock market. It includes the prevalent carry trade index as a proxy, and also produces individual currency pair carry trade, associating major funding currencies against New Zealand Dollar. It would provide plausible and more detailed evidence on the New Zealand Dollar carry trade. Given that conditions of carry trade vary over time, it examines the legitimacy and evolution of New Zealand Dollar carry trade as investment currency over the years associated with particular funding currency to discover any changes of profitability, pattern for carry trade and its effect on another type of asset: stocks.

Moreover, this study investigates the stock market in a more specific approach attempting to offer even more practical insight. The investigation of the relationship between carry trade returns and the New Zealand stock market is extended to carry trade and stock market sectors. It gives more insights in a more realistic sense for fund managers both globally and domestically. Foreign investors who establish carry trade strategy involving New Zealand as investment country with pre-determined funding currency will be able to make better decisions on selecting the New Zealand stock market sector with respect to portfolio management. This knowledge would also be beneficial to local funds who plan to add New Zealand equity assets to their portfolio with financing from overseas where it has lower cost due to a lower interest rate.

Furthermore, this study investigates the Granger causality relationship between carry trade and the stock market in different periods. Sample data in this study covers the most recent global financial crisis in 2008. It allows investigation of the relationship between carry trade returns and the stock market under different market conditions. Many propose that carry trade performs differently over time for various reasons. Market sentiment is tremendously different among periods of global financial crisis (GFC) and non-crisis. During financial crisis, fear across the financial market makes investors substantially unwind their carry trade position in their portfolio to reduce their risk exposure. Melvin and Shand (2017) say there were large developed country currencies that experienced carry trade position unwinding during the crisis of 2007 to 2009. Kim (2015) suggests that, during financial crisis, investors are unwilling to do carry trades due to higher realised volatility of exchange rates. During such unstable times, lack of liquidity in the financial market may occur as investors are reluctant to invest. Smales and Kininmonth (2016) suggest investment currencies tend to depreciate when there is increasing fear in the market. Such depreciation of currency would cause decreasing carry trade returns and inactivity of carry traders. In addition, major reserve banks change monetary policies by lowering interest rates. Some reserves banks even set negative interest rates over time including the reserve banks of Japan, the Eurozone and Switzerland. A tremendous amount of capital in the markets after financial crisis, due to central bank programs such as Quantitative Easing, makes investors initiate carry trade even more easily and cheaply: they do not need to even borrow to fund such activities. The level of speculative capital affects carry trade returns (Jylhä and Suominen,2011. Jylhä et al, 2008, Barroso and Santa-Clara,2015). So, it would be valuable to look into the validity and consistency of how carry trade affects the stock market in different periods with the most updated data.

This study's empirical results indicate that overall there is a significant causal relationship between carry trade and the New Zealand stock market, and the direction is from carry trade to the New Zealand Stock market. Wide circulation of the Japanese Yen as funding currency is not the case in the New Zealand Dollar carry trade. The US dollar, Euro and Swiss Franc lead the category, especially the US dollar and Swiss Franc. Carry trade return transmission generally attributed to all New Zealand stock market with various degree, with only one exception, being the Basic Material sector. And the Granger causality relationship between carry trade and New Zealand stock market was stronger in the crisis period than in post crisis period.

This study is structured as follows: Section 2 outlines related literature of carry trade returns, and its relationship with stock market; Section 3 presents the methodology used to test the relationship; Section 4 describes data sets and descriptive statistics; Section 5 presents the empirical results on the relationship between carry trade and stock market; Section 6 concludes.

2. Related Literature

2.1 Popularity

Capital seeks higher yield globally, and carry trade has been providing impressive excess returns on average over past two decades. It has been fairly recognised from the perspective of the finance industry and, at the same time, well documented in the academic world. Doskov and Swinkels (2015) test the carry trade of 20 currencies for the period from 1900 to 2012, and carry trade has been profitable. The Sharpe ratio of carry trade for approximately two decades has been markedly higher than overall in the sample period. Neely and Weller (2013) test over 20 currency carry trade samples ranging from 1970s to 2012, and provide empirical evidence that carry trade dramatically outperforms the S&P 500 with much higher Sharpe ratios. De Zwart et al (2009) initiate a trading strategy of investing in high real interest rate currencies and funding with low real interest rate currencies, and provide empirical evidence that such a strategy made substantial excess returns over the period of 1997-2007. Burnside, Eichenbaum and Rebelo (2008) give empirical evidence that a well-diversified multi-currency carry trade portfolio increases an extremely favourable Sharpe Ratio by 50 percent. Darvas (2009) tests 11 major currencies pairs, sampling from 1976 to 2008, and shows carry trades are significantly profitable without using leverage.

Global fund managers do include carry trade in their portfolios for another reason: diversification benefits. In industry, performance of global fund portfolios has been measured not only by their accumulated returns, also by their risk management. Fund managers consistently seek to reduce overall portfolio risk exposure, and carry trade becomes a popular strategy for them to gain both return (referred to as “Carry Pick-up”) and diversification benefits. Many studies have contributed to support such practices. Pojarliev and Levich (2012) offer supportive evidence that adding even a small amount of currency exposure to an institutional investor’s portfolio can produce a meaningful positive impact on performance of the overall portfolio. Das et al (2013) suggest that Carry trade is a viable asset class. Covering 22 years of data, carry trade shows low standard deviation and also relatively low correlation with conventional equity assets. Koijen et al (2013) also present a significant Sharpe ratio improvement in portfolios with different assets classes rather than currency carry trade portfolios alone. Kroencke et al (2014) created style-based currency portfolios using sample of both the top 30 mostly used currencies and G10 currencies[1]. Different style currency portfolios cover carry trade, momentum and value. Carry trade provides significant diversification benefits when applied to the overall portfolio with stocks and bonds in it. It increases the Sharpe ratio over 60% without adding negative skewness to the portfolio. Barroso and Santa-Clara (2015) formed a parametric currency portfolio including different strategies of carry trade, momentum and value reversal, further applying to the overall portfolio of stocks and

[1] G10 currencies include US Dollar, Euros, Japanese Yen, Canadian Dollar, Swiss Franc, British Pound, Australian Dollar, New Zealand Dollar, Norwegian Krone, and Swedish Krona

bonds. They present empirical evidence that currency portfolio improves the overall performance of the diversified portfolio with an increase in the Sharpe Ratio of 0.5 on average.

2.2 Carry trade Return

There is some emerging literature that gives explanations for carry trade returns not being risk based. They are more connected to behavioural finance theory. The following are a few of the famous examples: Bacchetta and Wincoop (2010) suggest infrequent portfolio decisions by investors can partially account for carry trade return; Burnside et al (2011) propose that overconfident individuals overreact to information about future inflation, and that causes such an anomaly in the exchange rate as to generate a carry trade return; Yu (2013) proposes over and under estimating the growth rate of the economy could cause such an exchange rate puzzle; Spronk et al (2013) suggest carry traders and other types of currency traders interact with each other and cause such an anomaly which generates a carry trade return.

However, many commonly propose that the carry trade return compensates for bearing various types of risk. Considerable effort has been contributed by researchers to explain the payoffs of carry trade. However, there is still no conclusive result explaining such a payoff. It is beneficial to understand the risk-based explanation of currency carry trade returns with respect to fund management. Liu and Yang (2017) suggest there is risk contagion between carry trade portfolios and stock markets. Risk management-orientated fund managers would have a better understanding and decision-making ability.

Many scholars explain such carry trade risk premia are through cross-asset channels compensating for traditional risk factors. Gyntelberg and Remolona (2007) suggest carry trade returns may in part reflect compensation for large downside risks. Christiansen et al (2011) study carry trade returns that are exposed to traditional risk factors of equity and bond. They propose that volatility and liquidity have important effects on returns. Dobrynskaya (2014) proposes a new factor of Downside market risk, supports the point that carry trades have high downside market risk and restates that high returns of carry trade are fair compensation for the higher downside market risk. Similarly, Lettau et al (2014) propose that the traditional capital asset pricing model could not explain risk-based currency return, and that the Downside risk-capital asset pricing model (DR-CAPM) produces rationalisation to currency return.

Some other scholars attempt to explain carry trade payoffs in the scale of nations. Lustig and Verdelhan (2007) propose a consumption growth risk that attempts to explain why low interest rate currencies do not appreciate as much as the interest rate differential, and why high interest

rate currencies do not depreciate at the same rate as scale interest rate difference. Such an anomaly creates the chance for carry trades and profitability. Corte et al (2016) propose that countries' external imbalance, and Global imbalance risk factors have can explain currency excess returns. Such factors are also priced in cross-sections of major other asset markets.

Carry trade payoffs are explained by a few others in the context of the exchange rate. Lustig et al (2011) study a few common risk factors in the currency market to add a risk-based explanation to carry trade return, and identify a "slope" factor in exchange rates. The currencies with higher interest rates are more exposed to the "slope" factor. Further they show empirically that the factor is related to interest rate differential character or global volatility of the equity market. Menkhoff et al (2012) present similar empirical results: they investigate the relationship of carry trades and global foreign exchange volatility risk to present a global currency volatility factor. They use global foreign exchange volatility innovation as a systematic risk factor, and propose that global foreign exchange volatility innovations are a powerful risk factor to explain the cross-section of carry trade returns.

A number of scholars are not content to explain carry trade returns by reference to traditional risk factors, and instead they contribute by rationalising them by untraditional ones such as rare events. Brunnermeier et al (2008) and Menkhoff et al (2012) show that carry trade currencies are more vulnerable to crashing, because in carry trade there may be funding constraints so that the carry trader might suddenly unwind their position, capital outflow causes liquidity to dry up, liquidity risk, and causes substantial volatility. Burnside (2011) and Burnside et al (2010) argue that carry trade payoffs are uncorrelated with traditional risk factors, and reflect rare events better, the so-called "peso problem". Farhi et al (2009) propose a disaster risk factor and empirical evidence that such a risk premium explains a third of carry trade excess returns. Rafferty (2011) presents global currency skewness risk factors to add explanatory power for currency excess return in the context of a crash risk. Berge et al (2010) provide evidence that carry trade returns cannot be rationalised away using any standard risk factors. Jurek (2014) suggest crash risk premia account for one third of the excess return to carry trades. Similarly, Corte,Ramadorai and Sarno (2016) restate that currency carry trade returns cannot be explained using traditional risk factors.

2.3. Relationship between carry trade and stock market

There are only a few studies that directly investigate the relationship between carry trade returns and stock markets. Tse and Zhao (2012) firstly examined the relationship between carry trade and US stock market sampling from January 1995 to September 2010. The carry trade return portfolio is constructed with all G10 Currencies and the US stock market is represented by S&P

500 futures index. Under their Vector Autoregression (VAR) Model, carry trade returns and the US stock market do not show a Granger causality relationship in either direction. The US stock market is major stock market on both a global and domestic scale, and may be influenced by many factors, not just carry trade. The question is whether there is relationship between the relatively remote and small New Zealand stock market and heavy carry trade investing targeting the New Zealand Dollar.

Cheung et al (2012) empirically study carry trade returns and stock returns in target currency countries. Their study focuses on Japanese Yen as the funding currency, using weekly sampling from 2001 to 2008. Using the variable of Yen carry trade returns and currency specific futures positions as a measure, they empirically suggest the Yen carry trades generate various degrees of positive impact on investment currency stock market returns in the United Kingdom, Canada and Mexico, but not in Australia and New Zealand. However, using the G10 Deutsche Bank Harvest Index as one of the proxy measures of carry trade activities, they provide evidence that carry trade positively affects the stock market of all sample countries. It supports the point of view that carry trade helps ratchet up stock prices in target countries. Japanese Yen carry trade could not reflect the whole picture of carry trade activities using the New Zealand Dollar as the investment currency. There is a need to use other funding currencies in New Zealand Dollar carry trade to investigate the relationship between carry trade and New Zealand's stock market.

Fung et al (2013) extended the Tse and Zhao (2012) study of the relationship between carry trade and stock markets by adding Asian currencies together with G10 currencies and the Asia Pacific stock markets of Japan, Australia, Korea and India. The sample of daily data covers from January 1995 to December 2011. Data are sorted into three carry trade portfolios of G10 currencies, Asian currencies and all combined currencies. Employing a similar Vector Autoregression (VAR) model, it provides empirical evidence that carry trade return significantly Granger-causes Asian stock market returns. The stock markets in their work include both traditional funding currency country of Japan and traditional investment currency country of Australia. The authors cast doubt on the traditional view of carry trade being merely to bet with funding money on making profits from small interest rate differences: carry trade, it seems, has a much more complicated intention. The New Zealand stock market is left out of the study, the gap in the relationship between carry trade and stock market needs to be filled. The total market capitalisation of the New Zealand stock market is relatively small; however, the portion of New Zealand dollar carry trade may not be small in total carry trade activities. That makes the case worth further investigation.

Lee and Chang (2013) examine cross-market linkage between spillovers of currency carry trade and the US stock market. They construct a total spill-over index for currency carry trade returns, and propose that the total magnitude of spill-over of currency carry trade returns is higher in bull

markets than in bear: it implies investors are more willing to do carry trade in bullish markets than in bear. They also empirically provide evidence that there is a significantly positive relationship between such spill-over of currency carry trade and corresponding stock market return of investment currency. They use a similar approach of a Generalised Vector Autoregression (VAR) model to investigate carry trade effects using daily data samples from January 3, 1994 to March 28, 2012. Currencies of the carry trade are the G10 currencies. They specifically test data in both bull market and bear market to investigate whether such spill-overs of carry trade are different in both periods. They propose the relationship of carry trade return Granger-causes stock market return to be stronger in a bear market than in a bull market. Nonetheless, the study focuses on investing the magnitude of total spill-over of carry trade and its effect on stock market only in US market.

2.4 Sub period analysis related

2.4.1 Market Sentiment

In the period of the Global Financial Crisis, carry trade experienced large unwinding activities. Melvin and Taylor (2009) developed the Financial Stress Indicator (FSI) to reveal market conditions, and they empirically suggest that carry trade produces more superior performance of conditioning the carry trade investment on the FSI. That indirectly implies market conditions influence carry trade. Melvin and Shand (2017) propose that carry trade experiences periodic negative returns caused by carry trade position unwinding. They present evidence that developed market currencies experienced the largest drawdown in carry trade portfolios associated with the financial crisis of 2007 to 2009. Australian Dollar, New Zealand Dollar, Japanese Yen and Swiss Franc show frequently as major contributors to drawdowns.

Such unwinding of positions tends to result in a change of supply and demand of associated currencies, and it would likely to cause volatile exchange rates. Clarida et al (2009) suggest foreign exchange volatility is a major determinant of carry trade returns. Christiansen et al (2011) empirically suggest carry trade strategy shows characteristics of regime dependence, its risk exposure showing different degrees to stock markets in midst of financial turmoil and those in stable economic condition. As another major investment currency, Kim (2015) employs the Markov Regime Switching Model over the period from 1999 to 2012, empirically suggesting that the Australian Dollar has been major investment currency in carry trade. However, during the period of the Global Financial Crisis, carry trade probabilities are significant lower due to higher realised volatility of the exchange rate between US Dollar and Australian Dollar.

Exchange rate changes influence carry trade returns of associated currencies. It is quite significant in respect to carry trade in periods of financial crisis. Smales and Kininmonth (2016)

empirically suggest that investment currencies tend to depreciate when such fear increases. Currency returns are more sensitive to changes in investors' fear during periods of financial crisis. It is particularly noticeable in funding currencies that are considered to be safe haven currencies. Ranaldo and Söderlind (2010) test multiple currencies, and suggest major carry trade funding currencies such as US Dollar, Euro and Swiss Franc show strong safe haven currency properties. Currencies with high interest rates such as the Australian Dollar and New Zealand Dollar are the mirror-image of safe haven currencies. Plantin and Shin (2006) restate currencies with high interest rate exhibit classic pattern of "going up by the stairs and coming down in the elevator". Campbell et al (2010) and Habib and Stracca (2012) suggest a similar point, that currencies of US Dollar, Euro and Swiss Franc show safe haven currency properties. These currencies tend to appreciate when international stock markets decline, especially in financial crisis. Investors are willing to accept lower compensation for holding these currencies for hedging purpose.

2.4.2 Monetary Policy

Central banks change monetary policies over time which may change interest rates and capital liquidity. Interest rate no doubt is an important factor to carry trade. Laborda et al (2014) developed a global monetary policy indicator, and empirically suggest that global monetary policy is one of the key drivers of optimal currency carry trade strategies. Plantin and Shin (2011) suggest that the reserve banks of recipient countries in carry trade alter monetary policy by increasing the interest rate to react to too much capital inflow. Such increase of interest rate would also increase the attractiveness of carry trade, it creates a vicious circle.

2.4.3 Excessive Speculative Capital

Market conditions in a financial crisis period and post financial crisis period are different, and so are the speculative capital level and liquidity. There has been a large improvement of these conditions since the financial crisis.

Many propose there is correlation between such conditions and carry trade return. A typical speculative capital source, the hedge fund, thrives as a segment of the financial market over years. Jylhä and Suominen (2011) suggest that carry trade return explains more than 16% of the overall hedge fund index returns. It implies that hedge fund investment does carry trades. Jylhä et al (2008) suggest empirically that carry trade returns decrease over time due to an increase in arbitrage capital, as such new arbitrage capital flow will lead to appreciation of investing currencies in carry trade activities. Barroso and Santa-Clara (2015) also propose a similar result regarding speculative capital's effect on expected carry trade return.

Liquidity condition also influences carry trade returns. Bakshi and Panayotov (2013) empirically suggest that a measure of global liquidity has predictive power to carry trade payoffs. Mancini et al (2013) look into foreign exchange markets and analyse the impact of liquidity risk on carry trade, suggesting liquidity risk factors had an unusually strong impact on carry trade returns in the period of financial crisis from 2007 to 2009.

3. Methodology

This study investigates the Granger causality in returns between carry trade of the New Zealand Dollar as investment currency and the New Zealand stock market. The Granger causality relationship in daily returns between carry trade and the stock market is examined using the Vector Autoregressive (VAR) model with four lags:

$$CT_{\mathrm{t}} = a_1 + \sum_{i=1}^{4} b_{1i}\, CT_{t-i} + \sum_{i=1}^{4} r_{1i}\, ST_{t-i} + \varepsilon_{1,t} \qquad \text{(a)}$$

$$ST_{\mathrm{t}} = a_2 + \sum_{i=1}^{4} b_{2i}\, CT_{t-i} + \sum_{i=1}^{4} r_{2i}\, ST_{t-i} + \varepsilon_{2,t} \qquad \text{(b)}$$

This VAR model is estimated using OLS with the Newey-West heteroscedasticity and an autocorrelation consistent covariance matrix. *CT* is the daily log return of carry trade, *ST* is the daily log return of the stock market. ε_{1t} and ε_{2t} are error terms. $\sum\ r_{1i}$ in equation (a) represents the sum of the cross-asset coefficients and it describes the total causality from the stock market return to the carry trade return. $\sum\ b_{2i}$ in equation (b) represents the sum of the cross-asset coefficients and it describes the total causality from carry trade return to stock market return. Each carry trade return pair and stock market returns are entered in the model in each estimation. In the Vector Autoregression (VAR) model, two restrictions are employed for cross markets coefficients using the Wald Test:

Restriction 1:

$$\mathrm{H}_0 : r_{1i} = 0 \ (= 1, \ldots, 4)$$

$$\mathrm{H}_0 : b_{2i} = 0 \ (= 1, \ldots, 4)$$

The Granger causality measures the past value of a variable that helps forecast future value of another variable in such model. $\mathrm{H}_0 : r_{1i}$ represents that all the coefficients are jointly equal to zero. If such hypothesis is rejected, that means stock market return Granger-causes carry trade return. Past values of stock market price improve the prediction of future changes of carry trade return.

Inversely, $\mathrm{H}_0 : b_{2i}$ posits that all the coefficients are jointly equal to zero, and rejecting this hypothesis means carry trade return Granger-causes stock market return, and past value of carry trade return improves the prediction of future change of stock market price. Furthermore, below restriction 2 is employed concurrently to explain the causality relationship between two cross markets regarding the magnitude of economic impact.

Restriction 2:

$$\mathrm{H}_0 : \sum_{i=1} r_{1i} = 0$$

$$\mathrm{H}_0 : \sum_{i=1} b_{2i} = 0$$

The sum of total coefficients $\sum_{i=1} r_{1i}$ describes the total causality from stock market to carry trade, and $\sum_{i=1} b_{2i}$ is the sum of coefficients which describes the total causality from the carry trade to stock market. The rest under restriction 2 assumes sums of coefficients are equal to zero. Rejecting both restrictions means there is statistically significant Granger causality relationship between these two asset classes.

Variance decomposition is also used under the VAR to examine explanatory relationships between carry trade returns and stock returns. Decomposition of variance indicates the amount of information each variable contributes to the other variables in the VAR model. It demonstrates how much the size of each return can be explained by the other and itself. This paper also uses Impulse Response functions to examine the response of different carry trade returns and stock returns over time.

4. Data

In this study, the sample of daily data covering from 2nd July 2007 to 15th August 2017 are obtained from DataStream and official Swiss National Bank (SNB) portal, and total of 2642 observations were generated. It contains two sets of data: carry trade return and stock market return.

4.1. Carry trade

On the side of carry trade, this study has two categories. First is the Deutsche Bank G10 Currency Future Harvest Index as a baseline analysis. It is widely used as a benchmark of carry trade performance that provides a wider picture of carry trade activities. This index is comprised of currency futures contracts on G10 currencies to exploit the trend that high interest rate currencies tend to rise in value relative to low interest rate currencies. The G10 currencies are US dollar (USD), Swedish Krona (SEK), New Zealand Dollar (NZD), Norwegian Krone (NOK), Japanese Yen (JPY), British Pound (GBP), Euro (EUR), Swiss Franc (CHF), Canadian Dollar (CAD) and Australian Dollar (AUD). The strategy is to invest in the three highest-yielding G10 currencies and to go short on the three lowest-yielding G10 currencies, and the portfolio is rebalanced monthly.

The second category is for individual currency pairs of carry return - the excess return of carry trade depends on exchange rates of currency pairs and the interest rate differential between funding countries and investing countries. Carry trade strategy generates profit when the interest rate difference is bigger than the potential loss caused by exchange rate movement. This study follows previous works shown by Brunnermeier et al (2008), Christiansen et al (2011), Lustig et al (2011), Tse and Zhao (2012) and many others, regarding the excess return of carry trade by borrowing funding currencies and investing in target currencies. The formula is constructed as

$$CT_{\mathrm{t}} = \left(i_{t-1}^{p} - i_{t-1}^{q}\right) - \left(s_{t}^{p} - s_{t-1}^{p}\right) \qquad \text{(c)}$$

In the equation above, CT_{t} is the excess return of carry trade. In the first bracket is the difference between domestic interest rate and foreign interest rate, i_{t-1}^{p} is one-day lagged interest rate in the investment currency country, and i_{t-1}^{q} is the one-day lagged interest rate in the funding currency country. $s_{t}^{p} - s_{t-1}^{p}$ represents the appreciation of foreign currency, s_{t}^{p} is the log spot exchange rate of that currency, s_{t-1}^{p} is the log one-day lagged spot exchange rate of currency. When Uncovered Interest Rate Parity (UIP) does not hold, the excess return from carry trade will be positive. In the context of New Zealand Dollar carry trade, this study chooses to follow four pairs of individual currency: USD/NZD, JPY/NZD, Euro/NZD and CHF/NZD. These four currencies are

widely considered to be funding currencies. Only the interest rate data of the Swiss Franc is obtained from the official portal website of Swiss National Bank (SNB) instead of DataStream.

4.2. Stock Market

This study chooses S&P/NZX50 index as the New Zealand stock market overall proxy. The NZX50 is designed to measure the performance of the 50 largest, eligible stocks listed on the New Zealand Main Board (NZSX) of the NZX by float-adjusted market capitalisation. It is representative, liquid and investable and widely considered New Zealand's benchmark index. It covers approximately 90% of New Zealand equity market capitalisation. Daily data of index return is logarithmic return.

There were 141 active stocks listed in New Zealand Stock Exchange by the time the data was collected. All the stocks are categorised based on SIC code into ten sectors as follows: Basic Materials, Consumer Goods, Consumer Service, Financials, Health Care, Industrials, Oil & Gas, Technology and Telecommunications and Utilities. Sector stock return is weighted and calculated based on the individual stock's market capitalisation within that sector; it gives a general sector stock performance measurement.

4.3 Descriptive Summary

Summary statistics of daily carry trade returns and daily stock market returns are shown in table 1. G10 Currency Future Harvest Index shows negative mean of 0.0042%; that may be due to the sample of this study starting from 2007. The index experienced an extremely large drop during the global financial crisis. All the individual currency pairs show positive mean ranging from 0.0085% to 0.0121%, suggesting the New Zealand Dollar is indeed an investment currency in carry trade. EU/NZD carry trade shows the highest mean return. For the mean of daily stock market returns, NZX50 index and all other ten sectors present figures from 0.0105% to 0.1141%. The Oil & Gas sector is the lowest, while the Technology sector shows the highest.

Standard deviation implies overall risk exposure. Standard deviation of the G10 index shows highest of 0.9794% among carry trade returns, which is not surprising, because such an index tracks carry trade portfolios consisting of three highest yield currencies and three lowest. For individual currency pair carry trade daily return, they range from 0.3350% to 0.5039%. EU/NZD carry trade return is lowest, and JPY/NZD is the highest. For the stock market, return of Technology sector shows highest standard deviation of 2.2674%. The financial sector has the lowest standard deviation, and it is even lower than the standard deviation of the NZX50.

Table 1
Summary Statistics

Panel A

Daily Return	Mean	Std Dev	Skewness	Kurtosis
G10 Index	-0.0042%	0.9794%	-0.4193	188.72170
USD/NZD	0.0098%	0.4007%	-0.3260	8.37518
JPY/NZD	0.0105%	0.5039%	-0.4348	9.90391
EU/NZD	0.0121%	0.3350%	-0.6311	7.52032
CHF/NZD	0.0085%	0.4096%	-0.9729	16.02213
NZX50 Index	0.0232%	0.6965%	-0.4653	8.91956
Basic Materials	0.0123%	1.9152%	-1.0995	38.35357
Consumer Goods	0.0215%	0.8946%	-0.0333	10.11116
Consumer Services	0.0339%	0.8115%	-0.1766	6.25015
Financials	0.0276%	0.5717%	-0.4996	7.05307
Health Care	0.0714%	0.9017%	-0.0506	6.30800
Industrials	0.0367%	0.9203%	-0.1199	7.65658
Oil & Gas	0.0105%	1.3451%	0.0961	15.31493
Technology	0.1141%	2.2674%	0.5148	9.94119
Telecommunications	0.0382%	1.5296%	-0.2330	5.04140
Utilities	0.0298%	0.9718%	-0.0887	6.48090

Panel B

Correlation

	G10 Index	USD/NZD	JPY/NZD	EU/NZD	CHF/NZD
NZX50 Index	0.1396	0.1906	0.3624	0.1729	0.2041
	0.0000	0.0000	0.0000	0.0000	0.0000
Basic Materials	0.0318	0.0406	0.1070	0.0371	0.0407
	0.1028	0.0371	0.0000	0.0565	0.0366
Consumer Goods	0.0564	0.0840	0.2069	0.0770	0.0811
	0.0037	0.0000	0.0000	0.0001	0.0000
Consumer Services	0.0816	0.1365	0.3200	0.1285	0.1490
	0.0000	0.0000	0.0000	0.0000	0.0000
Financials	0.0711	0.1157	0.2784	0.1244	0.1235
	0.0003	0.0000	0.0000	0.0000	0.0000
Health Care	0.0400	0.0510	0.1509	0.0583	0.0799
	0.0396	0.0088	0.0000	0.0027	0.0000
Industrials	0.1241	0.1678	0.3215	0.1550	0.1759
	0.0000	0.0000	0.0000	0.0000	0.0000
Oil & Gas	0.0558	0.0802	0.1839	0.0555	0.0728
	0.0041	0.0000	0.0000	0.0043	0.0002
Technology	0.0300	0.0642	0.1443	0.0650	0.0713
	0.1226	0.0010	0.0000	0.0008	0.0002
Telecommunications	0.0835	0.0973	0.0929	0.0812	0.1155
	0.0000	0.0000	0.0000	0.0000	0.0000
Utilities	0.0842	0.1245	0.2603	0.1175	0.1119
	0.0000	0.0000	0.0000	0.0000	0.0000

Table 1

Table 1 Panel A reports daily return of carry trade including G10 currency index and Calculated individual currency pair carry trade returns. For stock market, it reports NZX50 index return and all ten sector returns. It shows their mean, standard deviation, skewness and kurtosis. Panel B reports correlation between carry trade returns and stock market returns.

A few noteworthy points are: first, standard deviation of individual currency carry trade return is generally much smaller than standard deviation of stock returns; second, skewness of carry trade returns is all negative, which is consistent with the common understanding that carry trade is exposed to downside risk. Carry trade returns tend to be left skewed. Last, G10 index's kurtosis is much higher than its individual currency pair carry trade: it means it has fatter tail, risk comes from rare events and extreme changes are more likely to occur.

Carry trade return mostly correlates to the stock market, and the degree of correlation varies according to different currency carry trade pairs and stock market sectors. All the stock index returns have the highest correlation, with carry trade currency pair of JPY/NZD at the highest significant level compared to other carry trade returns except for the Telecommunications sector.

5. Empirical results

This section is divided into three sub sections. The first section shows the empirical results of the relationship between carry trade returns and the NZX50 index. The second represents carry trade returns and New Zealand stock market sectors, while the last shows sub period analysis results of the relationship between carry trade returns and the NZX50 index in both period of crisis and post crisis.

5.1 Carry trade and NZX50

Table 2 reports the Granger causality results on the relationship between carry trade returns and the NZX50 index. When looking at the G10 currency carry trade index and the NZX50 index, they are two benchmark returns of carry trade return and stock return. It shows a significant Granger causality relationship only from carry trade to stock market, not the other way around. When there is a carry trade transaction, the return increases when the investing currency appreciates against the funding currency. It attracts even more capital into carry trade that results in capital inflow into the recipient country. The capital inflow would flow into the stock market and cause an increase of the equity price. According to the results, higher carry trade returns of the G10 currency carry trade index lead to increasing stock market returns in New Zealand (Restriction 2 Sum of Coefficient = 0.2766). The result is consistent with Fung et al (2013) that carry trade returns positively affect the target country's stock returns. Lee et al (2013) also added additional evidence that currency carry trade return affects market return. It confirms that the New Zealand Dollar is indeed an investment currency.

The estimated results of individual currency pair carry trade returns are generally consistent with the carry trade benchmark return of the G10 index except for the Japanese Yen. Both the US Dollar and Swiss Franc carry trade show statistically significant results at the 1% level, and the EU carry trade shows significance at the 5% level. The implication is that the US Dollar, Swiss Franc and Euro are major funding currencies in the New Zealand Dollar carry trade. The Japanese Yen may still be a funding currency in carry trade, but not in the case of the New Zealand Dollar. A similar result is also found in Cheung et al (2012), where they specifically study the Yen carry trade and suggest the Yen carry trade did not generate positive returns on stock returns in New Zealand and Australia.

Variance decomposition in table 3 confirms the Granger causality relationship. The G10 currency index return's variance is almost explained by its own, but the NZX50 index return explains extremely little. On the other hand, the G10 currency carry trade index return explains around 9% of the NZX50 index's variance: it is consistent with the previous result of carry trade return Granger causing the stock market return. Individual currency pair carry trade of US Dollar, Euro

and Swiss Franc show similar patterns only with a smaller percentage of variance in explanatory power.

The impulse response function in Figure 1 shows consistent results regarding the carry trade return's reaction to the stock return, and vice versa. It shows the magnitude and duration. It provides consistent results that currency carry trade return indeed causes NZX50 index return.

Table 2 Granger – Causality Test Between Carry Trade Return And Return Of NZX50 Index

	Carry trade Granger causes								Stock Granger causes						
	Stock				itself				Carry trade				itself		
	Rest 1	Rest 2	Sum Coeff		Rest 1	Rest 2	Sum Coeff		Rest 1	Rest 2	Sum Coeff		Rest 1	Rest 2	Sum Coeff
G10	143.5119	62.1760	0.2766	***	115.8923	38.2280	-0.3073	***	8.7829	0.8446	0.0513		13.1131	0.0944	-0.0121
	0.0000	0.0000			0.0000	0.0000			0.0668	0.3581			0.0107	0.7587	
USD	38.2397	15.8167	0.2810	***	4.8512	0.1302	-0.0148		1.0609	0.2052	-0.0102		11.0267	0.7038	0.0326
	0.0000	0.0001			0.3029	0.7182			0.9004	0.6506			0.0263	0.4015	
JPY	2.8708	0.6408	0.0486		6.5022	2.1092	-0.0639		4.3878	0.3114	0.0165		15.1727	1.5111	0.0502
	0.5797	0.4234			0.1647	0.1464			0.3561	0.5768			0.0044	0.2190	
EUD	24.6376	6.6101	0.2178	**	4.5403	2.1741	-0.0605		1.2508	0.3262	0.0107		13.3585	1.3667	0.0453
	0.0001	0.0101			0.3378	0.1403			0.8697	0.5679			0.0097	0.2424	
CHF	68.8669	14.4809	0.2632	***	9.1494	0.2643	-0.0212		0.2054	0.1215	0.0082		10.6838	0.7696	0.0345
	0.0000	0.0001			0.0575	0.6072			0.9951	0.7274			0.0304	0.3803	

Table 2

Table 2 reports Granger causality test on the VAR (4) model below, that tests return series of carry trade return including G10, USD, JPY, EU , and CHF and NZX50 index return:

$$CT_{\mathrm{t}} = a_1 + \sum_{i=1}^{4} b_{1i}\, CT_{t-i} + \sum_{i=1}^{4} r_{1i}\, ST_{t-i} + \varepsilon_{1,t}$$

$$ST_{\mathrm{t}} = a_2 + \sum_{i=1}^{4} b_{2i}\, CT_{t-i} + \sum_{i=1}^{4} r_{2i}\, ST_{t-i} + \varepsilon_{2,t}$$

The upper value in the table shows F-statistics of a Wald coefficient restriction test, while the lower value shows the P-value. There are two restrictions taken, and Sum Coefficients represents the sum of coefficients under restriction 2.

*** significant at 1% level ** significant at 5% level * significant at 10% level

Table 3 Decomposition Of Variance

G10 Currency Index

Variance Decomposition of G10_CT_INDEX:

Period	S.E.	G10_CT_INDEX	NZX50_INDEX
1	0.009598	100.0000	0.000000
2	0.009806	99.77745	0.222554
3	0.009812	99.67158	0.328421
4	0.009812	99.67000	0.330002
5	0.009815	99.62762	0.372376
6	0.009815	99.62579	0.374212
7	0.009815	99.62574	0.374257
8	0.009815	99.62572	0.374281
9	0.009815	99.62571	0.374287
10	0.009815	99.62571	0.374289

Variance Decomposition of NZX50_INDEX:

Period	S.E.	G10_CT_INDEX	NZX50_INDEX
1	0.006774	3.735126	96.26487
2	0.006961	8.814891	91.18511
3	0.006970	8.794968	91.20503
4	0.006977	8.928065	91.07194
5	0.006980	9.004428	90.99557
6	0.006980	9.017703	90.98230
7	0.006980	9.017705	90.98229
8	0.006980	9.017767	90.98223
9	0.006980	9.017762	90.98224
10	0.006980	9.017774	90.98223

Cholesky Ordering: G10_CT_INDEX NZX50_INDEX

USD/NZD

Variance Decomposition of NZX50_INDEX:

Period	S.E.	NZX50_INDEX	USD_CT
1	0.006906	100.0000	0.000000
2	0.006967	98.66221	1.337795
3	0.006974	98.65168	1.348321
4	0.006980	98.58956	1.410440
5	0.006980	98.58596	1.414039
6	0.006980	98.58563	1.414366
7	0.006980	98.58563	1.414375
8	0.006980	98.58558	1.414420
9	0.006980	98.58558	1.414422
10	0.006980	98.58558	1.414422

Variance Decomposition of USD_CT:

Period	S.E.	NZX50_INDEX	USD_CT
1	0.004010	3.798895	96.20111
2	0.004011	3.826769	96.17323
3	0.004011	3.827080	96.17292
4	0.004014	3.843658	96.15634
5	0.004015	3.850003	96.15000
6	0.004015	3.850010	96.14999
7	0.004015	3.850006	96.14999
8	0.004015	3.850027	96.14997
9	0.004015	3.850031	96.14997
10	0.004015	3.850031	96.14997

Cholesky Ordering: NZX50_INDEX USD_CT

JPY/NZD

Variance Decomposition of NZX50_INDEX:

Period	S.E.	NZX50_INDEX	JPY_CT
1	0.006953	100.0000	0.000000
2	0.006968	99.95459	0.045406
3	0.006974	99.94554	0.054458
4	0.006979	99.91929	0.080715
5	0.006980	99.89052	0.109479
6	0.006980	99.89027	0.109731
7	0.006980	99.89015	0.109850
8	0.006980	99.89015	0.109850
9	0.006980	99.89014	0.109864
10	0.006980	99.89014	0.109864

Variance Decomposition of JPY_CT:

Period	S.E.	NZX50_INDEX	JPY_CT
1	0.005041	13.21180	86.78820
2	0.005045	13.19039	86.80961
3	0.005046	13.20561	86.79439
4	0.005049	13.26140	86.73860
5	0.005050	13.26933	86.73067
6	0.005050	13.26980	86.73020
7	0.005050	13.26992	86.73008
8	0.005050	13.26993	86.73007
9	0.005050	13.26995	86.73005
10	0.005050	13.26995	86.73005

Cholesky Ordering: NZX50_INDEX JPY_CT

EU/NZD

Variance Decomposition of NZX50_INDEX:

Period	S.E.	NZX50_INDEX	EUD_CT
1	0.006924	100.0000	0.000000
2	0.006968	99.14885	0.851153
3	0.006974	99.13874	0.861259
4	0.006979	99.11696	0.883039
5	0.006980	99.09501	0.904994
6	0.006980	99.09430	0.905698
7	0.006980	99.09400	0.905998
8	0.006980	99.09399	0.906006
9	0.006980	99.09399	0.906007
10	0.006980	99.09399	0.906007

Variance Decomposition of EUD_CT:

Period	S.E.	NZX50_INDEX	EUD_CT
1	0.003354	3.065345	96.93465
2	0.003354	3.066091	96.93391
3	0.003357	3.072012	96.92799
4	0.003357	3.081192	96.91881
5	0.003358	3.086115	96.91388
6	0.003358	3.086506	96.91349
7	0.003358	3.086603	96.91340
8	0.003358	3.086613	96.91339
9	0.003358	3.086613	96.91339
10	0.003358	3.086613	96.91339

Cholesky Ordering: NZX50_INDEX EUD_CT

CHF/NZD

Variance Decomposition of NZX50_INDEX:

Period	S.E.	NZX50_INDEX	SWF_CT
1	0.006867	100.0000	0.000000
2	0.006969	97.51166	2.488345
3	0.006975	97.51357	2.486431
4	0.006979	97.51536	2.484636
5	0.006980	97.49724	2.502760
6	0.006980	97.49725	2.502751
7	0.006980	97.49695	2.503052
8	0.006980	97.49694	2.503056
9	0.006980	97.49694	2.503063
10	0.006980	97.49694	2.503063

Variance Decomposition of SWF_CT:

Period	S.E.	NZX50_INDEX	SWF_CT
1	0.004097	4.092989	95.90701
2	0.004100	4.098722	95.90128
3	0.004104	4.089834	95.91017
4	0.004105	4.089907	95.91009
5	0.004105	4.090697	95.90930
6	0.004105	4.090743	95.90926
7	0.004105	4.090746	95.90925
8	0.004105	4.090746	95.90925
9	0.004105	4.090746	95.90925
10	0.004105	4.090746	95.90925

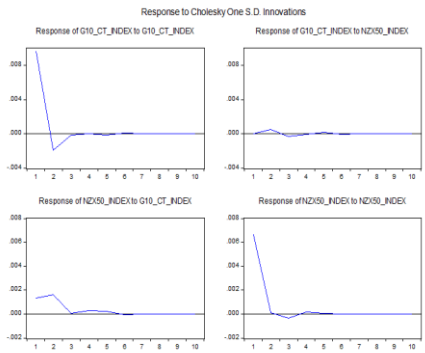
Cholesky Ordering: NZX50_INDEX SWF_CT

Table 3

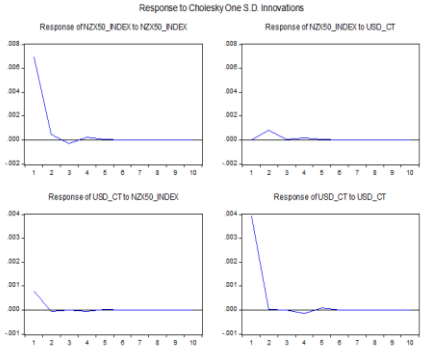
Table 3 reports Variance decomposition based on VAR model testing carry trade return and NZX50 index return. Carry trade return consists G10 currency carry trade, USD/NZD, JPY/NZD, EU/NZD and CHF/NZD.

Figure 1 Impulse Response Function

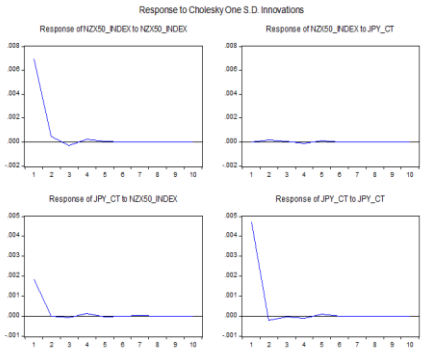
G10 Currency Index



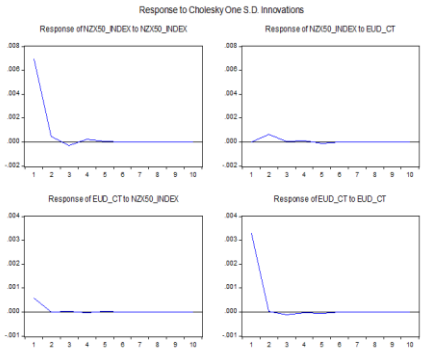
USD/NZD



JPY/NZD



EU/NZD



CHF/NZD

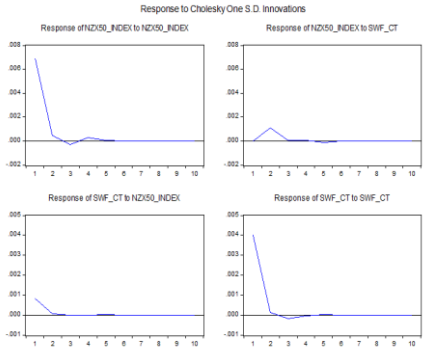


Figure 1

Figure 1 reports impulse response function of carry trade return of G10 index and US Dollar, Japanese Yen, Euro and Swiss Franc with NZX50 stock return index.

5.2 Carry trade and New Zealand stock sectors

Table 4[2] reports the Granger causality results on the relationship between carry trade returns and New Zealand market sectors, given that the NZX50 index represents a benchmark measure of the New Zealand stock market, and the relationship between carry trade returns and the stock market was covered previously. When investigating stock market sectors, it is expected that there will be similar results to the NZX50 index under same mechanism. However, It will provide more detailed information regarding the relationship: for example, which sectors are more likely to be affected by carry trade? Which sectors are affected by a different funding currency carry trade? Returns transmission from carry trade to stock market sectors certainly shows different preferences.

Unlike the NZX50 index, for the basic materials sector for example, there is no Granger causality relationship in either direction. The Carry trade return of the G10 currency index is well explained by its own lags. The consumer goods sector projects a similar pattern. Consumer goods sector returns are better explained by the G10 currency index (P-value=significant at 1, sum Coefficients = 0.2481), not by its own lags. The G10 currency index returns cannot be predicted by this sector's return but by its own return. Individual currency pair carry trade returns of EU and CHF show significant causality on the stock market both at 1% level with higher sum coefficients of 0.3184 and 0.3486. They show a stronger carry trade effect than the US dollar carry trade with 0.2035 of sum coefficients at 5% significant level. One interesting point is the consumer goods sector return leads to only the US Dollar carry trade return. It implies that sector return attracts capital inflow in the US dollar which causes a higher carry trade return of USD/NZD. The Japanese Yen shows no carry trade effect on the consumer goods sector.

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[2] Table 4 reports a Granger causality test using VAR (4) model testing carry trade returns of G10 currency carry trade index, US Dollar, Japanese Yen, Euro and Swiss Franc associated with New Zealand Dollar with ten sector returns of the New Zealand stock market. The sectors of the New Zealand stock market are Basic Materials, Consumer Goods, Consumer Service, Financials, Health Care, Industries, Oil & Gas, Technology, Telecommunication and Utilities. The VAR (4) model is as follows:

$$CT_t = a_1 + \sum_{i=1}^{4} b_{1i}\, CT_{t-i} + \sum_{i=1}^{4} r_{1i}\, ST_{t-i} + \varepsilon_{1,t}$$

$$ST_t = a_2 + \sum_{i=1}^{4} b_{2i}\, CT_{t-i} + \sum_{i=1}^{4} r_{2i}\, ST_{t-i} + \varepsilon_{2,t}$$

The upper value in the table shows F-statistics of a Wald coefficient restriction test, while the lower value shows the P-value. There are two restrictions taken, Sum Coefficients represents the sum of coefficients under restriction 2.

*** significant at 1% level

** significant at 5% level

* significant at 10% level

Table 4 Granger – Causality Test Between Carry Trade Return And Stock Market Sector Return

Basic Materials

	Carry trade Granger causes							Stock Granger causes						
	Stock			itself				Carry trade			itself			
	Rest 1	Rest 2	Sum Coeff	Rest 1	Rest 2	Sum Coeff		Rest 1	Rest 2	Sum Coeff	Rest 1	Rest 2	Sum Coeff	
G10	18.0035	1.6116	0.1168	110.3246	40.2821	-0.2937	***	1.2755	0.0532	0.0047	7.1905	3.7530	-0.0779	
	0.0012	0.2043		0.0000	0.0000			0.8655	0.8176		0.1262	0.0527		
USD	9.5779	0.3707	0.1147	4.9354	0.2821	-0.0209		9.1099	0.7099	0.0071	6.8635	3.6438	-0.0767	
	0.0482	0.5426		0.2940	0.5953			0.0584	0.3995		0.1433	0.0563		
JPY	3.9826	0.1650	-0.0628	4.6721	1.5278	-0.0503		10.4295	0.0514	-0.0024	7.0799	3.5034	-0.0755	
	0.4084	0.6846		0.3226	0.2164			0.0338	0.8206		0.1317	0.0612		
EU	8.9061	0.0049	-0.0158	4.0677	1.5692	-0.0496		14.6452	0.0478	-0.0015	6.5190	3.3946	-0.0739	
	0.0635	0.9444		0.3969	0.2103			0.0055	0.8270		0.1636	0.0654		
CHF	11.6370	0.7867	0.1619	9.9123	0.0800	-0.0110		13.3899	0.0013	-0.0003	6.4549	3.4984	-0.0751	
	0.0203	0.3751		0.0419	0.7773			0.0095	0.9713		0.1677	0.0614		

Consumer Goods

	Carry trade Granger causes							Stock Granger causes						
	Stock			itself				Carry trade			itself			
	Rest 1	Rest 2	Sum Coeff	Rest 1	Rest 2	Sum Coeff		Rest 1	Rest 2	Sum Coeff	Rest 1	Rest 2	Sum Coeff	
G10	69.6923	32.5255	0.2481	***	116.1506	43.3682	-0.3120	***	9.7641	1.7466	0.0533	18.4864	1.0104	0.0372	
	0.0000	0.0000			0.0000	0.0000			0.0446	0.1863		0.0010	0.3148		
USD	23.5620	5.2027	0.2035	**	5.7929	1.0312	-0.0408		9.5841	4.7544	0.0365	**	20.1772	2.3520	0.0569	
	0.0001	0.0226			0.2152	0.3099			0.0480	0.0292			0.0005	0.1251		
JPY	5.0900	0.7283	0.0634		6.8827	2.3703	-0.0646		5.1967	0.7570	0.0186		21.9013	2.8249	0.0635	*
	0.2782	0.3934			0.1422	0.1237			0.2677	0.3843			0.0002	0.0928		
EU	25.4654	8.8600	0.3184	***	5.1081	2.8538	-0.0682		6.9898	1.9818	0.0196		20.0066	2.2247	0.0552	
	0.0000	0.0029			0.2764	0.0912			0.1364	0.1592			0.0005	0.1358		
CHF	53.6655	16.2587	0.3486	***	10.4813	0.7330	-0.0343		7.8804	2.6926	0.0282		19.5072	1.6840	0.0481	
	0.0000	0.0001			0.0331	0.3919			0.0961	0.1008			0.0006	0.1944		

Table 4

Table 4 Continued

Consumer Service

	Carry trade Granger causes							Stock Granger causes						
	Stock				itself				Carry trade			itself		
	Rest 1	Rest 2	Sum Coeff		Rest 1	Rest 2	Sum Coeff		Rest 1	Rest 2	Sum Coeff	Rest 1	Rest 2	Sum Coeff
G10	113.9803	44.1137	0.2662	***	116.7712	42.5532	-0.3159	***	7.4271	1.5098	0.0565	3.5365	1.1740	0.0412
	0.0000	0.0000			0.0000	0.0000			0.1150	0.2192		0.4724	0.2786	
USD	52.9056	23.8011	0.3980	***	4.7570	0.2046	-0.0184		1.8585	0.0048	0.0013	4.1618	2.4007	0.0587
	0.0000	0.0000			0.3132	0.6510			0.7618	0.9450		0.3846	0.1213	
JPY	5.0804	2.5567	0.1114		5.5119	1.8197	-0.0584		7.6821	0.1140	0.0083	5.6574	2.7708	0.0658
	0.2791	0.1098			0.2387	0.1773			0.1039	0.7356		0.2262	0.0960	
EU	36.2026	10.4338	0.3167	***	4.8041	2.5816	-0.0655		2.5423	1.4768	0.0191	5.5803	3.3355	0.0691
	0.0000	0.0012			0.3080	0.1081			0.6371	0.2243		0.2328	0.0678	
CHF	62.0333	10.9896	0.2630	***	9.4414	0.5069	-0.0288		2.5660	1.1884	0.0212	5.4772	3.2735	0.0688
	0.0000	0.0009			0.051	0.4765			0.6329	0.2757		0.2417	0.0704	

Financials

	Carry trade Granger causes							Stock Granger causes						
	Stock				itself				Carry trade			itself		
	Rest 1	Rest 2	Sum Coeff		Rest 1	Rest 2	Sum Coeff		Rest 1	Rest 2	Sum Coeff	Rest 1	Rest 2	Sum Coeff
G10	114.0038	54.5430	0.2079	***	114.4930	40.1220	-0.3054	***	6.1269	0.3721	0.0417	5.2032	0.3301	-0.0229
	0.0000	0.0000			0.0000	0.0000			0.1899	0.5418		0.2671	0.5656	
USD	52.3854	16.5510	0.2328	***	4.7080	0.2357	-0.0196		0.9261	0.0012	-0.0010	4.0690	0.0882	0.0118
	0.0000	0.0000			0.3186	0.6274			0.9208	0.9729		0.3967	0.7664	
JPY	4.1185	0.7599	0.0421		5.0598	1.6378	-0.0545		0.8807	0.0002	0.0006	2.9577	0.2519	0.0206
	0.3902	0.3834			0.2812	0.2006			0.9273	0.9874		0.5649	0.6158	
EU	55.1689	9.2133	0.2097	***	3.8152	1.8264	-0.0552		3.2696	0.0848	0.0069	5.2485	0.2819	0.0211
	0.0000	0.0024			0.4316	0.1766			0.5138	0.7709		0.2627	0.5954	
CHF	82.2425	19.0674	0.2437	***	9.2702	0.3156	-0.0228		1.1392	0.4570	0.0196	5.2740	0.0475	0.0087
	0.0000	0.0000			0.0547	0.5743			0.8880	0.4990		0.2603	0.8274	

Table 4 Continued

Health Care

	Carry trade Granger causes							Stock Granger causes						
	Stock				itself			Carry trade			itself			
	Rest 1	Rest 2	Sum Coeff		Rest 1	Rest 2	Sum Coeff	Rest 1	Rest 2	Sum Coeff	Rest 1	Rest 2	Sum Coeff	
G10	15.5302	9.2765	0.1319	***	111.4475	38.8027	-0.2879	***	6.9375	1.7394	-0.0534	5.2983	1.2846	0.0430	
	0.0037	0.0023			0.0000	0.0000			0.1392	0.1872		0.2580	0.2570		
USD	3.4002	0.3341	0.0512		5.7471	0.2470	-0.0196		5.1629	1.5012	-0.0206	6.1894	1.6685	0.0489	
	0.4932	0.5633			0.2188	0.6192			0.2710	0.2205		0.1854	0.1965		
JPY	2.3804	1.1521	0.0784		4.2000	1.1814	-0.0443		9.2962	1.9556	-0.0298	5.1568	1.2867	0.0433	
	0.6662	0.2831			0.3796	0.2771			0.0541	0.1620		0.2716	0.2567		
EU	1.8287	0.1770	0.0449		3.9745	1.7978	-0.0532		2.1426	1.6695	-0.0182	6.1266	1.6750	0.0491	
	0.7672	0.6740			0.4095	0.1800			0.7095	0.1963		0.1899	0.1956		
CHF	7.5202	4.9533	0.1920		9.0012	0.0711	-0.0105		3.9242	1.6510	-0.0222	5.2003	1.2906	0.0432	
	0.1108	0.0260			0.0611	0.7897			0.4164	0.1988		0.2674	0.2559		

Industrial

	Carry trade Granger causes							Stock Granger causes						
	Stock				itself			Carry trade			itself			
	Rest 1	Rest 2	Sum Coeff		Rest 1	Rest 2	Sum Coeff	Rest 1	Rest 2	Sum Coeff	Rest 1	Rest 2	Sum Coeff	
G10	112.0120	49.7469	0.3224	***	113.1837	37.0804	-0.2962	***	10.5356	0.1481	0.0167	12.8286	3.8226	-0.0797	*
	0.0000	0.0000			0.0000	0.0000			0.0323	0.7003		0.0121	0.0506		
USD	39.5845	17.7923	0.3928	***	4.5039	0.2104	-0.0187		0.9524	0.0283	-0.0030	9.8634	1.6364	-0.0520	
	0.0000	0.0000			0.3421	0.6464			0.9169	0.8664		0.0428	0.2008		
JPY	7.5891	5.5586	0.1868		4.9568	2.1440	-0.0637		0.6403	0.3812	0.0143	8.1671	1.6997	-0.0551	
	0.1078	0.0184			0.2918	0.1431			0.9585	0.5369		0.0856	0.1923		
EU	21.3801	7.0295	0.2959	***	4.3749	2.4295	-0.0636		1.4563	0.9083	0.0141	9.6307	0.9018	-0.0385	
	0.0003	0.0080			0.3576	0.1191			0.8344	0.3406		0.0471	0.3423		
CHF	51.4983	15.7980	0.3601	***	8.3676	0.2088	-0.0186		0.6165	0.0716	0.0049	9.0988	1.4823	-0.0497	
	0.0000	0.0001			0.079	0.6477			0.9612	0.7890		0.0587	0.2234		

Table 4 Continued

Oil & Gas

	Carry trade Granger causes							Stock Granger causes						
	Stock				itself			Carry trade			itself			
	Rest 1	Rest 2	Sum Coeff		Rest 1	Rest 2	Sum Coeff	Rest 1	Rest 2	Sum Coeff	Rest 1	Rest 2	Sum Coeff	
G10	25.6908	11.8549	0.2229	***	111.4360	39.6399	-0.2933	***	2.8268	0.2717	0.0143	9.0161	0.0906	-0.0115	
	0.0000	0.0006			0.0000	0.0000			0.5872	0.6022		0.0607	0.7634		
USD	15.2276	4.4632	0.2801	**	4.7930	0.3064	-0.0220		2.2017	0.1834	0.0049	8.8907	0.0197	-0.0054	
	0.0043	0.0346			0.3092	0.5799			0.6987	0.6685		0.0639	0.8884		
JPY	5.2877	0.8820	0.1028		3.8745	1.6143	-0.0523		7.3889	0.0150	0.0018	9.3577	0.0194	-0.0054	
	0.2590	0.3477			0.4233	0.2039			0.1167	0.9024		0.0528	0.8892		
EU	6.5312	0.0921	0.0482		3.9243	1.9269	-0.0551		5.1329	0.3774	0.0058	9.5883	0.0020	0.0017	
	0.1628	0.7616			0.4163	0.1651			0.2739	0.5390		0.0480	0.9642		
CHF	20.4532	1.6149	0.1628		8.5070	0.1757	-0.0165		2.7559	0.2502	0.0058	8.7347	0.0002	0.0005	
	0.0004	0.2038			0.0747	0.6751			0.5995	0.6169		0.0681	0.9890		

Technology

	Carry trade Granger causes							Stock Granger causes						
	Stock				itself			Carry trade			itself			
	Rest 1	Rest 2	Sum Coeff		Rest 1	Rest 2	Sum Coeff	Rest 1	Rest 2	Sum Coeff	Rest 1	Rest 2	Sum Coeff	
	38.0165	10.2729	0.3507	***	112.9900	39.9499	-0.2951	***	6.3929	0.0086	-0.0015	12.7250	9.6020	0.1042	**
	0.0000	0.0013			0.0000	0.0000			0.1717	0.9262		0.0127	0.0058		
USD	20.0893	3.8923	0.4420	**	5.0413	0.2638	-0.0204		3.0549	0.0002	-0.0001	12.2912	8.0528	0.1072	**
	0.0005	0.0485			0.2831	0.6075			0.5487	0.9899		0.0153	0.0045		
JPY	7.4869	0.8039	0.1661		5.6469	1.9584	-0.0578		2.2887	0.1808	0.0036	12.3306	7.4933	0.1046	**
	0.1123	0.3699			0.2271	0.1617			0.6828	0.6707		0.0151	0.0062		
EU	21.4286	9.9157	0.8516	***	4.2661	2.1123	-0.0583		9.2871	1.3364	0.0065	11.1571	6.7392	0.0984	**
	0.0003	0.0016			0.3712	0.1461			0.0543	0.2477		0.0249	0.0094		
CHF	22.1789	8.2182	0.6240	***	8.9424	0.1665	-0.0161		2.1993	0.0288	0.0012	11.6164	7.1308	0.1011	**
	0.0002	0.0041			0.0626	0.6832			0.6992	0.8653		0.0204	0.0076		

Table 4 Continued

Telecommunication

	Carry trade Granger causes							Stock Granger causes						
	Stock			itself				Carry trade			itself			
	Rest 1	Rest 2	Sum Coeff		Rest 1	Rest 2	Sum Coeff		Rest 1	Rest 2	Sum Coeff	Rest 1	Rest 2	Sum Coeff	
G10	20.9388	18.4754	0.3166	***	110.3690	39.8703	-0.2938	***	8.0017	0.2236	0.0126	28.6319	26.5872	-0.2179	***
	0.0003	0.0000			0.0000	0.0000			0.0915	0.6363		0.0000	0.0000		
USD	5.2206	3.8047	0.2938		5.2091	0.1869	-0.0171		2.2312	1.6157	-0.0141	24.1767	22.6833	-0.2007	***
	0.2654	0.0511			0.2665	0.6655			0.6933	0.2037		0.0001	0.0000		
JPY	4.0897	1.5603	0.1545		5.5887	1.7783	-0.0545		4.1092	0.0348	0.0026	23.5037	21.8768	-0.1980	***
	0.3940	0.2116			0.2320	0.1824			0.3914	0.8520		0.0001	0.0000		
EU	7.2661	4.9026	0.4013		3.7010	1.7413	-0.0527		1.5261	0.6670	-0.0076	24.5281	22.7681	-0.2011	***
	0.1225	0.0268			0.4480	0.1870			0.8220	0.4141		0.0001	0.0000		
CHF	13.2605	6.1013	0.3624	**	8.3194	0.0864	-0.0116		2.7971	1.0078	-0.0114	25.1528	23.4885	-0.2053	***
	0.0101	0.0135			0.0806	0.7688			0.5923	0.3154		0.0000	0.0000		

Utilities

	Carry trade Granger causes							Stock Granger causes						
	Stock			itself				Carry trade			itself			
	Rest 1	Rest 2	Sum Coeff		Rest 1	Rest 2	Sum Coeff		Rest 1	Rest 2	Sum Coeff	Rest 1	Rest 2	Sum Coeff	
G10	82.1825	28.0767	0.2512	***	108.0192	36.9505	-0.2895	***	1.9621	0.0224	-0.0059	10.4384	5.1011	-0.0888	**
	0.0000	0.0000			0.0000	0.0000			0.7427	0.8811		0.0337	0.0239		
USD	43.3812	10.2625	0.3106	***	6.1019	0.0886	-0.0120		13.0899	0.3092	-0.0091	9.2235	3.6741	-0.0753	*
	0.0000	0.0014			0.1917	0.7660			0.0108	0.5782		0.0557	0.0553		
JPY	1.0922	0.0003	0.0015		6.2040	1.2077	-0.0462		7.5561	0.4591	-0.0141	10.7658	2.6050	-0.0649	
	0.8955	0.9854			0.1844	0.2718			0.1093	0.4980		0.0293	0.1065		
EU	22.6679	4.7534	0.2537	**	4.8313	1.7677	-0.0536		10.3684	0.0166	0.0017	10.7006	3.4855	-0.0732	*
	0.0001	0.0292			0.3051	0.1837			0.0347	0.8975		0.0301	0.0619		
CHF	51.6621	6.5092	0.2390	**	10.6346	0.1407	-0.0149		8.5119	0.0991	0.0052	9.3160	3.1044	-0.0691	*
	0.0000	0.0107			0.031	0.7075			0.0745	0.7529		0.0537	0.0781		

For the consumer service and financial sectors, exactly the same pattern is shown. All carry trade returns including G10 and individual pair Granger cause the consumer service sector and the financial sector return at 1% significant level except for the Japanese Yen. Sum coefficients, a measure of economic impact, are larger for the consumer service sector ranging from 0.2662 to 0.3980 (USD/NZD) than they are for the financial sector (sum coefficients between 0.2097 and 0.2437).

The Health Care sector shows a weaker carry trade effect. Individual currency pair carry trade returns do not cause any return. Only the G10 index shows a causality relationship; however, the magnitude is relatively smaller (Sum Coefficients = 0.1319). It implies that carry trade less likely impacts health care sector of stock market. Industrial sector returns and carry trade returns show a strong causality relationship. The G10 currency index return and individual currency pair return of US Dollar, Euro and Swiss Franc Granger cause an industrial sector return all at significant levels with the sum of coefficients around 0.3 least.

Not surprisingly, the G10 currency index as a measure of carry trade performance does Granger-cause the Oil & Gas sector return as well. But only the US Dollar carry trade return shows causal effect on this sector at 5% level (Sum coefficient = 0.2801). The Technology sector return is affected by all carry trade returns at a very significant level, except with the Japanese Yen. A noteworthy point is the magnitude of such effect (sum coefficients) is much higher than other sectors ranging from 0.8516 of EU/NZD carry, being the highest, to 0.6240 of CHF/NZD, and 0.4420 of USD/NZD. The Technology sector itself also has explanatory power on its own lags at 5% significant level.

For the Telecommunication sector, besides the G10 currency carry trade index causing stock return, the Swiss Franc carry trade is the only funding currency in carry trade to show Granger causality relationship on the sector return. The sector return does Granger-cause itself at a high significant level. Carry trade return causes a utilities sector return with a similar pattern, with the USD/NZD carry trade return leading the group with the highest 0.3106 of sum coefficients at 1% significant level.

A benchmark measure of carry trade return, the G10 currency index does Granger-cause stock return in all sectors with the one exception of the basic materials sector. It implies that carry trade does positively affect the target currency's stock market. Individual currency pair carry trade returns provide supportive evidence of such effect, only to different degrees and with preference in various sectors.

In the perspective of stock market sectors, the consumer goods, consumer service and utilities sectors show a strong relationship with carry trade returns. These three sectors are considered to be defensive stocks which normally do not tend to be reactive to economy conditions. It is understandable that global investors who do carry trade may choose these sectors to invest in carry trade due to their being less likely to be influenced by market downturn, mainly for diversification. Another stock sector widely considered to be defensive stock sector is the Health care sector though in New Zealand it is not so regarded.

Technology sector returns are affected by carry trade returns to the highest economic magnitude. Its mean return and standard deviation over all sample periods are the highest in all sectors. Such popularity might be because carry traders pursue stock returns as well, Technology stocks are commonly considered high growth stocks, the trace of global technology boom in stock market for past decade is reflected in New Zealand stock market as well.

The basic materials sector return cannot be predicted and explained by both carry trade return and its return of own lags. The contrast to similar cyclical sectors such as the financial and industrial sectors invite investigation; however, it is beyond the scale of this study.

5.3 Sub period Analysis

The Sub periods are divided as follow: crisis period is from 2nd July 2007 to 31st March 2009. Post crisis period is from 1st April 2009 to end date of sample period of 15th August 2017.

Table 5 reports the empirical result of the Granger causality relationship between carry trade return and the Stock market index. G10 currency carry trade index return causes stock return both in the crisis and post crisis periods. Both period show a sum of coefficients of 0.4072 and 0.1978 at 1% significant level.

Table 5 Granger – Causality Test Between Carry Trade Return And Return Of NZX 50 Index During And After Global Financial Crisis

NZX50 INDEX

		Carry trade Granger causes								Stock Granger causes							
		Stock				itself				Carry trade				itself			
		Rest 1	Rest 2	Sum Coeff		Rest 1	Rest 2	Sum Coeff		Rest 1	Rest 2	Sum Coeff		Rest 1	Rest 2	Sum Coeff	
G10	Crisis	55.0944	20.2715	0.4072	***	3.3095	0.7346	0.0929		8.8989	3.2129	-0.2143	*	6.3576	0.4840	-0.0694	
		0.0000	0.0000			0.5074	0.3914			0.0637	0.0731			0.1740	0.4866		
	Post Cri	73.1980	29.4434	0.1978	***	190.2797	91.0201	-0.5435	***	24.1341	9.4507	0.2027	***	5.9654	0.0568	-0.0101	
		0.0000	0.0000			0.0000	0.0000			0.0001	0.0021			0.2017	0.8117		
USD	Crisis	9.0795	5.5110	0.4287	*	8.5354	1.2985	0.1138		3.9568	1.9197	-0.0781		9.5145	0.1664	-0.0420	
		0.0591	0.0189			0.0738	0.2545			0.4119	0.1659			0.0495	0.6833		
	Post Cri	27.0728	7.0801	0.1975	***	4.0528	2.6674	-0.0736		2.0547	0.6588	0.0202		10.2995	0.5666	0.0308	
		0.0000	0.0078			0.3989	0.1024			0.7257	0.4170			0.0357	0.4516		
JPY	Crisis	2.3409	0.8559	0.1389		0.7101	0.0384	-0.0218		5.3700	0.8156	-0.0727		8.2446	0.0117	-0.0118	
		0.6733	0.3549			0.9501	0.8446			0.2514	0.3665			0.0830	0.9137		
	Post Cri	4.7237	0.0069	-0.0055		12.0653	3.0627	-0.0821	*	7.3899	5.3807	0.0707		15.0347	1.1071	0.0449	
		0.3168	0.9338			0.0169	0.0801			0.1167	0.0204			0.0046	0.2927		
EUD	Crisis	12.7363	1.3999	0.2892		3.8749	0.2763	-0.0546		0.9045	0.0005	0.0010		11.5318	0.0057	0.0078	
		0.0126	0.2367			0.4232	0.5991			0.9239	0.9814			0.0212	0.9399		
	Post Cri	9.4328	4.9693	0.1868	*	3.0051	1.7598	-0.0590		4.5929	0.2825	0.0115		11.3718	0.6065	0.0318	
		0.0511	0.0258			0.5570	0.1847			0.3317	0.5951			0.0227	0.4361		
CHF	Crisis	22.6742	3.9995	0.3948	**	3.0030	0.2320	-0.0521		1.9448	0.0001	0.0006		9.8896	0.0634	-0.0267	
		0.0001	0.0455			0.5573	0.6300			0.7459	0.9917			0.0423	0.8012		
	Post Cri	34.4830	9.5270	0.2121	***	7.1564	0.0038	-0.0027		5.0395	0.2460	0.0131		8.6422	0.3766	0.0253	
		0.0000	0.0020			0.1278	0.9510			0.2833	0.6199			0.0707	0.5394		

Table 5

Table 5 reports the Granger causality test using VAR (4) model testing the relationship between carry trade returns of G10, USD, JPY, Euro and Swiss Franc and NZX50 index in both crisis and post crisis period.

Similarly to the overall sample period results, individual currency pair carry trade of the US Dollar and Swiss Franc Granger-causes stock returns in both periods. In the crisis period, the result of USD/NZD carry trade on the NZX50 stock index shows the sum of coefficient of 0.4287 at 10% significant level and sum of coefficient of 0.1975 at 1% significant level in the post crisis period. CHF/NZD shows 0.3948 of sum coefficient at 5% significant level in crisis period, 0.2121 of sum coefficient at 1% significant in post crisis period. Euro carry trade only shows Granger cause to stock returns in the post crisis period with much less significance at 10% level (sum of coefficients 0.1868). USD/NZ and CHF/NZ carry the trade return lead in the group: they Granger-cause stock returns that are consistent with the G10 index. The empirical result indicates that carry trade return Granger-causes stock return with positive sum coefficients; it implies that, from the direction of carry trade to stock, such strategies still exist, although it may be less active.

Gourinchas and Rey (2007) suggest countries with large debt are most likely to encounter currency devaluations and countries with highest interest rates are much riskier. Atanasov and Nitschka (2014) also suggest the global downside risk and associated risk of carry trade return are much stronger for developed countries. If such sudden currency devaluation were to happen, it would wipe out cumulated carry trade return and even turn it into a loss. It would stop investors from doing carry trade in this scenario. The New Zealand Dollar experienced large depreciation during the financial crisis. However, the empirical results show evidence that New Zealand Dollar carry trade existed during that period. USD/NZD and CHF/NZD strategies seem to be more active. This finding is supported by Jordà and Taylor (2012) whose empirical results suggest that carry trade with simple and more realistic fundamentals-augmented trading strategies still would have generated strong and sustained positive profits through the financial turmoil. MacDonald and Nagayasu (2015) investigate US dollar and Japanese Yen carry trade and suggest that exchange rate stability is not the main reason for not initiating carry trade, but perception of how long and committed the reserve bank would be to maintain a low interest rate. They believe carry trade still existed during the period of financial turmoil.

For carry trade returns that have an impact on stock index return, the sum of coefficients is generally higher in crisis period than those in post crisis. The sum of coefficients of the G10 currency index return are 0.4072 for crisis period and 0.1978 for post crisis period. Both are at 1% significant level. The sum of coefficients for USD/NZD are 0.4287 for crisis period and 0.1975 for post crisis period. The sum of coefficients for CHF/NZD are 0.3948 for crisis period and 0.2121 for post crisis period. The sum of coefficients indicates the economic magnitude of the carry trade effect on stock market return. It implies the carry trade return has more impact on stock return during crisis period. This result is consistent with Lee et al (2013) where they suggest the spill-over effect of currency carry trade returns on the stock market are higher, in other word, the relationship between returns of two asset class is stronger in a bear market than they are in a bull market.

The magnitude of carry trade return on stock market return may be smaller in post crisis period (smaller sum of coefficients), however, looking at the statistical significance of P-value in post crisis period (USD/NZD shows 1% significant level in post crisis period, 10% significant level in crisis period, CHF/NZD shows 1% significance in post crisis period and 5% significance in post crisis period). it is much more significant in post crisis period than it is in crisis period. It may suggest carry trade is more active in post crisis period. The result is consistent with Lee et al (2013) that carry trade are more active in bullish market. Frijns (2008) suggest investors prefer riskier assets in a bull market. Carry trade obviously is one type of risky asset. In addition, empirical result shows stock return also Granger-causes carry trade return in post crisis period in sub period analysis. The NZX50 index return Granger-causes the G10 currency carry trade index return with sum of coefficients of 0.2027 at 1% significant level. It suggests stock market return also attracts carry trade capital, and causes carry trade return to increase. It indirectly supports the fact that carry trade is more active in post crisis period. It may be due to gradual improvement of market sentiment.

The empirical results of sub period analysis add some robustness to the results of the overall sample period. Both generally show consistent results. It suggests some difference regarding the Granger causality relationship between carry trade and the New Zealand stock market both in a recovering period as well as one of financial turmoil.

6. Conclusion

Carry trading is a widely adopted strategy that involves investing in high yield interest rate currencies, funded by low interest rate currencies. Such carry trade strategies are practised by both individuals and institutions seeking yield and diversification. The carry trade is related to stock markets through global capital flows. This study examines the lead-lag relationship between New Zealand carry trade returns and New Zealand stock market returns using up-to-date daily data from 2007 to 2017.

Empirical results of the study show that there is a significant Granger causality relationship between two assets, and it is positively related. However, the direction is from carry trade to stock market. It supports the fact that the New Zealand dollar does indeed act as an investment currency. The US Dollar, Euro and Swiss Franc are popular funding currencies. Widely reported Japanese Yen carry trade is not found associated with New Zealand Dollar. Direction of causality between carry trade and stock sectors is consistent. They show a certain pattern of preference. It may be due to different characteristic of stock sectors and unique traits of New Zealand economy. Using the same approach, empirical results for crisis and post crisis periods are generally consistent with the whole sample. However, the Granger causality relationship between carry trade return and stock market return is stronger in the crisis period.

Carry trade produces constant profits, which seems to defy the concept of Efficient Market hypothesis. Instead of studying such an inevitable fact, this study attempts to offer additional supportive evidence on how carry trade interacts with the stock market. It also provides practical implications for investors on asset pricing and risk management. Traces of carry trade can still be found during a crisis period, which has high volatility and higher probability of depreciation of investment currency, but this suggests that carry trade is probably not a conventional behaviour any more only seeking high yield. Hattori and Shin (2009) suggest that carry trade should be viewed in broader context of global credit condition, activities so prevail and show complicated intention that reflect much more factors such as global capital flow, monetary policies across countries. Carry trade, as a way of capital flow, links global assets. It is important to investigate carry trade in a continuous manner.

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