Econometric Models in Foreign Exchange Market

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Abstract

According to the significance of the econometric models in foreign exchange market, the purpose of this research is to give a closer examination on some important issues in this area. The research covers exchange rate pass-through into import prices, liquidity risk and expected returns in the currency market, and the common risk factors in currency markets. Firstly, with the significant of the exchange rate pass-through in financial economics, the first empirical chapter studies on the degree of exchange rate pass-through into import in emerging economies and developed countries in panel evidences for comparison covering the time period of 1970-2009. The pooled mean group estimation (PMGE) is used for the estimation to investigate the short run coefficients and error variance. In general, the results present that the import prices are affected positively, though incompletely, by the exchange rate. Secondly, the following study addresses the question whether there is a relationship between cross-sectional differences in foreign exchange returns and the sensitivities of the returns to fluctuations in liquidity, known as liquidity beta, by using a unique dataset of weekly order flow. Finally, the last study is in keeping with the study of Lustig, Roussanov and Verdelhan (2011), which shows that the large co-movement among exchange rates of different currencies can explain a risk-based view of exchange rate determination. The exploration on identifying a slope factor in exchange rate changes is brought up. The study initially constructs monthly portfolios of currencies, which are sorted on the basis of their forward discounts. The lowest interest rate currencies are contained in the first portfolio and the highest interest rate currencies are in the last. The results performs that portfolios with higher forward discounts incline to contain higher real interest rates in overall by considering the first portfolio and the last portfolio though the fluctuation occurs.

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Author's Declaration

I declare that, except where explicit reference is made to the contribution of others, that this dissertation is the result of my own work and has not been submitted for any other degree at the University of Glasgow or any other institution.

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Chapter 1

Introduction

Exchange Rate Pass-Through into Import Prices

Goldberg and Knetter (1997, p.1248) addressed in their textbook that, “The definition of exchange rate pass-through is the percentage change in local currency import prices resulting from a one-percentage change in the exchange rate between the exporting and importing countries.” This can be concisely explained as the incident with significant changes in the foreign exchange rate value. This leads to the possibility of import price changes. Exchange rate pass-through can also be described as the responsiveness of domestic prices, producer prices, consumer prices, import prices and sometimes the prices set by domestic exporters to exchange rate movements (Sekine, 2006) and renowned as the nominal exchange rate.

A number of literature reviews have observed different perspectives on exchange rate pass-through (ERPT) concerning specific industries or product studies. The movement of ERPT can have a great impact on the price of any kinds of trading product. Prior studies identified different perspectives, such as the contradiction of ERPT for countries with emerging market economies (Choudhri and Hakura, 2006; Frankel, Parsley and Wei, 2005; Mihaljek and Klau, 2000) and also for developed countries (Anderton, 2003; Campa and Goldberg, 2004; Campa, Goldberg and Gonzalez-Minguez, 2005; Gagnon and Ihrig, 2004; Hahn, 2003; Ihrig, Marazzi and Rothenberg, 2006; McCarthy, 2000).

Dornbusch (1987) noticed four features, which influenced the degree of ERPT on import prices; the composition of the market or segmentation level, the degree of product segregation, the practical framework of the demand curve and the market structure and the stage of monetary collaboration among providers. McCarthy (2000) cited that ERPT was positively correlated with the openness of the countries and with the existence of the exchange rate adjustment, but negatively correlated with the exchange rate volatility.

Bache (2006) focused on factors affecting the degree of ERPT and on the market segmentation that it mostly impacted. He also expressed that other factors affected the degree of ERPT as the degree of price stickiness, the alternative selection of currency, the distribution margin and the degree of competition from other domestic companies. The New Open Economy Macroeconomics (NOEM) literature discussed more prospective issues, involving the changes of ERPT, which were clarified in terms of the probable perseverance of the exchange rate, the sensitivity of the elasticities of demand relating to the exchange rate and the weight of imported goods in the manufacturing function for domestic goods. These all had their own assumption on the financial stock distribution, exchange rate volatility and the best possible monetary policy.

One of the substantial points of view in previous researches on ERPT was based on four issues resulting from exchange rate change as the effects on import and export prices, consumer prices, investments and trade volumes. Import and export prices are the principal aspect to be considered as they are primarily affected by the adjustment in exchange rate followed by consumer prices, investments and trade volumes (Darvas, 2001). The diffusion of stocks and optimal monetary policy in open economies are also other important implications, considered as the responsiveness of price adjustments to the degree of ERPT.

The importance of ERPT can be revealed by three explanations of the monetary policy of trading prices (Bussiere, 2007). One of the most significant points of the degree of ERPT is that it is the major factor performing monetary policy resulting from the adjustment in import prices on domestic inflation. Adolfson (2001) opined that in a small open economy the exchange rate implies an additional transmission channel for monetary policy and the consumer price (CPI) inflation is affected directly by changes in the exchange rate through the effect on import prices.

An interesting study by Barhoumi (2005) examined the ERPT equation on 24 developing countries. For the multi-country framework, the panel unit root tests consisted of two tests advocated by Im, Pesaran and Shin (IPS) (1997) and Hadri and Larson (HL) (2001) as the non-stationary panel estimation method and the panel cointegration test. The results showed a long-term relationship of ERPT with import prices comprising four main variables; a nominal effective exchange rate, the price of the competing domestic product, the exporter’s cost and the domestic demand conditions.

A major contribution was presented by Byrne, Chavali and Kontonikas (2010). They explored the nature of ERPT to import prices for a panel of 14 emerging economies from 1980 to 2004. Their model contained import prices, nominal effective exchange rates, a foreign marginal cost measure, domestic demand measures and the locally available import substitute goods price index as variables. Tests expressing the panel heterogeneity (the Hausman Test), investigated the pass through effects in both the short and long-term (the pooled mean group estimation known as PMGE), taking into account the asymmetries. The results showed that import prices had a positive but incomplete impact on average to the exchange rates.

Pesaran, Whin and Smith (1999) also proposed the procedure of PMGE and stated that one important advantage of the technique was that it allowed short-term coefficients and error variances to be diverse across panel groups and distinguishable from the long-term coefficients. The sample data for this study was two groups; 24 Organisation for Economic Co-operation and Development (OECD) countries from 1962 to 1993 and 10 Asian developing economies from 1974 to 1990. This was different from the study mentioned before and the cases of stationary and non-stationary regressors were both taken into consideration. Other techniques, Mean Group (MG) and Dynamic Fixed Effect (DFE) estimators were also used for comparisons. Their results contained some unresolved issues, but suggested that PMGE was an applicable method even though the null hypothesis of the homogeneity was rejected under the condition that the bias influencing the correlations was not systematic.

This previous research led to an interesting motivation of this study by further considering three types of panel data of emerging countries, developed countries and combined countries (consisting of emerging countries and developed countries from the first and second panel data groups respectively) to investigate and compare the different natures of the short and long-term effects of each economy.

Liquidity Risk and Expected Returns in the Currency Markets

The foreign exchange (FX) market is regarded as highly liquid and economically considerable. A co-movement in cross-section liquidity in the FX market has not been considered by many researchers compared to that in the stock market. One of the reasons why the FX market is more popular for research than the stock market is that liquidity is likely to be an interesting determinant for a priced state variable. Therefore, liquidity is frequently considered as a significant factor in making decisions. The investment topics researched by Hasbrouck and Seppi (2001), Huberman and Halka (2001), Lesmond (2005) and Past and Stambaugh (2003) paid pay particular attention to exploring the aspect of liquidity consistent with price fluctuations influenced by order flow.

Interestingly, on the other hand the co-movement of cross-sectional liquidity has attracted several recent studies by Melvin and Taylor (2009), Mancini et al. (2011) and Banti, Phylaktis and Sarno (2012). Consequently, this study focused on the question as to whether cross-sectional differences in foreign exchange returns are associated with the sensitivities of the returns to fluctuations in both aggregate and disaggregate liquidity.

A unique dataset in this study contained a set of order flows from UBS containing nine currencies, weekly nominal exchange rates and a set of macroeconomic and financial variables covering six years from November 2, 2001 to November 11, 2007. The customer order flow, considered as the active side of the trade and the source of the transactions conducted in the inter-broker market (Cerrato, Sarantis and Saunders, 2011), were specifically taken into account. The data was aggregated across currency pairs at a weekly frequency with customers split into four classifications: real money (asset managers), leverage (hedge funds), corporate and private clients.

The aspect chiefly focused upon was the dimension of the exchange rate changes related to the order flows. The principal model was primarily the initiative from the study of Pastor and Stambaugh (2003) on liquidity risk and expected returns in the stock market. A market liquidity measure was constructed as the equally weighted average of the liquidity measures of individual currencies for each five month block period using a weekly dataset. The approximation of the innovation in the aggregate liquidity was then examined.

The study captured the question of whether the expected foreign exchange return was associated with the sensitivity to the innovation in the aggregate liquidity, represented by the liquidity beta. The liquidity beta was estimated by two measures motivated by Pastor and Stambaugh (2003) and Acharya and Pedersen (2005). An ordinary portfolio-base was formed by sets of portfolios containing scattered liquidity betas. Currencies were sorted by their predicted values of the liquidity beta based on the historical sensitivities of foreign exchange returns to the liquidity risk. Subsequently, the returns on post-formed portfolios in the following year were linked across year with the intention of constructing an individual return series for each set of the portfolios. The excess returns on the portfolios were then regressed on factors correlated with returns.

Common Risk Factors in Currency Markets

Lustig, Roussanov and Verdelhan (2011) determined that large co-movements among exchange rates of different currencies can explain a risk-based view of exchange rate determination. The investigation identified a slope factor in exchange rate changes as the key estimation. The main assumption was that the exchange rates of high interest rate currencies loaded positively on this slope factor, with negative loading of low interest rate currencies.

The study primarily constructed monthly portfolios of currencies sorted on the basis of their forward discounts. The lowest interest rate currencies were contained in the first portfolio with the highest interest rate currencies in the last. The study also specified two most principal components of currency portfolio returns, which explained the time-series variation in currency returns. The most significant point of this study was similar to that of Lustig, Roussanov and Verdelhan (2011); considering the common factors in exchange rates sorted by interest rates, indicated as major factors in the clarification of carry trade returns with a risk-based point of view.

Chapter 2

Literature Review

Exchange Rate Pass-Through into Import Prices

Goldberg and Knetter (1997, p.1248) stated in their text book that, "The definition of exchange rate pass-through is the percentage change in local currency import prices resulting from a one percent change in the exchange rate between the exporting and importing countries." or its explanation can be shortly explained as the incident containing changes in the foreign exchange rate value, which lead to the possibility in import price changes. Exchange rate pass-through can also be defined as the responsiveness of domestic prices, producer prices, consumer prices, import prices and sometimes the prices set by domestic exporters to exchange rate movements (Sekine, 2006) and recognized as the nominal exchange rate.

There have been many literature reviews in different perspectives on exchange rate pass-through (ERPT) disclosing the specific industry or product studies. The movement of the exchange rate pass-through can bring a great impact on the price of any kinds of trading products. Some studies concern the contradiction of the ERPT of countries with the emerging market economies, such as Frankel et al. (2005), Mihaljek et al.

(2000) and Choudhri and Hakura (2006), and that of the developed countries, for instance, Campa and Goldberg (2004), Gagnon and Ihrig (2004), Ihrig et al (2006), McCarthy (2000), Hahn (2003), Campa et al. (2005) and Anderton (2003).

According to the early study of Dornbusch (1987), it discovers four features influencing on the degree of exchange rate pass-through to import prices; which are the composition of the market or segmentation level, the degree of product segregation, the practical framework of the demand curve, and the market structure and the stage of monetary collaboration among providers. McCarthy (2000) later mentioned in the result of his study that the exchange rate pass-through was positively correlated with the openness of the countries and with the existence of the exchange rate adjustment, and negatively correlated with the exchange rate volatility.

Afterward, Bache (2006) focused on factors affecting the degree of exchange rate pass-through and agreed on the market segmentation that it has an impact on it. Additionally, his study expressed that other factors affecting the degree of the exchange rate pass-through are the degree of price stickiness, the alternative selection of currency, the distribution margin and the degree of competition by other domestic companies. In the New Open Economy Macroeconomics (NOEM) literature, more prospective issues involving in the change of the degree of exchange rate pass-through were explained in terms of the probable perseverance of the exchange rate, the sensitivity of the elasticities of demand relating to the exchange rate and the weight on imported goods in the manufacturing function for domestic goods, which have their own assumption on the financial shock distribution, exchange rate volatility and the best possible monetary policy.

In the same period of time, Ghosh (2006) reviewed the 5 factors affecting the extent of exchange rate pass-through but into domestic prices with the specialization in Asian countries, which are Japan, Korea, Hong Kong, India and Southeast Asia including Indonesia, Thailand, Malaysia, and the Philippines.

1) The nature of the goods or industries under consideration at the micro-level

   If exporters do not face much competition, mark-ups or prices of the exporters may be less responsive to fluctuation in the value of the exporter's currency against the buyers. However, if the destination market is highly competitive, firms may try and guard their market share by absorbing exchange rate changes by accepting lower mark-ups.

2) The duration of exchange rate changes

   Exchange rate pass-through tends to be almost complete in the long run with persistent exchange rate shocks. If the exchange rate change is temporary, an exporter may be more willing to accept a temporary cut in profit margins to maintain market share given the possibility of hysteresis effects.

3) The direction of exchange rate changes

The response of exporters to exchange rate changes is asymmetric, depending on whether the exchange rate appreciates or depreciates. It can be considered that when the exporters' currency depreciates, exports became cheaper in the destination market to create an incentive for exporters to maintain their export prices or reduce their currency price and amplify the impact of currency depreciation.

4) The size of the exchange rate changes

When the magnitude of the exchange rate change is small, firms will absorb it and keep domestic prices unchanged due to the costs associated with changing prices.

5) Macroeconomic variables

Exchange rate pass-through tends to be greater in lower income economies and smaller and more open ones where there is a high share of traded goods, high import content, limited domestic substitutes and high degree of integration with the global trading system. This inevitable issue makes much of developing Asia more vulnerable to exchange rate pass-through than other parts of the world.

Another point of view of the previous researches on ERPT are based on four issues according to the exchange rate change consequences, which are the effects on import and export prices, consumer prices, investments, and trade volumes. The import and export prices are stated to be the principal aspect to be considered as they are the initial matter affected by the adjustment in exchange rate following by consumer prices, investments and trade volumes (Darvas, 2001), which is similar to the work of Bandt (2008) that separated its literature in exchange rate pass-through into 2 main groups; ERPT into import prices as the first step pass-through and ERPT into consumer prices as the second step pass-through. The diffusion of shocks and optimal monetary policy in open economies are also other important implications, considered as the responsiveness of price adjustments in the degree of exchange rate pass-through.

The importance of the exchange rate pass-through reveals especially into 3 explanations in terms of monetary policy of trading prices (Bussiere, 2007). One of the most significant points of the degree of exchange rate pass-through is that it is the major factor performing monetary policy resulted from the adjustment in import prices on domestic inflation as it can be seen in Adolfson's study (2001) that in a small open economy, the exchange rate implies an additional transmission channel for monetary policy and the consumer price (CPI) inflation is affected directly by changes in the exchange rate through the effect on import prices.

Subsequently, the elasticity of export prices to the changes in exchange rate is a fundamental component in price competitiveness estimation, influencing the net exports and trading activities. Lastly, the trading prices response to the exchange rate implies the trading quantity outcome. Therefore, a precise approximation of pass-through to trade prices is an essential pace in the global economic unbalance, particularly the trade equilibrium reaction to the exchange rate change.

These are some significant econometric techniques used for exchange rate pass-through (ERPT).

Vector Autoregressive (VAR) Model

This major methodology is widely and increasingly used in estimating the degree of exchange rate pass-through because of its prospect for the definite process in lagged variable selection by inserting economic variables into a time series model with no explicit dynamic relation scheme (Fuss, 2007) and the approximation permission of pass-through in the set of import prices, producer prices and consumer prices (Bache, 2006).

In Bache's study (2006), it also states that one of the most motivating points of using this approach is that the endogeneity of the exchange rate is taken obviously and that the Vector Autoregressive (VAR) model is a helpful approach to approximate the parameters in Dynamic Stochastic General Equilibrium (DSGE) models by minimizing to locate an optimal determination of the distance between the impulse responses from DSGE models and those from VAR models, depending on some limitations.

In order to estimate the degree of exchange rate pass-through, a given exchange rate, price indices, which are import prices, producer prices and consumer prices, and essential supplementary variables for some cases such as oil prices, wages and interest rates are needed. As expressed by Bache (2006), VAR model directs to three termination points. Primarily, ERPT is found to be incomplete yet in the long-run. Secondly, the speed and the size of the ERPT decrease down the distribution chain; however, it shows that the response of the import prices to exchange rate shocks is more convincing and more rapid than consumer prices and the producer prices. Lastly, consumer prices have no relationship to the exchange rate shocks.

In the study of Darvas (2001) on exchange rate pass-through into consumer prices of four EU countries, he found that one important problem in international economics is to include the short-run adjustment of the exchange rates in the models so he altered his initial constructed models by consisting of the preceding disequilibrium of the real exchange rate in the short-run exchange rate equation, leading to the new model as shown in the following part. Nonetheless, findings of the research state that its VAR model is dissimilar to error correction term and the random walk by the time-varying drift since no adequate explanatory variables are found in the empirical section of the research.

The main foundation equations of study of Darvas are

$$\Delta p_t = \beta_{0,t} + \beta_{1,t}\Delta s_t + \beta_{2,t}\Delta p_t^* + \beta_{3,t}(p_t^{(A)} - p_t) + \beta_{4,t}(q_{t-1} - q_{t-1}^{EQ}) + u_{1,t}$$

$$\Delta s_t = \gamma_{o,t} + \gamma_{1,t}(q_{t-1} - q_{t-1}^{EQ}) + u_{2,t}$$

where Δ is the first different operator

p_t is the domestic price level

p_t^* is the foreign fundamental price level

s_t is the nominal exchange rate

$p_t^{(A)}$ is the price of goods or services in charge of administrative measures

$q_i \equiv p_i - p_i^* - s_i$ is the real exchange rate for i are positive integers

q_t^{EQ} is the equilibrium real exchange rate

$\beta_{i,t}$ are time-varying parameter for i are positive integers

$\gamma_{i,t}$ are time-varying parameter for i are positive integers

$u_{i,t}$ are residuals (errors) for i are positive integers

Administered prices are taken into relative terms since they are not included in the exchange rate adjustment, the foreign inflation and the error correction impact. Nevertheless, another main issue is that a supplementary inflationary consequence is expected to be consisted in the equation if its growth is faster than the increase in fundamental prices. However, the model of this study failed for the change in fixed coefficient approximation and for the question whether the difference in countries is one of the factors affecting the exchange rate regime, the exchange rate volatility and the inflation stage of the country or not.

A later study of Zorzi et al. (2007) concentrated on more countries; not only EU countries but also in Asia and Latin America, to estimate the degree of exchange rate pass-through. The research contains the baseline issue in the output variables, the exchange rate, the import and consumer price, a short-term interest rate, and the oil prices so its VAR model recognizes the exchange rate shocks by involving variable arrangement and the consideration on a recursive identification idea because of the indication that the exchange rate shocks influence all other variables. Other than performing a sensitivity analysis for placing the different involved variables, the study furthers its attention on approximating equivalent models for each specific developed country in EU, Japan and the United States.

The VAR model of the study of Zorzi et al. (2007) is

$$Y_t = c + \sum_{i=1}^{P} \phi_i Y_{t-1} + \varepsilon_t$$

where Y_t is the vector of endogenous variables

c is a vector of constants

ϕ_i are the matrices of autoregressive coefficients for i are positive integers

ε_t is a vector of white noise processes

The study includes six variables in the VAR model for each country of the interest, which are an oil price index, oil_t , an output variable, Y_t , an exchange rate, e_t, an import price index, $pimp_t$, a consumer price index (CPI), cpi_t, and a short-term interest rate, i_t. In the model, the exchange rate, an import price index and the consumer price index are major variables while an output variable and an oil price index are consisted in the model in order to control the real result occurred in the economic. One last term, which is the short-term interest rate, is taken into account for the money market contemplation in terms of the monetary policy effect to control the exchange rate pass-through relationship.

Rowland (2003) also applied the VAR model in the estimation of exchange rate pass-through to import prices, consumer prices, producer prices and domestic prices with a case study taken in one specific country, Colombia, with the reason of its advantage on the straightforwardness of the model that the exchange rate the price indices are required in the approximation. The study used two different econometric approaches, both under the VAR model framework, which are unrestricted VAR model McCarthy (2000) and multivariate cointegration framework originated by Johansen (1988), both with the exchange rate pass-through dynamic analysis concerning impulse-response structures.

The unrestricted VAR model is identified by four equations:

$$\Delta S_t = \sum_{i=1}^{k} \gamma_{11}^{i} \Delta S_{t-i} + \sum_{i=1}^{k} \gamma_{12}^{i} \Delta imp_{t-i} + \sum_{i=1}^{k} \gamma_{13}^{i} \Delta ppi_{t-i} + \sum_{i=1}^{k} \gamma_{14}^{i} \Delta cpi_{t-i} + \varepsilon_{1t}$$

$$\Delta imp_t = \sum_{i=1}^{k} \gamma_{21}^{i} \Delta S_{t-i} + \sum_{i=1}^{k} \gamma_{22}^{i} \Delta imp_{t-i} + \sum_{i=1}^{k} \gamma_{23}^{i} \Delta ppi_{t-i} + \sum_{i=1}^{k} \gamma_{24}^{i} \Delta cpi_{t-i} + \varepsilon_{2t}$$

$$\Delta ppi_t = \sum_{i=1}^{k} \gamma_{31}^{i} \Delta S_{t-i} + \sum_{i=1}^{k} \gamma_{32}^{i} \Delta imp_{t-i} + \sum_{i=1}^{k} \gamma_{33}^{i} \Delta ppi_{t-i} + \sum_{i=1}^{k} \gamma_{34}^{i} \Delta cpi_{t-i} + \varepsilon_{3t}$$

$$\Delta cpi_t = \sum_{i=1}^{k} \gamma_{41}^{i} \Delta S_{t-i} + \sum_{i=1}^{k} \gamma_{42}^{i} \Delta imp_{t-i} + \sum_{i=1}^{k} \gamma_{43}^{i} \Delta ppi_{t-i} + \sum_{i=1}^{k} \gamma_{44}^{i} \Delta cpi_{t-i} + \varepsilon_{4t}$$

where $Y_{nm}^{\ i}$ are parameters to be approximated for n and m are positive integers

k is the maximum distributed lag length

Δ is the difference operator

ε_{nt} are independent and identically distributed error terms for n are positive integers

s is the exchange rate

imp is the import price index

ppi is the producer price index

cpi is the customer price index

Moreover, multivariate cointegration framework is later used to approximate the cointegrating relationships between variables by grouping the variables into 3 models;

(s, imp), (s, ppi, gap), and (s, cpi, gap), where gap is the difference between exact traded production and possible output, while $(s, imp, ppi, cpi, gap, i)$, where i is interest rate, is mostly used by many other studies. Some specific conditions are taken into account on data of Colombia; nevertheless, the normality test gets rejected leading to the conclusion that the test results were not valid. Though $(s, imp, \exp^*)$, where $\exp^*$ is the US import price index, is later tested, the results are still erroneous. The reason of this problem might be significantly from a fact that there should be Purchasing Power Parity (PPP), a theory of long-term equilibrium exchange rates based on relative price levels of two countries, among the US export prices and Colombian import prices.

According to multivariate cointegration framework, the outcomes in terms of relationships are

$$s = a_{11} + a_{12} imp$$

$$s = a_{21} + a_{22} ppi + a_{23} gap$$

$$s = a_{31} + a_{32} cpi + a_{33} gap$$

Therefore, this point of view in the estimation of the confidence intervals, which has not been taken into account for the approximation and becomes a weakness in this study, should be more concentrated.

Bache (2006) also focuses on the VAR approach in the first differences of the nominal prices and the exchange rate. The study notifies that in order to approximate the degree of exchange rate pass-through, a nominal exchange rate, one or a set of prices, such as import prices, producer prices and consumer prices, and some supplementary variables; for instance, oil prices, incomes, and interest rates are essential. Each type of shock has a particular influence on the movement relationship between prices and the exchange rates and that leads to the fact that the exchange rate pass-through is also identified as an external exchange rate shock, which is the price impulse responses depending to each shock.

Two ordinary techniques are applied in order to achieve a stationary representation of the VAR models. The first approach is to distinguish the non-stationary variables and the second approach is to assess for cointegration and impose the cointegration limitations. Its model is listed below:

$$\Delta y_t = A_1 \Delta y_{t-1} + A_2 \Delta y_{t-2} + \ldots + A_p \Delta y_{t-p} + \varepsilon_t$$

where

$$\Delta y_t' = \{\Delta \ln \overline{P}_t^m, \Delta \ln \overline{P}_t^x, \Delta \ln P_t^y, \Delta \ln P_t^c, \Delta \ln S_t\}$$

Nevertheless, regarding the equations above, the combination of four roots of the matrix $A-BD^{-1}C$ equals to one, whereas other remaining roots are all lesser than one in the module. This indicates that there is no VAR allocation in the model and consequently, the explanation given to the fact that why a VAR allocation is successful to be present is that the variables comprised in the VAR models are over differenced. In the future research related to this study, the variables included in the VAR models should be inspected before being attached to any cases.

Dynamic Stochastic General Equilibrium (DSGE) Model

The general point of DSGE models is to evaluate the impulse response functions between those from DSGE models and those from VAR models, depending on some limitations. The condition of the model is that the exchange rate pass-through and the actual prices are non-stationary unit root processes; however, other comparative prices and the actual exchange rate are stationary. One of the consistent sustainable assumptions between VAR models and DSGE model is the identification scheme to classify the structural shocks.

In the study of Bache (2006) again, it reflects on the nominal exchange rate – the degree of exchange rate pass through with the data on the import prices of UK and Norway and takes the accurateness of confidence intervals into consideration with the bootstrap procedure, which some previous researches failed to achieve before. The main idea is to rise up impulse responses from a VAR model with the artificial data approximation and discover whether the results from VAR models retrieve the impulse responses of DSGE models especially for the small open economy.

By taken this study to be an example, the models are separated mainly into those for firms and those for households as the study concentrates on the exchange rate pass-through to consumer price but only those for firms are stated in this literature review. There are two goods in the firm open economy, which are a non-tradable final consumption good and a tradable intermediate good with the assumption that non-traded component is always included in all goods in the consumer price index and the imported goods are considered to be inputs in the domestic goods manufacture, indicating an obvious relationship between import prices and the manufacture costs for the domestic firms.

For the non-tradable final consumption goods market that is identified in terms of monopolistic competition, the model used is

$$C_t(c) = Q_t(c)^{\gamma_c} H_t^c(c)^{1-\gamma_c}$$

where:

$C_t(c)$ = the output of non-tradable final consumption good c at time t

$Q_t(c)$ = the amounts of intermediate goods in the manufacture of non-tradable final consumption good c and $\gamma_c \in [0,1]$

$H_t^c(c)$ = the amounts of labour in the manufacture of non-tradable final consumption good c and $\gamma_c \in [0,1]$

Therefore, the expected consumption price index of the non-tradable final consumption goods is

$$P_t^c \equiv \left[\int_0^1 P_t^c(c)^{1-\theta_t^c}\, dc\right]^{\frac{1}{1-\theta_t^c}}$$

where:

$\theta_t^c > 1$ is the time-varying resilience of substituted alternative between consumption goods.

For the tradable intermediate goods, the model used is as below

$$Y_t(i) = Z_t(i)^{\gamma_y} H_t^y(i)^{1-\gamma_y}$$

where: $Y_t(i)$ = the output of tradable intermediate good i at time t

$Z_t(i)$ = the amounts of tradable intermediate goods in the manufacture of tradable intermediate good i and $\gamma_y \in [0,1]$

$H_t^y(i)$ = the amounts of labour in the manufacture of tradable intermediate good i and $\gamma_y \in [0,1]$

Nonetheless, prices of any tradable intermediate goods can be set at various stages according to which market the goods are; domestic market or foreign market.

The expected consumption price index of the domestic tradable intermediate goods is

$$P_t^c \equiv \left[\alpha(P_t^y)^{1-v} + (1-\alpha)(P_t^m)^{1-v}\right]^{\frac{1}{1-v}}$$

Consequently, tradable intermediate goods prices in the foreign market are set in the producer currency (known as Producer Currency Pricing, PCP) so the exchange rate pass-through to import prices is prompt and complete, while the import goods prices will counter slowly with the changes in exchange rates for the Local Currency Pricing (LCP). The expected export price index in domestic currency of the domestic tradable intermediate goods is

$$P_t^x \equiv [\overline{\omega}(P_t^{xp})^{1-\theta_t^x} + (1-\overline{\omega})(S_t P_t^{xl})^{1-\theta_t^x}]^{\frac{1}{1-\theta_t^x}}$$

where: P_t^{xp} = the export price indices attained by the combination over firms with Producer Currency Pricing (PCP) system

P_t^{xl} = the export price indices attained by the combination over firms with Local Currency Pricing (LCP) system

Lastly, for foreign firms, their intermediate goods are treated similarly with those from domestic firms. The import price index in the currency of the importing country is

$$P_t^m \equiv [\varpi_f (S_t P_t^{mp})^{1-\theta_t^m} + (1-\varpi_f)(P_t^{ml})^{1-\theta_t^m}]^{\frac{1}{1-\theta_t^m}}$$

where:

P_t^{mp} = the price indices attained by the combination over firms with Producer Currency Pricing (PCP) system

$$P_t^{mp} \equiv [\frac{1}{\varpi_f} \int_0^{\varpi_f} P_t^{mp}(m)^{1-\theta_t^m} dm]^{\frac{1}{1-\theta_t^m}}$$

P_t^{ml} = the price indices attained by the combination over firms with Local Currency Pricing (LCP) system

$$P_t^{ml} \equiv [\frac{1}{1-\varpi_f} \int_{\varpi_f}^{1} P_t^{ml}(m)^{1-\theta_t^m} dm]^{\frac{1}{1-\theta_t^m}}$$

Incompleteness of ERPT

The phenomenon of incompleteness of exchange rate pass-through appears if the prices expressed in home currency are sticky, then national prices of imported goods do not change in the same proportion as exchange rate changes, even when the exchange rate changes influence on marginal costs. Various studies have justified about the incompleteness of ERPT; for instance, the study of Rowland (2003), which is one of the evidences showing the incompleteness of ERPT in the case of Columbia. Its import prices react moderately rapidly to a change in exchange rate, while its producer prices respond awkwardly. The study applied the unrestricted VAR model approach and multivariate cointegration approach to explore the exchange rate pass-through to domestic prices but the outcome was found to be dissimilar. That of unrestricted VAR model capitulate a pass-through of 8 percent after one year and a pass-through of 15 percent for the other technique used.

However, it is still questionable because of no exact answer until now. As mentioned in Dornbush's work (1987), one of the most important reasons making the ERPT imperfect is taken place from the operation in a flawed competition markets and the mistaken price adjustment is a significance in consistent with an exchange rate shock. In a different way, Burstein et al. (2005) disputed that the incompleteness actually originates from the slow price change in non tradable goods and services and the incorrectness problem in consumer price index (CPI) estimation, which takes no notice of the quality adjustment of any tradable goods and services.

Glodberg-Knetter (1997) suggested a feature in the incompleteness of ERPT that it is a continuance of the third-degree price discrimination, caused by the situation that different prices are allocated to two or more product buying groups, distinguished by some characteristics such as, sex, age or location, with diverse demand resilience by the seller. Another imperative literature review on this issue established by Magee (1973) is that not only one single consistent revaluation or devaluation theory but the combination of reasons leading to the question why, for some cases, product prices are not in accordance with the exchange rate adjustment completely.

Apart from the incompleteness of pass through, inflation is one of the related concerns in exchange rate movement guiding to the price adjustment of any goods or services. Taylor (2000) advocated a hypothesis that the price adjustment follows not only the exchange rate instability, but positively on inflation as well. He implied a positive relationship between the level and the tenacity of inflation that the more tenacious in inflation brings about the less exchange rate movements to be apperceived to be temporary and it will later causes more reactions of organizations in price adjustments.

In consequence of the incompleteness of ERPT, the common impact is recognized by Menon (1995) and he also proposed the difference in ERPT stages between each country and the distinction among researches studying the same countries. There is no accession on the pass-through relationship whether the prices should pursue the exchange rate adjustment or continue steadily as normal.

Liquidity Risk and Expected Returns in the Currency Markets

Primarily, liquidity measures have essentially been developed and chiefly used for the investigation in the stock market. Starting with the study of Amihud and Mendelson (1986), which empirically explores the correlation between liquidity and expected stock returns, it performs that a higher return is a consequence of lower liquidity and higher transaction costs. Related literatures on a systematic risk premium in stock returns are subsequently observed and confirmed by Chen (2005), Korajczyk and Sadka (2008), Hasbrouck (2009) and Lee (2011).

One of the most significant benchmarks among all related papers in the research field concentrating on the liquidity in the stock market is achieved by Pastor and Stambaugh (2003), which considers the market-wide liquidity, denoting to high level of trading activities at a great amount but low cost without affecting the price, as one of the significant state variables in asset pricing. Using the liquidity measure by taking into account a dimension of liquidity corresponding to the strength of volume-related return reversals, they concentrate on a perspective of liquidity linked with the temporary price fluctuations, in relation to expected return reversals that are influenced by a determinant of a microeconomic factor: order flow[1], conducted as signed transaction volume employed by the stock returns. The results show the evidence of a cross-sectional relationship between expected stock returns and the sensitivities of returns to fluctuations in aggregate liquidity in the sense that the stocks that are more responsive to aggregate liquidity considerably have higher expected returns. The measure shows that smaller stocks are less liquid and the smallest ones indicate high sensitivities to aggregate liquidity. Additionally, stocks' liquidity betas, which denote the sensitivities of stocks to innovations in aggregate liquidity, are indicated to be another significant feature for asset pricing and can be approximated by their historical estimates and other associated variables. Besides, the study of Pastor and Stambaugh (2003) also explores the consequence of systematic liquidity risk on expected returns. Differently from other previous researches considering liquidity as a pertinent variable for pricing, the paper regards the market-wide liquidity as a characteristic relevant to expected stock returns instead.

However, other literatures have also had an intention in exploring the equivalent aspect on the liquidity in the foreign exchange market. Exchange rate is addressed for its prominence in the international economy especially on the economy growth and inflation through the consequence on import and export prices. This feature has not been taken into account by many researchers as seen in previous literatures yet some literatures on this aspect are found. Mark (1985) initially proposes the prominence of

[1] The term 'order flow' is indicated by SSC (State Street Corporation) as a buying pressure on a currency, calculated by the subtracting of the number of sells from the number of buys in a currency. Essentially, it is approximated by the aggregate result of signed trades, which is authorised according to the trading action (Banti, Phylaktis and Sarno, 2012).

macroeconomic characteristics, such as prices and income levels, on exchange rate changes; nevertheless, this content has been disappointed by related literatures. On the other hand, Lyon (1995), conversely, suggests the foreign exchange microstructure fundamentals on exchange rate movements instead. The acknowledgment of taking order flow into consideration as a determinant for the liquidity estimation in the foreign exchange market is later brought into the literature.

The feature of foreign exchange microstructure approach can be recognisably found in the study of Evans and Lyons (2002a), which asserts strongly substantial relationship evidence between order flow and spot exchange rate movements. According to their paper, order flow, which declares the detail on the size, direction and transactions, is outlined as a component playing an important role on magnificently clarifying a substantial share of the movements in the exchange rates; therefore, the feature is taken into account. In other words, order flow can be used prosperously to describe the exchange rate movements. The considerable contribution of the study is the approximation on the systematic liquidity risk premium, alternatively regarded as the investigation on the innovations in the foreign exchange market liquidity whether they have an impact on exchange rate movements, and whether the outcomes of the study significantly present the higher relationship level between liquidity risk and emerging market currencies compared to that and the other. This essentially asserts the important variation in liquidity across foreign exchange excess returns. The evidence shown in the results of the latter focus in the study additionally supports that liquidity risk is one of the important components particularly in specifying the cross-section of emerging market currencies.

Evans and Lyons (2002b) declare that time-varying liquidity can be measured in the foreign exchange market. The results show that the liquidity, addressed as the impact of trades, varies over time and is dependent on the pace of public information flow.

Moreover, the study presents an important evidence of the relationship between the order flow and returns. Berger et. al (2008) document a prominent role of liquidity in the relation between order and exchange rate movements in it does not systematically measure the benchmark liquidity or investigates commonality in liquidity.

The simultaneous relationship between customer order flows and exchange rate movements is also prominently taken into consideration in the paper of Marsh and O'Rourke (2005) in the context of European commercial bank's foreign exchange market and the results of the study strongly confirm that customer order flows in their case are correlated with exchange rate changes at both the daily and weekly frequency. The further significant evidence is that different determinants of order flow distinctively affect the exchange rate changes. Specifically, the study presents the negative correlation between order flow from non-financial corporations and exchange rate movements; whereas, the positive correlation is found between order flow from companies and exchange rate changes.

Subsequently, King, Sarno and Sojli (2010) take the concentration on microeconomic aspects, particularly order flow, in a foreign exchange market of the Canadian dollar/US dollar (CAD) exchange rate as Canada is importantly stated to be a small open market that is powerfully bonded with the US economy. The explanatory forecasting power of foreign exchange order flow is examined by taking into account the 11-year disaggregated dataset on sales and purchases, which is quite long time series compared to previous relative literature relying on shorter samples of data and from a restricted sector of the market. Nevertheless, order flow used in the paper is not apparently an exact estimate. Instead, it is a proxy approximated from the replication of the microstructure characteristics. In the results, they address perceptibly that order flow is a considerable determinant in forecasting exchange rate movements.

Later, the remarkable studies on systematic liquidity risk, which is an adjusted form of the Pastor and Stambaugh's liquidity measure, in the foreign exchange market is provided by Mancini, Ranaldo and Wrampelmeyer (2011) with intraday dataset in shorter time period from January 2009 to December 2009 consisting of significant currency pairs. The study also confirms the substantiation that there is the cross-sectional variation in liquidity. Differently from other previous literatures, the paper additionally contributes an analysis of liquidity risk consequences on the carry trade, which is a widespread trading strategy used by traders to capture the difference between the interest rates. Carry trade strategy is defined when a certain currency yielding a low interest rate is borrowed in order to invest in a different higher interest rate. In an empirical analysis, they denote the evidence that insurance against the liquidity risk is likely to be proposed by low interest rates and insurance disclosure to the liquidity risk is offered by relatively high interest rates instead. In contrast to the perceptions that the foreign exchange market is usually considered as extremely liquid, this means that there is significantly an existence of a determined impact of liquidity risk factors on daily carry trade returns during the sample period implying that liquidity risk is priced in currency returns. This is as the result of that liquidity betas are regarded as one of those factors, leading to the estimation of liquidity betas taken place in the paper by bringing a novel tradable liquidity risk factor into consideration because of its strong impact on carry trade returns. The additional study on the impact of liquidity risk on the carry trade returns in other periods of time is suggested in the future work due to the restriction of data availability of the study that the further investigation on that matter cannot be continued.

Another considerable research on an analogous aspect on a measure of liquidity risk, which is of Banti, Phylaktis and Sarno (2012), is later published. The study presents the foreign exchange liquidity measure, an extension comparable to that of Pastor and Stambaugh (2003) initially constructed for the US stock market. A prominent characteristic is its wide-ranging dataset of 20 developed and emerging market currencies and order flows spanning 14 years, covering both crisis and non-crisis periods. The concentration of the study is also on whether a systematic liquidity risk premium exists in the foreign exchange market or whether there is a correlation between the exchange rate returns and the innovations (unexpected changes) in the liquidity. Another substantial feature of the study is the investigation of liquidity risk premium[2], which is practically infrequent in the foreign exchange market but bond markets and stock markets.

The literature of Banti, Phylaktis and Sarno (2012) extends the previous researches by taking the consideration on the liquidity risk feature in the foreign exchange (FX) market, which is determined to have high liquidity and be economically considerable in the world yet complicated concerning the transaction information (Cerrato et. al, 2011). Furthermore, the paper is also considered to be the first study on global foreign exchange liquidity of a long-period order flow dataset of 14 years, responding to the intention proposed by Mancini, Ranaldo and Wrampelmeyer (2011). The dataset consist of the data on crisis and non-crisis periods, and developed and emerging markets including 20 currencies. According to the substantiation of strong common properties in liquidity across currencies as the inspired liquidity measure of Pastor and Stambaugh (2003) on the US stock market as mentioned earlier in this literature review section, the foreign exchange liquidity measure is constructed in a comparable measure, initially starting with the liquidity estimation on each individual currency by expressing the liquidity formed on the basis of the temporary price change as the expected return reversal related to the order flow, and estimating an annualized liquidity risk premium. The fundamental perception is that low liquidity is associated with a high volume-related return reversal.

[2] The definition of the liquidity risk premium is determined in terms of the foreign exchange market by Mehrling and Neilson (2008) that it is the difference between the forward exchange rate and the future exchange rate and can be estimated as a dollar payoff. In other words, the liquidity risk premium is considered as the return in dollar according to buying a unit of foreign currency at the future exchange rate and selling it at the forward exchange rate.

Moreover, Banti, Phylaktis and Sarno (2012) extends their analysis on the liquidity risk premium with the additional adjustment of liquidity risk definition by taking into account the covariance of individual asset liquidity and market liquidity, and the covariance of individual asset liquidity and market returns in the foreign exchange market, inspired by Acharya and Pedersen (2005). This is considered to be a supplementary to the study of Pastor and Stambaugh (2003), which is mentioned earlier in this section, that concentrates on the covariance of an asset return and market liquidity in the stock market. Hence, the Acharya-Pedersen liquidity measure is regarded as an analogue of the Pastor-Stambaugh liquidity measure. The incentive is on an investor to have a premium in order to keep an illiquid currency when the overall market is illiquid.

In conclusion for the previous literatures reviewed for this research, the study of Pastor and Stambaugh (2003), which is our main previous literature, explores liquidity risk and expected stock returns on the stock market, following by the study of Mancini, Ranaldo and Wrampelmeyer (2011) or Banti, Phylaktis and Sarno (2012) that investigates the foreign exchange market but only on the liquidity risk aspect. Therefore, liquidity risk and expected returns in other financial markets are suggested to be taken into account, importantly leading to the motivation of this study in foreign exchange market, which contains various investment and international trade with currency conversion authorisation.

Common Risk Factors in Currency Market

The literature review of this study starts with the results from the study of Lustig, Roussanov and Verdelhan (2011), which shows that the large co-movement among exchange rates of different currencies can explain a risk-based view of exchange rate determination. This aspect leads to the investigation on identifying a slope factor in exchange rate changes, which is the key estimation of this study. The assumption is primarily placed as that the exchange rates of high interest rate currencies load positively on this slope factor at the same time as the negative loading of low interest rate currencies on it. The returns on the currency carry trade[3], known as the average returns between baskets of high and low interest rate currencies, are explicated by the co-variation with this slope factor

In integrated capital markets, risk is defined as exposure to some common or global factor, which has performed a significant role and is intimately associated with changes in volatility of equity markets around the world (Poirson and Schmittmann, 2013). The study of Lustig, Roussanov and Verdelhan (2011) also presents that the slope factor in exchange rates grants an accurate measure of the global risk factor. The factor is constructed from currency portfolios and can also clarify the variation in the country-level returns. Therefore, a constructed no-arbitrage model of interest rates and exchange rates with two state variables, which are country-specific and global risk factors, is taken into account.

Initially, the study of Lustig, Roussanov and Verdelhan (2011) begins by constructing monthly portfolios of currencies, which are sorted on the basis of their forward discounts. The lowest interest rate currencies are contained in the first portfolio and the highest interest rate currencies are in the last. The study also states two most important components of the currency portfolio returns, which give a considerable explanation for the time-series variation in currency returns. The first main component is called a level factor, which accounts for the average excess return on all foreign currency portfolios (the dollar risk factor, RX). In addition, the second primary component is a slope factor whose loadings decrease monotonically from

[3] Carry Trade is an approved strategy in which an investor borrows in currencies with relatively low interest rates (funding currencies) and concurrently lending in currencies with high interest rates (investment currencies) (Corte, Riddiough and Sarno, 2013) . A trader using this strategy attempts to capture the difference between the rates, which can often be substantial, depending on the amount of leverage used.

positive to negative and from high to low interest rate currency portfolios. This component is also entitled as the carry trade risk factor (HML_{FX}) for high interest rate currencies minus the low ones. The most significant point of the study of Lustig, Roussanov and Verdelhan (2011) is that the aspect of considering the common factor in exchange rates sorted by interest rates, which are indicated as major factor in the clarification of carry trade returns with a risk-based point of view.

The comparable research is, presently, explored by Corte, Riddiough and Sarno (2013) on a currency risk factor, or called as the global imbalance risk factor, which account exposure to countries' external imbalances. This factor is addressed with the basis on global imbalances describing the average excess return between baskets of high and low interest rate currencies, and, in addition, gives a risk-based explanation on carry trade returns. It is stated that, by employing the carry trade strategy, the investors achieve a positive excess return on average, which is contrary to an assumption of the uncovered interest rate parity (UIP)[4] condition.

Originally, the research of Backus, Foresi and Telmer (2001), which reports that heterogeneity in exposure to the country-specific risk can distribute negative UIP slope coefficients for individual currency pairs; however, it cannot expound the cross-section of carry trade returns. The perception for the investor to obtain the carry trade premium is basically by going long in baskets of high interest rate currencies and short in baskets of low interest rate currencies.

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[4] Uncovered interest rate parity (UIP) refers to the interest rate parity that lacks of a forward contract to hedge risk in the exchange rate market. The condition of interest rate parity is when the domestic interest rate equals to the sum of foreign interest rate plus the expected change of the exchange rates. (Aggarwal S, 2013)

Afterwards, the further study, produced by Lustig, Roussanov and Verdelhan (2011), shows that heterogeneity in exposure to common risk can both describe the carry trade returns and generate the negative uncovered interest rate parity (UIP)[5] slope coefficients. They give some evidence that temporary heterogeneity in exposure to common risk captures the conditional deviations from UIP, implying that currencies with currently high interest rate can generate higher returns. On the other hand, permanent differences in exposure to common risk corresponds with the unconditional deviations from UIP, which means currencies with, on average, high interest rates distribute higher returns.

Various literatures have pointed out the failure of uncovered interest rate parity (UIP) in the time series. Examples of papers regarding this feature begin with the study of Hansen and Hodrick (1980) and Fama (1984), which both confirm that higher than usual interest rates direct to further appreciation, and investors are likely to obtain more returns by holding bonds in currencies with interest rates that are higher than usual.

Subsequently, in terms of the cross-section, the studies of Lustig and Verdelhan (2005, 2007), which construct currency portfolios in the forward contracts with the basis on forward discounts, report the failure of uncovered interest rate parity (UIP) although developing currencies are taken into account. The study performs that investors receive more excess returns by carrying bonds from currencies with interest rates that are currently high.

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[5] Uncovered interest rate parity (UIP) refers to the interest rate parity that lacks of a forward contract to hedge risk in the exchange rate market. The condition of interest rate parity is when the domestic interest rate equals to the sum of foreign interest rate plus the expected change of the exchange rates. (Aggarwal S, 2013)

Furthermore, Bansal and Dahlquist (2000) and Lustig, Roussanov and Verdelhan (2011) addresses their further evidence that the interest rate is stated to be one of the characteristics defining returns.

Chapter 3
Exchange Rate Pass-Through Into Import Prices

Abstract

According to the significant of the exchange rate pass-through in financial economics, this study explores the degree of exchange rate pass-through into import price in emerging economies and developed countries in panel evidences for comparison; covering the time period of 1970-2009. The import prices, the nominal effective exchange rates, the producer prices and the domestic demand condition are considered as variables in the model. The pooled mean group estimation (PMGE) is used for the estimation because of its advantage that it allows the short run coefficients and error variance to differ across cross-sections, while constrains the long run coefficients to be homogeneous across countries. In general, the results present that the import prices are influenced positively, but incompletely, by the exchange rate.

3.1 Introduction

Goldberg and Knetter (1997, p.1248) stated in their text book that, “The definition of exchange rate pass-through is the percentage change in local currency import prices resulting from a one-percentage change in the exchange rate between the exporting and importing countries.” or its explanation can be shortly explained as the incident containing changes in the foreign exchange rate value, which lead to the possibility in import price changes. Exchange rate pass-through can also be defined as the responsiveness of domestic prices, producer prices, consumer prices, import prices and sometimes the prices set by domestic exporters to exchange rate movements (Sekine, 2006) and recognized as the nominal exchange rate.

There have been many literature reviews in different perspectives on exchange rate pass-through (ERPT) disclosing the specific industry or product studies. The movement of the exchange rate pass-through can bring a great impact on the price of any kinds of trading products. Some studies concern the contradiction of the ERPT of countries with the emerging market economies, such as Frankel, Parsley, and Wei (2005), Mihaljek and Klau (2000) and Choudhri and Hakura (2006), and that of the developed countries, for instance, Campa and Goldberg (2004), Gagnon and Ihrig (2004), Ihrig, Marazzi and Rothenberg (2006), McCarthy (2000), Hahn (2003), Campa, Goldberg and Gonzalez-minguez (2005) and Anderton (2003).

According to the early study of Dornbusch (1987), it discovers four features influencing on the degree of exchange rate pass-through to import prices; which are the composition of the market or segmentation level, the degree of product segregation, the practical framework of the demand curve, and the market structure and the stage of monetary collaboration among providers. McCarthy (2000) later mentioned in the result of his study that the exchange rate pass-through was positively correlated with the openness of the countries and with the existence of the exchange rate adjustment, and negatively correlated with the exchange rate volatility.

Afterward, Bache (2006) focused on factors affecting the degree of exchange rate pass-through and agreed on the market segmentation that it has an impact on it. Additionally, his study expressed that other factors affecting the degree of the exchange rate pass-through are the degree of price stickiness, the alternative selection of currency, the distribution margin and the degree of competition by other domestic companies. In the New Open Economy Macroeconomics (NOEM) literature, more prospective issues involving in the change of the degree of exchange rate pass-through were explained in terms of the probable perseverance of the exchange rate, the sensitivity of the elasticities of demand relating to the exchange rate and the weight on imported goods in the manufacturing function for domestic goods, which have their own assumption on the financial shock distribution, exchange rate volatility and the best possible monetary policy.

One of the significant points of view in the previous researches on ERPT is based on four issues according to the exchange rate change consequences, which are the effects on import and export prices, consumer prices, investments, and trade volumes. The import and export prices are stated to be the principal aspect to be considered as they are the initial matter affected by the adjustment in exchange rate following by consumer prices, investments and trade volumes (Darvas, 2001). The diffusion of shocks and optimal monetary policy in open economies are also other important implications, considered as the responsiveness of price adjustments in the degree of exchange rate pass-through.

The importance of the exchange rate pass-through reveals especially into 3 explanations in terms of monetary policy of trading prices (Bussiere, 2007). One of the most significant points of the degree of exchange rate pass-through is that it is the major factor performing monetary policy resulted from the adjustment in import prices on domestic inflation as it can be seen in Adolfson's study (2001) that in a small open economy, the exchange rate implies an additional transmission channel for monetary policy and the consumer price (CPI) inflation is affected directly by changes in the exchange rate through the effect on import prices.

One interesting previous literature is by Barhoumi (2005), which studies the exchange rate pass-through equation on 24 developing countries. The multi-country framework, the panel unit root tests consisting of 2 tests advocated by Im, Pesaran and Shin (IPS) (1997) and Hadri and Larson (HL) (2001), the non-stationary panel estimation methods and the panel cointegration tests are taken into account. The results show a long run relationship of exchange rate pass-through into import prices comprising 4 main variables; a nominal effective exchange rate, the price of the competing domestic product, the exporter's cost and the domestic demand conditions.

Later, the major literature of this study is performed by Byrne, Chavali and Kontonikas (2010), which explores the nature of exchange rate pass-through to import prices for a panel of 14 emerging economies covering the time period from 1980 to 2004. Their model contains import prices, nominal effective exchange rates, a foreign marginal cost measure, domestic demand measure and the locally available import substitute goods price index as variables and the tests expressing the panel heterogeneity (the Hausman Test), investigating the pass through effects in the both the short run and the long run (the pooled mean group estimation known as PMGE), and taking into account the asymmetries are presented. The results show that import prices have a positive, but incomplete, impact on average to the exchange rates.

Furthermore, Pesaran, Whin, and Smith (1999) also propose the procedure of the Pooled Mean Group Estimator (PMGE) and state one important advantage of the technique that it allows the short run coefficients and error variances to be diverse across panel groups with the indistinguishable long run coefficients. However, the sample data of this study is in 2 groups; 24 OECD countries over 1962 to 1993 and 10 Asian developing economies over 1974 to 1990, which is different from the study mentioned before, and the cases of stationary and non-stationary regressors are both taken into consideration. Other techniques, Mean Group (MG) Estimator and Dynamic Fixed Effect (DFE) estimators are also used for the estimation for comparisons. Their results leave some unresolved issues on the results but suggest that Pooled Mean Group Estimation (PMGE) is an applicable method even with that the null hypothesis of the homogeneity is rejected under the condition that the bias influencing the correlations are not systematic.

Those previous researches lead to an interesting motivation of this research by further considering 3 types of panel data of emerging countries, developed countries and combined countries (consisting of emerging countries and developed countries from the first and second panel data groups respectively) in order to investigate and compare the different natures for the short run and the long run of each economy.

The rest of the chapter is arranged as follows. Section 2 presents the theoretical models used. Section 3 expresses the data observed for the study. Section 4 explains the econometric methodologies and the empirical results of the study are performed in Section 5. Finally, Section 6 presents the conclusion of the study.

3.2 The Theoretical Model

According to the previous literature on exchange rate pass-through by Byrne et. al (2010), Khundrakpam (2007), Fujii (2004), and Bailliu and Fujii (2004)

The first order condition with respect to the import price can be defined as

$$\frac{\partial \pi_t^f}{\partial P_t} = E_t^{-1} Q_t + E_t^{-1} P_t \left(\frac{\partial Q_t}{\partial P_t} \right) - \left(\frac{\partial C_t(Q_t, W_t)}{\partial Q_t} \right) \left(\frac{\partial Q_t}{\partial P_t} \right) = 0 \qquad \text{... (2)}$$

Where: $\frac{\partial C_t(Q_t, W_t)}{\partial Q_t}$ expresses the marginal cost (M_t)

This can be modified into a function of the import price, which will be mainly used in the study, as a consequence of the derivation shown in the appendix 1-A.

$$P_t = E_t M_t G_t \qquad \text{... (3)}$$

Where: P_t are import prices

E_t are nominal effective exchange rates

M_t are foreign marginal costs

G_t are domestic mark-up factors

$\left(G_t = \frac{\eta_t}{(\eta_t - 1)} \right)$ refer to the mark-up factor over the marginal cost and η_t are the elasticities of the output

The model for country i can be written in the logarithmic form:

$$\ln P_{it} = \beta_0 + \beta_1 \ln E_{it} + \beta_2 \ln M_{it} + \beta_3 \ln G_{it} + \varepsilon_{it} \qquad \text{... (4)}$$

Equation (4) can also be written as

$$p_{it} = \beta_0 + \beta_1 e_{it} + \beta_2 m_{it} + \beta_3 g_{it} + \varepsilon_{it} \qquad \text{... (5)}$$

Where lowercase letters reflect the logarithmic values of the variables and ε_{it} is the error disturbance term of country i.

3.3 Data

The consideration is taken on 3 groups of data consisting of a panel of 7 emerging countries, a panel of 19 developed countries and a panel of 26 countries that are a combination of the first two groups. The emerging countries that we take into account in this study are Brazil, Colombia, India, Jordan, Morocco, Pakistan and Thailand, while the developed countries in this study include Australia, Canada, Denmark, Finland, Germany, Greece, Hungary, Ireland, Israel, Italy, Japan, the Netherlands, New Zealand, Norway, the Republic of Korea, Spain, Sweden, the United Kingdom and the United States. The separation of emerging countries and developed countries is as defined by the International Monetary Fund's World Economic Outlook Report (April 2011) and IMF (International Financial Statistics). The reason of having a small number of emerging countries is given to the restriction on the data availability. All data are collected annually and cover the period 1970 – 2009 by taking the year 2005 as a common base year. In accordance with equation (3), the variables, which are all later transformed by the natural logarithm, contain the import price index or the import unit value in domestic currency from IMF (International Financial Statistics) as a measure for the import prices (P_t), the nominal effective exchange rate[1] (E_t) index obtained from IMF (International Financial Statistics) and UN Data, the producer price index or the wholesale price index, which is replaced as a proxy for the foreign marginal costs[2] (M_t) since they are difficult to be assessed (Fuji, 2004), from World Bank and UN Data, and the domestic mark-up factor (G_t) depending on the domestic demand condition that we consider the Gross Domestic Product (GDP) as a proxy (Barhoumi, 2005) also from IMF(International Financial Statistics). The limitation lies on the

[1] The nominal effective exchange rate (NEER) expresses the unadjusted weighted average value of a country's currency relative to other major currencies being traded in the pool.

[2] The foreign marginal costs (M_t) is constructed by dismissing the Nominal Effective Exchange Rate $(NEER_t)$ and the Wholesale Price Index (WPI_t) from the Real Effective Exchange Rate $(REER_t)$. The exchange rate is determined as domestic currency per unit of foreign currency. Hence, an increase in the exchange rate denotes a domestic currency depreciation. (Byrne et al., 2010)

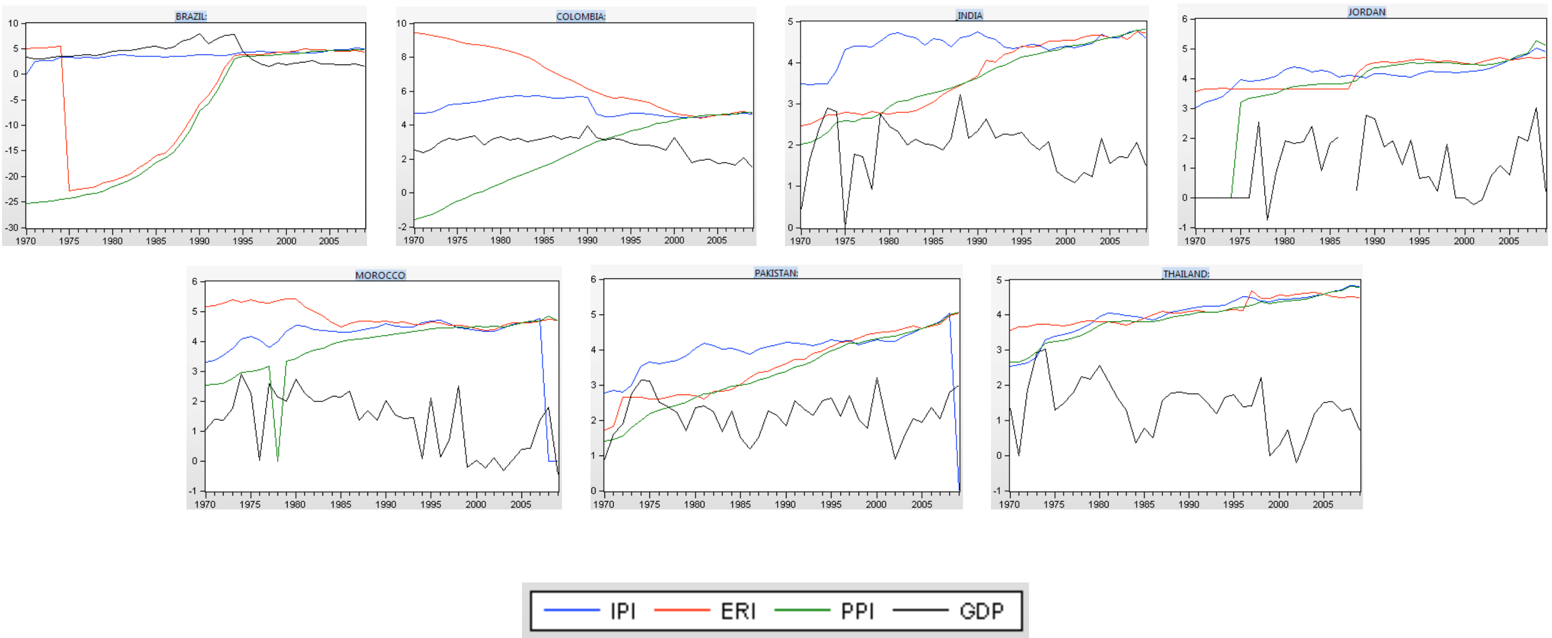
availability of the data so the observations were combined from different sources to ensure the appropriate coverage.

Figure 3-1 shows the plots of time series of the logarithmic values on all variables; import prices, nominal effective exchange rates, foreign marginal costs and domestic mark-up factors for each emerging country. By considering especially on import prices and nominal effective exchange rates during 1970 - 2009, Byrne et. al (2010) states that there were radical changes on the monetary policy and the estimation of exchange rate regimes into a floating regime on several Latin American economies including Brazil in the year 1999 as a result from the financial crisis in Asia and Russia in 1997 and 1998 respectively. Import prices of Colombia were obviously in a higher level in the late 1970s continuing to the 1990s by reason of inflation perseverance. As stated in the study of Fu (n.d.), the Indian currency, which pursued an exchange rate regime and was linked to the Pound Sterling, was broken in 1975, expressing in the plot that the domestic mark-up factors drastically dropped down in that period. However, later in 1993, the exchange rate of Indian was taken on to be a market-determined system as a replacement.

For Jordan, there is a limitation on data availability of the domestic mark-up factor for Jordan so the dataset missed one observation year. As shown in the plot that there was a significant jump on the exchange rates in late 1980s, Jordan confronted a severe problem on foreign exchange erosion; therefore, a decision of bringing down the unit and taking into account a floating regime was arranged. Nevertheless, this exchange rate structure was substituted shortly later by an Effective Rate tied with a trade-weighted system in 1990. Pakistan began getting connected its currency to the U.S. Dollar in 1971 as a consequence of more economic dependence on the country as in the figure 1-1. However, the financial crisis occurred in Pakistan in 1998 leading to an important change of the exchange rate regime of the country to become a floating system until now. Thailand, which is one of the Asian countries that faced the financial crisis during

1997 – 1998, made a decision on the adjustment of its monetary policy and the exchange rate targeting measures to be more elastic (Pesaran et. al, 1999) and market determined as shown in the plot with a significant change on the domestic mark-up factor line.

Figure 3-1: Plots of the time series of the logarithmic values of all variables; import prices (p_t), nominal effective exchange rates (e_t), foreign marginal costs (m_t) and domestic mark-up factors (g_t) for each emerging country.



Time series of the logarithmic values of import prices, nominal effective exchange rates, foreign marginal costs and domestic mark-up factors for developed countries are plotted in figure 3-2. According to the plot of Australia, there is a change on the nominal effective exchange rate line in 1973. This adjustment was due to the breakdown of the Bretton Woods system (Fu, n.d.), the monetary system ruling for the financial and commercial relations among major industrial countries, which leads to the floating exchange rate system and the market-determined one later in 1983. According to the domestic mark-up factor in the plot for Canada, it is shown that there was a noticeable fall in the early 1990s when the currency of the country depreciated leading to an adjustment in the monetary regime and the interest rates decreased. Another significant weakness in the currency of Canada occurred in 1997 and turned out to be obvious in 1998 as in the plot.

An immediate and drastic drop of the nominal effective exchange rate line in the plot during 1985 and 1986 for Israel is a result of the replacement of the new currency system in the country from the Israel Shekel to New Sheqel (NIS), which is tied with the U.S. Dollar, but was broken in the following year as suggested by Fu (n.d.). Therefore, the crawling exchange rate regime with the consideration on the fluctuation zone was taken into account in 1989 as a resolution and the exchange rate system became market dependent and closer to the floating exchange rate regime. The currency system of Japan, Yen, was controlled by the Ministry of Finance (MOF) and there were various exchange rates until an adjustment to one fixed particular exchange rate in 1949, which was continued up to the year 1971. Considering the nominal exchange rate line in the plot, there was a higher change the exchange rate system in Japan in early 1970s and there has been no significant adjustment since then. This is due to the introduction of the new exchange rate regime letting the exchange rate float freely in February 1973.

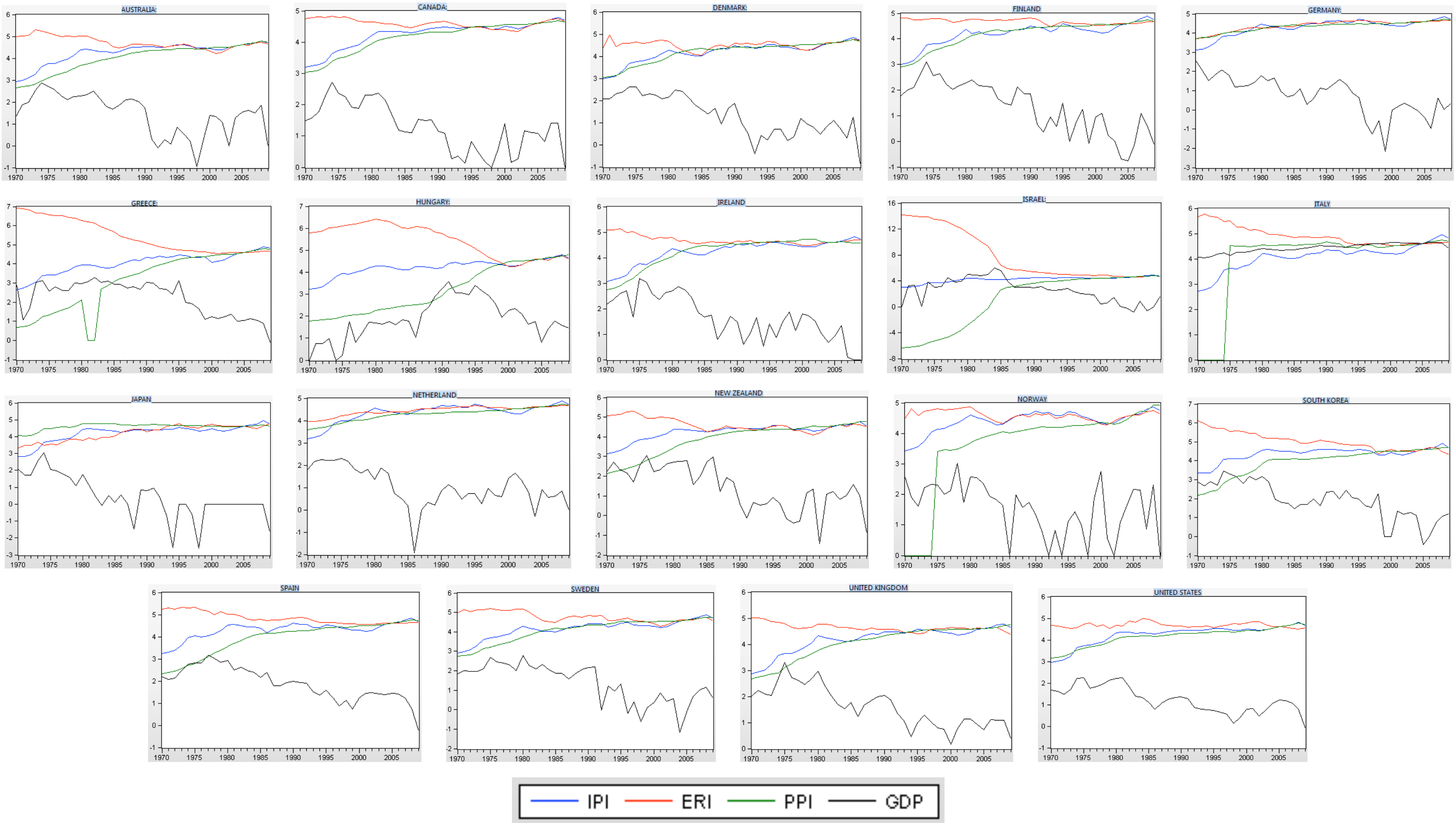
The New Zealand Dollar, the currency of New Zealand, was decided to be tied with Pound Sterling in 1973; however, it was later replaced by the floating exchange rate regime in 1973. The nominal effective exchange rates line shown in figure 1-2 indicates a change in the exchange rate system of the New Zealand in 1985. Fu (n.d.) mentioned in his study about this adjustment that the New Zealand dollar was allowed to be flexible with the assignation by the demand and supply in foreign exchange market.

Consistent with the plot shown in Figure 3-2, it suggests that there was not much adjustment on the exchange rate structure of the Republic of Korea (South Korea), which the currency is in Korean Won, during 1970 – 1997 though with a decision to renounce its link of the currency to the U.S. Dollar to be floated in 1980. There was a sudden dropping phenomenon in the exchange rate system of the Republic of Korea in 1997 as a result of the resolution of Thailand rapidly letting its currency float in that year due to the financial crisis in Asia. This leaded to the prompt depreciation in Korean Won.

During 1977 to 1991, the exchange rate regime of Sweden was determined by a trade-weighted basket of 15 foreign currencies, which of are the major trading partners of the country, (Fu, n.d.) with the allowance of the double weight on the U.S. Dollar. According to the plot of all variables, there is an obvious falling point of the domestic mark-up factors in approximately 1991-1992. This is a result of the adjustment in the exchange rate regime of Sweden from the trade-weighted basket to the European Currency Unit (ECU) in 1991 and the currency was decided to be flexible with a floating basis in 1992.

Finally, the plot on the nominal effective exchange rate of the United States indicates that there was no substantial phenomenon affecting much on its exchange rate system as shown in figure 3-2. However, there were some adjustments occurred with the exchange rate regime of the United States during 1970 to 2009, such as the devaluation of the U.S. Dollar in 1971 as seen in the plot that the nominal effective exchange rate line dropped slightly in that year. Again in 2002, the U.S. dollar was weakened and the interest rates were low encouraging non-national investors took less consideration on the U.S. assets.

Figure 3-2: Plots of the time series of the logarithmic values of all variables; import prices (p_t), nominal effective exchange rates (e_t), foreign marginal costs (m_t) and domestic mark-up factors (g_t) for each developed country.



3.4 The Methodology

3.4.1 Panel Unit Root Tests

Firstly, before progressing the estimation of the exchange rate pass-through, this study begins by identifying whether the panel data are stationary of the individual variables in each panel by applying the test proposed by Im, Pesaran and Shin (2003) (IPS), which relates to the Autoregressive model of order 1 AR(1) process for the panel time series.

$$y_{it} = \alpha_i + \rho_i y_{it-1} + u_{it} \qquad \text{... (6)}$$

Where:

i = 1, 2, ..., N are cross section units that are observed over T time periods

t = 1, 2, ..., T. y_{it} are the dependent variables that are import prices.

ρ_i are the autoregressive coefficients, which varies across cross-sections.

$\alpha_i = \mu_i(1 - \rho_i)$,

where μ_i denote the process mean for each cross-section i, an

u_{it} are the error term that are mutually independent, with zero mean and constant variance and may be normally distributed.

The test that is used in this study to determine whether the variables are stationary or non-stationary is the w-statistic (IPS) based on the Augmented Dickey-Fuller (ADF) test, which is preferred rather than the non-augmented one to certify the errors are uncorrelated, for each cross section.

$$y_{it} = \rho_i y_{it-1} + \sum_{j=1}^{p_i} \varphi_{ij} \Delta y_{it-1} + x_{it}{}' \delta + u_{it} \quad \text{... (7)}$$

$$u_{it} = \sum_{j=1}^{p_i} \varphi_{ij} \Delta u_{it-1} + \varepsilon_{it} \quad \text{... (8)}$$

The hypotheses for the panel unit root tests by the process above are

$H_0 : \rho_i = 1$ for all i

$H_1 : \rho_i < 1$ for at least one i

If the null hypothesis is rejected, it indicates that $\rho_i < 1$ referring that y_{it} (import prices) are weakly stationary while for another case, it specifies that $\rho_i = 1$, which means y_{it} contain a unit root or they are non-stationary.

3.4.2 Pooled Mean Group Estimation (PMGE)

The pooled mean group estimation (PMGE) suggested by Pesaran et al. (1999) is used in this study according to its advantage that the approach allocates the short run coefficients and error variance to vary for each cross-section, while restricts the long run effect to be homogeneous across countries with an Autoregressive Distributive Lag (p, q, q … q) (ARDL) structure as shown below.

$$y_{it} = \sum_{j=1}^{p} \lambda_{ij} y_{it-j} + \sum_{j=0}^{q} \delta_{ij} x_{it-j} + w_i + u_{it} \quad \text{... (9)}$$

Where: x_{it} are the vector of explanatory variables for group i

w_i are the fixed effects

λ_{ij} are the scalars (the coefficients of the lagged dependent variables)

δ_{it} are coefficients to be estimated

The short run coefficients are approximated by taking the average of the cross-sectional estimates and the error correction[3] is also performed.

On the other hand, it is noted that the long run coefficients are pooled for the stronger implications as in the economic theory for the long run relationships and the homogeneity of long run coefficients is tested by a joint Hausman test[4] χ^2.

The hypotheses for the homogeneity[5] are

$H_0 : \beta_1 = \beta_2 = \beta_3 = ... = \beta_i$

H_1 : At least 1 of the null hypothesis statements is false.

The homogeneity tests a null hypothesis emphasizing the different populations are homogeneous with reference to some concentrated characteristics against an alternative hypothesis stating in the opposite aspect.

[3] The error correction test partially but critically captures the short run behaviour by measuring any dynamic changes between the first-differences of the variables giving error correction coefficients and holding an allowance that the information may be incomplete.

[4] The Hausman test is a statistical test in econometrics assessing the significance of the difference between the random effect estimates and the fixed effect estimates. If the difference is significant, the correlation between the random effects and the explanatory variables are different whereas, if not, it means no evidence leads to divergent correlation.

[5] The test for homogeneity evaluates whether the populations are distributed identically across cross-sections with respect to some characteristics.

3.5 Results

3.5.1 Descriptive Statistics

The descriptive statistics of the dataset are shown in Appendix 3-B, presenting 2 groups of country samples that are emerging market economies (consisting of 7 countries) in table B1 and developed economies (consisting of 19 countries) in table 3-B2. Both tables display the data on the logarithm values of 5 variables; import prices, nominal effective exchange rates, foreign marginal costs and domestic mark-up factors, all containing 40 observations (covering the period year from 1970 to 2009) for each variable and each country excluding 39 observations on the mark-up factors for Jordan.

Considering the descriptive statistics on 7 emerging countries in table 3-B1, the mean of log import prices and log nominal effective exchange rate for these countries show similar results that Brazil has the lowest mean values (3.750510 and -4.673867 respectively) while Colombia has the highest mean values (5.002552 and 6.669302 respectively) on both variables. The results indicate that the country with the lowest mean value of import prices displays the lowest mean value of the exchange rate as well. This may be relative to the expectation mentioned in the previous section that an increase in the exchange rate may be related to a rise in the import prices. For log foreign marginal costs, the lowest mean (-9.215756) lays on Brazil and the highest mean (3.925493) is on Thailand. Lastly on the mean value of log domestic mark-up factors, Brazil contrastingly has the highest value (3.938813) whereas Jordan gains the lowest one (1.033429). The standard deviations of all variables and countries are quite small and do not have big differences except those of log nominal effective exchange rate and log foreign marginal costs on Brazil highly valuing at 11.12611 and 12.45677 respectively. These imply that two variables greatly vary over 40-year observation period.

Table 3-B2 expresses the descriptive statistics of the same 5 variables over the same period of time on 19 developed countries. The lowest (4.028381 in Greece) and the highest (4.364740 in the Republic of Korea) mean values of log import prices do not have significant difference, also do the values from other countries ranging between 4 and 5 with the standard deviation assessing between 0 and 1, which are at the reasonably small values. The mean values of log nominal effective exchange rate are comparable to those of log import prices with the exception of that of Israel, which has the higher mean value (7.759302) than others. On the contrary, Israel has the lowest mean value (1.094576) in terms of log foreign marginal cost, where those from other countries are not very different from the overall mean value in other variables.

3.5.2 Panel Unit Root Results

The first step before we analyze the panel regression for the short run pass-through and the long run pass through is to ascertain whether the data are stationary. The panel unit root test by Im, Pesaran and Shin (2003) is applied in this study for both levels and first differences on the individual variables.

The results on 3 groups of data, which are emerging countries, developed countries and combined countries, for the level intercept at the 5% significance level are shown in table 3-1. The variables stated in the tables are mentioned in the previous section; p_t , e_t , m_t and g_t are the logarithmic values of import prices, nominal effective exchange rates, foreign marginal costs and domestic mark-up factors respectively.

For emerging countries, all variables except e_t are considered to be stationary in level intercept, which is the same consequence as for combined countries under the equivalent condition. For developed countries, the results show that the null hypothesis of unit root test is rejected on every variable, indicating that p_t, e_t, m_t and g_t have unit roots.

Therefore, in general, we can be certain that the panel regressions in this study do not suffer from a spurious regression problem and can be continued to the following section.

Variables	**Emerging Countries**		**Developed Countries**		**All Countries**	
	W-Stat	**Prob.**	**W-Stat**	**Prob.**	**W-Stat**	**Prob.**
p_t	-3.39509	0.0003*	-9.43158	0.0000*	-9.82422	0.0000*
e_t	1.09364	0.8629	-2.58168	0.0049*	-1.63949	0.0506
m_t	-3.31348	0.0005*	-12.8379	0.0000*	-12.6938	0.0000*
g_t	-5.43056	0.0000*	-1.78653	0.0370*	-4.03322	0.0000*

Table 3-1: The table shows IPS panel unit root results from Im et al. W-Stat on 7 emerging countries, 19 developed countries and 26 all combined countries for the level intercept. The results reject the null hypothesis of non-stationary at the 5% significance level or when the p-value is less than 0.05 and are marked with asterisk (*). p_t, e_t, m_t and g_t are the logarithmic values of import prices, nominal effective exchange rates, foreign marginal costs and domestic mark-up factors respectively.

3.5.3 Panel Regression Results from Pooled Mean Group Estimation (PMGE)

A panel data set is constructed with the availability of the observed data on each cross sections. The pooled mean group estimation (PMGE) by Pesaran et al. (1999) is the significant technique used in order to determine short run and long run effects on import prices with an Autoregressive Distributive Lag (p, q, q, …, q) structure basis.

Results for Emerging Countries

The results on short run estimation for emerging countries presented in table 3-2 point out that the short run coefficients for all variables have appropriate signs and are significant except for the foreign marginal costs m_t that shows the insignificance. Additionally, the negative error correction coefficient denotes that the import prices will fall and since it is significant at the 5% level, it indicates that the adjustment of the import prices (p_t) will be approximately 9% (0.091848857) of the deviation of p_{t-1}, which is considered to be a slow rate adjustment.

In the long run, the results shown in table 3-2 indicate that the exchange rate e_t has a positive effect on import prices, however, the outcome of the variable shows that it is insignificant so it means we do not have sufficient evidence to explicitly indicate whether a depreciation in the domestic currency, a rise in the exchange rate, would lead to a higher import price for the importing country. The foreign marginal costs m_t have a negative and significant effect, while the domestic mark-up g_t has a positive and significant effect on import prices. We can imply that an increase in the foreign marginal costs decreases the import prices but the favourable domestic demand conditions would result the import prices to be higher.

	Coefficients	t-values
Short Run Results		
e_t	0.068214	0.260473*
m_t	0.081325	2.604371
g_t	0.332252	0.630107*
Error Correction	(-0.091848857)	0.336434286
Long Run Results		
e_t	0.010657	1.122769
m_t	-0.068107	-1.965814*
g_t	0.072953	0.072953*

Table 3-2: The results of Pooled Mean Group Estimate (PMGE) for a panel of 7 emerging countries are shown in the table consisting of the short run (including the error correction results) and the long run. The panel data covers the time period of 1970 – 2009. The results are estimated at the significance level of 5% or when the p-value is less than 0.05, which are marked with asterisk (*). All variables, nominal effective exchange rates (e_t), foreign marginal costs (m_t) and domestic mark-up factors (g_t), are in the logarithmic terms and the dependent variable is import prices (p_t).

Results for Developed Countries

Table 3-3 performs the results on short run estimation for developed countries showing that e_t and m_t are both positive while g_t is the only negative coefficient but with significance in all variables. Moreover, the error correction coefficient denotes the same negative sign as that on the emerging countries. This means that with the significance at 5% level, the adjustment of the import prices (p_t) will be approximately 1% (0.016173368) of the deviation of p_{t-1}, which is the lowest rate compared to other groups of countries. The slow rate adjustment occurs.

In the long run, the results shown perform that the exchange rate e_t has a positive and significant effect on import prices. Therefore, higher import prices would be a consequence of the domestic currency depreciation, a rise in the exchange rate. The foreign marginal costs m_t have a positive and significant effect on import prices, which means that an increase in the foreign marginal costs would induce higher import prices, whereas the domestic mark-up g_t has a negative and significant effect on import prices referring that an increase in the domestic demand conditions would cause a fall in import prices.

	Coefficients	**t-values**
Short Run Results		
e_t	0.01505	-0.18421*
m_t	0.090214	1.491394*
g_t	-0.00374	-0.48413*
Error Correction	(-0.016173368)	-0.334073684
Long Run Results		
e_t	0.436565	97.38482*
m_t	0.476013	126.5942*
g_t	-0.054263	-26.73641*

Table 3-3: The results of Pooled Mean Group Estimate (PMGE) for a panel of 19 developed countries are shown in the table consisting of the short run (including the error correction results) and the long run. The panel data covers the time period of 1970 – 2009. The results are estimated at the significance level of 5% or when the p-value is less than 0.05, which are marked with asterisk (*). All variables, nominal effective exchange rates (e_t),

foreign marginal costs (m_t) and domestic mark-up factors (g_t), are in the logarithmic terms and the dependent variable is import prices (p_t).

Results for Combined Countries

The results in table 3-4 are on the short run estimation for combined countries (7 emerging countries and 19 developed countries). The table suggests that the short run coefficients on all variables are positive and significance except the insignificance in the foreign marginal costs m_t. In addition, the comparable outcome as previous groups of countries for the error correction coefficients is shown in the table that it is in a negative sign but significance. It indicates that the import prices will fall and as it is significant at the 5% level, it indicates that the adjustment of the import prices (p_t) will be approximately 3% (0.0305775) of the deviation of p_{t-1}

In the long run, the results state that the exchange rate e_t has a negative and significant effect on import prices, indicating that a domestic currency appreciation is associated with an increase in import prices for the importing country. The foreign marginal costs m_t have a positive and significant effect on import prices, implying that an increase in the foreign marginal costs would induce higher import prices, whereas the domestic mark-up g_t has a negative and significant effect on import prices, which leads to the outcome that an increase in the domestic demand conditions would lower the import prices.

	Coefficients	t-values
Short Run Results		
e_t	0.027046	-0.12189*
m_t	0.092351	2.024739
g_t	0.089279	-0.18231*
Error Correction	(-0.0305775)	-0.046470769
Long Run Results		
e_t	-0.025013	-7.318604*
m_t	0.086791	9.462267*
g_t	-0.041371	-9.086164*

Table 3-4: The results of Pooled Mean Group Estimate (PMGE) for a panel of 26 combined countries (7 emerging countries and 19 developed countries) are shown in the table consisting of the short run (including the error correction results) and the long run. The panel data covers the time period of 1970 – 2009. The results are estimated at the significance level of 5% or when the p-value is less than 0.05, which are marked with asterisk (*). All variables, nominal effective exchange rates (e_t), foreign marginal costs (m_t) and domestic mark-up factors (g_t), are in the logarithmic terms and the dependent variable is import prices (p_t).

3.6 Conclusion

Exchange rate pass-through (ERPT) is one of the significant issues in financial economics field since the price of any kinds of trading products can respond to its movement. There are some studies concentrating on the emerging market economies, such as the study of Byrne, Chavali and Kontonikas (2010), which explores the nature of exchange rate pass-through to import prices for emerging economies with models containing import prices, nominal effective exchange rates, a foreign marginal cost measure, domestic demand measure and the locally available import substitute goods price index as variables. Some researches express on the developing countries, such as the study of Barhoumi (2005) on the exchange rate pass-through equation of the developing countries by taking into account the multi-country framework, the panel unit root tests, the non-stationary panel estimation methods and the panel cointegration tests.

According to previous literatures, an interesting motivation of this study is followed by considering on 3 types of panel data of emerging countries, developed countries and combined countries (consisting of emerging countries and developed countries from the first and second panel data groups respectively) in order to investigate and compare the different natures for the short run and the long run of each economy. The sample data are collected annually and cover the period 1970 – 2009. This study analyses the model consisting of 4 variables; the import price index or the import unit value in domestic currency as a measure for the import prices (P_t), the nominal effective exchange rate (E_t) index, the producer price index or the wholesale price index, which is replaced as a proxy for the foreign marginal costs (M_t), and the domestic mark-up factor (G_t) depending on the domestic demand condition that we consider the Gross Domestic Product (GDP) as a proxy (Barhoumi, 2005). All variables are later transformed by the natural logarithm. However, there is a limitation on the data availability so a combination of different sources is obtained to ensure the appropriate coverage.

Initially, the unit root test identifying whether the panel data are stationary of the individual variables in each panel is taken into account and in general, the results show that it is certain that the panel regressions in this study do not suffer from a spurious regression problem and can be continued to the estimation of the degree of exchange rate pass-through.

The study is followed by the pooled mean group estimation (PMGE) with its advantage that the approach allows the short run coefficients and error variance to differ across cross-sections, while constrains the long run coefficients to be homogeneous across countries. In the short run, the estimation of 3 panel groups indicate that there is negative error correction coefficients in all groups denoting that the import prices will decrease and there is a slow rate adjustment of the import prices at approximately 9.18%, 1.62% and 3.06% respectively and significantly at the 5% significant level. The exchange rate has a positive effect on import prices on both emerging economies and developed countries in the short run and the long run but insignificantly on the emerging panel in the long run. It means there is no sufficient evidence to explicitly indicate whether a depreciation in the domestic currency (a rise in the exchange rate) would lead to a higher import price for the importing country but for the developed countries, the results show the positive significant effect on import prices. Therefore, higher import prices would be a consequence of the domestic currency depreciation, a rise in the exchange rate. In contrast, the results on the combined country panel express that the exchange rate performs a negative and significant effect on import prices, indicating that a domestic currency appreciation is associated with a rise in import prices. Nonetheless, the results generally note that import prices react positively, but incompletely, to the exchange rate. The further work can be on the investigation of other appropriate approaches to the degree of exchange rate pass-through for more accurate results and comparison.

Chapter 4
Liquidity Risk and Expected Returns in the Currency Markets

Abstract

The study address the question whether there is a relationship between cross-sectional differences in foreign exchange returns and the sensitivities of the returns to fluctuations in liquidity, known as liquidity beta, by using a unique dataset of weekly order flow, which consists of four customer classifications, across nine highly liquid currency pairs. The main liquidity measure used this study is comparable to the recognized Pastor-Stambaugh measure; however, an alternative liquidity beta analysis on the Archary-Pedersen measure is also taken into account. At last, the evidence of some dataset that liquidity is a significant variable in the cross-section of currency returns is provided.

4.1 Introduction

The foreign exchange (FX) market is regarded as a highly liquid and economically considerable market. A co-movement in cross-section liquidity in the foreign exchange market has not been taken into account by many researchers compared to that in the stock market. One of the reasons why it is more popular to investigate in the stock market among researchers is that liquidity is likely to be an interesting determinant for a priced state variable. Therefore, liquidity is frequently considered as a significant factor in making decisions in the investment investigated by researchers, such as Hasbrouck and Seppi (2001), Huberman and Halka (2001), Lesmond (2005) and Past and Stambaugh (2003), which pays attention particularly on exploring the aspect of liquidity in consistent with price fluctuations influenced by order flow.

On the other hand, interestingly, the co-movement of cross-sectional liquidity is evidenced by only several studies recently; for example, Melvin and Taylor (2009), Mancini et al. (2011) and Banti, Phylaktis and Sarno (2012). Consequently, this study focuses the question whether cross-sectional differences in foreign exchange returns are associated with the sensitivities of the returns to fluctuations in both aggregate and disaggregate liquidity.

A unique dataset in this study contains a set of order flows from UBS, containing 9 currencies, weekly nominal exchange rates and a set of macroeconomic and financial variables covering the time period of 6 years from November 2, 2001 to November 11, 2007. The customer order flow, which is considered as the active side of the trade and the source of the transactions conducted in the inter-broker market (Cerrato, Sarantis and Saunders, 2011), is specifically taken into account in this study. The data is aggregated across currency pairs at a weekly frequency with customers split into 4 classifications, which are real money (asset managers), leverage (hedge funds), corporate, and private clients.

The aspect that is chiefly focused in this study is the dimension relating to the exchange rate changes related to the order flows, which the principal model is primarily the initiative from the study of Pastor and Stambaugh (2003) on liquidity risk and expected stock returns yet in the stock market. A market liquidity measure is constructed as the equally weighted average of the liquidity measures of individual currencies for each 5-month block period with the use of weekly dataset. Afterwards, the approximation of the innovation in the aggregate liquidity is examined.

Furthermore, the study captures the question whether the expected foreign exchange return is associated with the sensitivity of its returns to the innovation in the aggregate liquidity, which is represented by the liquidity beta. In this study, the liquidity beta is estimated by two measures motivated by Pastor and Stambaugh (2003) and Acharya and Pedersen (2005). An ordinary portfolio-based is formed by sets of portfolios containing scattered liquidity betas. Currencies are sorted by their predicted values of the liquidity beta based on the historical sensitivities of foreign exchange returns to the liquidity risk. Subsequently, the returns on post-formed portfolios in the following year are linked across year with the intention of constructing an individual return series for each set of the portfolios and the excess returns on the portfolios are then regressed on factors correlated with returns.

The study is organized as follows. Section 2 presents an overview of previous pertinent literatures, which are related to the liquidity in the currency market. In Section 3 the information on the data used in the study, including the description of the data and descriptive statistics is provided. The methodologies for the liquidity risk measure construction are documented in Section 4. Section 5 reports the empirical results achieved and finally, Section 6 concisely assesses the conclusions and proposes some useful suggestions for future research.

4.2 Literature Review

Primarily, liquidity measures have essentially been developed and chiefly used for the investigation in the stock market. Starting with the study of Amihud and Mendelson (1986), which empirically explores the correlation between liquidity and expected stock returns, it performs that a higher return is a consequence of lower liquidity and higher transaction costs. Related literatures on a systematic risk premium in stock returns are subsequently observed and confirmed by Chen (2005), Korajczyk and Sadka (2008), Hasbrouck (2009) and Lee (2011).

One of the most significant benchmarks among all related papers in the research field concentrating on the liquidity in the stock market is achieved by Pastor and Stambaugh (2003), which considers the market-wide liquidity, denoting to high level of trading activities at a great amount but low cost without affecting the price, as one of the significant state variables in asset pricing. Using the liquidity measure by taking into account a dimension of liquidity corresponding to the strength of volume-related return reversals, they concentrate on a perspective of liquidity linked with the temporary price fluctuations, in relation to expected return reversals that are influenced by a determinant of a microeconomic factor: order flow[1], conducted as signed transaction volume employed by the stock returns. The results show the evidence of a cross-sectional relationship between expected stock returns and the sensitivities of returns to fluctuations in aggregate liquidity in the sense that the stocks that are more responsive to aggregate liquidity considerably have higher expected returns. The measure shows that smaller stocks are less liquid and the smallest ones indicate high sensitivities to aggregate liquidity. Additionally, stocks' liquidity betas, which denote the sensitivities of stocks to innovations in aggregate liquidity, are indicated to be another significant feature for asset pricing and can be approximated by their historical estimates and other associated variables. Besides, the study of Pastor and Stambaugh (2003) also explores the consequence of systematic liquidity risk on expected returns.

[1] The term 'order flow' is indicated by SSC (State Street Corporation) as a buying pressure on a currency, calculated by the subtracting of the number of sells from the number of buys in a currency. Essentially, it is approximated by the aggregate result of signed trades, which is authorised according to the trading action (Banti, Phylaktis and Sarno, 2012).

Differently from other previous researches considering liquidity as a pertinent variable for pricing, the paper regards the market-wide liquidity as a characteristic relevant to expected stock returns instead.

However, other literatures have also had an intention in exploring the equivalent aspect on the liquidity in the foreign exchange market. Exchange rate is addressed for its prominence in the international economy especially on the economy growth and inflation through the consequence on import and export prices. This feature has not been taken into account by many researchers as seen in previous literatures yet some literatures on this aspect are found. Mark (1985) initially proposes the prominence of macroeconomic characteristics, such as prices and income levels, on exchange rate changes; nevertheless, this content has been disappointed by related literatures. On the other hand, Lyon (1995), conversely, suggests the foreign exchange microstructure fundamentals on exchange rate movements instead. The acknowledgment of taking order flow into consideration as a determinant for the liquidity estimation in the foreign exchange market is later brought into the literature.

The feature of foreign exchange microstructure approach can be recognisably found in the study of Evans and Lyons (2002a), which asserts strongly substantial relationship evidence between order flow and spot exchange rate movements. According to their paper, order flow, which declares the detail on the size, direction and transactions, is outlined as a component playing an important role on magnificently clarifying a substantial share of the movements in the exchange rates; therefore, the feature is taken into account. In other words, order flow can be used prosperously to describe the exchange rate movements. The considerable contribution of the study is the approximation on the systematic liquidity risk premium, alternatively regarded as the investigation on the innovations in the foreign exchange market liquidity whether they have an impact on exchange rate movements, and whether the outcomes of the study significantly present the higher relationship level between liquidity risk and emerging market currencies compared to that and the other. This essentially asserts the important variation in liquidity across foreign exchange excess returns. The evidence shown in the results of the latter focus in the study additionally supports that liquidity risk is one of the important components particularly in specifying the cross-section of emerging market currencies.

Evans and Lyons (2002b) declare that time-varying liquidity can be measured in the foreign exchange market. The results show that the liquidity, addressed as the impact of trades, varies over time and is dependent on the pace of public information flow. Moreover, the study presents an important evidence of the relationship between the order flow and returns. Berger et. al (2008) document a prominent role of liquidity in the relation between order and exchange rate movements in it does not systematically measure the benchmark liquidity or investigates commonality in liquidity.

The simultaneous relationship between customer order flows and exchange rate movements is also prominently taken into consideration in the paper of Marsh and O'Rourke (2005) in the context of European commercial bank's foreign exchange market and the results of the study strongly confirm that customer order flows in their case are correlated with exchange rate changes at both the daily and weekly frequency. The further significant evidence is that different determinants of order flow distinctively affect the exchange rate changes. Specifically, the study presents the negative correlation between order flow from non-financial corporations and exchange rate movements; whereas, the positive correlation is found between order flow from companies and exchange rate changes.

Subsequently, King, Sarno and Sojli (2010) take the concentration on microeconomic aspects, particularly order flow, in a foreign exchange market of the Canadian dollar/US dollar (CAD) exchange rate as Canada is importantly stated to be a small open market that is powerfully bonded with the US economy. The explanatory forecasting power of foreign exchange order flow is examined by taking into account the 11-year disaggregated dataset on sales and purchases, which is quite long time series compared to previous relative literature relying on shorter samples of data and from a restricted sector of the market. Nevertheless, order flow used in the paper is not apparently an exact estimate. Instead, it is a proxy approximated from the replication of the microstructure characteristics. In the results, they address perceptibly that order flow is a considerable determinant in forecasting exchange rate movements.

Later, the remarkable studies on systematic liquidity risk, which is an adjusted form of the Pastor and Stambaugh's liquidity measure, in the foreign exchange market is provided by Mancini, Ranaldo and Wrampelmeyer (2011) with intraday dataset in shorter time period from January 2009 to December 2009 consisting of significant currency pairs. The study also confirms the substantiation that there is the cross-sectional variation in liquidity. Differently from other previous literatures, the paper additionally contributes an analysis of liquidity risk consequences on the carry trade, which is a widespread trading strategy used by traders to capture the difference between the interest rates. Carry trade strategy is defined when a certain currency yielding a low interest rate is borrowed in order to invest in a different higher interest rate. In an empirical analysis, they denote the evidence that insurance against the liquidity risk is likely to be proposed by low interest rates and insurance disclosure to the liquidity risk is offered by relatively high interest rates instead. In contrast to the perceptions that the foreign exchange market is usually considered as extremely liquid, this means that there is significantly an existence of a determined impact of liquidity risk factors on daily carry trade returns during the sample period implying that liquidity risk is priced in currency returns. This is as the result of that liquidity betas are regarded as one of those factors, leading to the estimation of liquidity betas taken place in the paper by bringing a novel tradable liquidity risk factor into consideration because of its strong impact on carry trade returns. The additional study on the impact of liquidity risk on the carry trade returns in other periods of time is suggested in the future work due to the restriction of data availability of the study that the further investigation on that matter cannot be continued.

Another considerable research on an analogous aspect on a measure of liquidity risk, which is of Banti, Phylaktis and Sarno (2012), is later published. The study presents the foreign exchange liquidity measure, an extension comparable to that of Pastor and Stambaugh (2003) initially constructed for the US stock market. A prominent characteristic is its wide-ranging dataset of 20 developed and emerging market currencies and order flows spanning 14 years, covering both crisis and non-crisis periods. The concentration of the study is also on whether a systematic liquidity risk premium exists in the foreign exchange market or whether there is a correlation between the exchange rate returns and the innovations (unexpected changes) in the liquidity. Another substantial feature of the study is the investigation of liquidity risk premium[2], which is practically infrequent in the foreign exchange market but bond markets and stock markets.

The literature of Banti, Phylaktis and Sarno (2012) extends the previous researches by taking the consideration on the liquidity risk feature in the foreign exchange (FX) market, which is determined to have high liquidity and be economically considerable in the world yet complicated concerning the transaction information (Cerrato et. al, 2011). Furthermore, the paper is also considered to be the first study on global foreign exchange liquidity of a long-period order flow dataset of 14 years, responding to the intention proposed by Mancini, Ranaldo and Wrampelmeyer (2011). The dataset consist of the data on crisis and non-crisis periods, and developed and emerging markets including 20 currencies. According to the substantiation of strong common properties in liquidity across currencies as the inspired liquidity measure of Pastor and Stambaugh (2003) on the US stock market as mentioned earlier in this literature review section, the foreign exchange liquidity measure is constructed in a comparable measure, initially starting with the liquidity estimation on each individual currency by expressing the liquidity formed on the basis of the temporary price change as the expected return reversal related to the order flow, and estimating an annualized liquidity risk premium. The fundamental perception is that low liquidity is associated with a high volume-related return reversal.

Moreover, Banti, Phylaktis and Sarno (2012) extends their analysis on the liquidity risk premium with the additional adjustment of liquidity risk definition by taking

[2] The definition of the liquidity risk premium is determined in terms of the foreign exchange market by Mehrling and Neilson (2008) that it is the difference between the forward exchange rate and the future exchange rate and can be estimated as a dollar payoff. In other words, the liquidity risk premium is considered as the return in dollar according to buying a unit of foreign currency at the future exchange rate and selling it at the forward exchange rate.

into account the covariance of individual asset liquidity and market liquidity, and the covariance of individual asset liquidity and market returns in the foreign exchange market, inspired by Acharya and Pedersen (2005). This is considered to be a supplementary to the study of Pastor and Stambaugh (2003), which is mentioned earlier in this section, that concentrates on the covariance of an asset return and market liquidity in the stock market. Hence, the Acharya-Pedersen liquidity measure is regarded as an analogue of the Pastor-Stambaugh liquidity measure. The incentive is on an investor to have a premium in order to keep an illiquid currency when the overall market is illiquid.

In conclusion for the previous literatures reviewed for this research, the study of Pastor and Stambaugh (2003), which is our main previous literature, explores liquidity risk and expected stock returns on the stock market, following by the study of Mancini, Ranaldo and Wrampelmeyer (2011) or Banti, Phylaktis and Sarno (2012) that investigates the foreign exchange market but only on the liquidity risk aspect. Therefore, liquidity risk and expected returns in other financial markets are suggested to be taken into account, importantly leading to the motivation of this study in foreign exchange market, which contains various investment and international trade with currency conversion authorisation.

4.3 Data

4.3.1 Description of the Data

The dataset used in this study includes a unique propriety set of order flows from UBS, containing 9 currencies; Canadian Dollar (CAD), Swiss Frank (CHF), Euro (EUR), Australian Dollar (AUD), New Zealand Dollar (NZD), UK Pound (GBP), Japanese Yen (JPY), Norwegian Krone (NOK), and Swedish Krone (SEK). All exchange rates are in foreign currency per US dollar (from Bloomberg 16:00 GMT mid prices). In particular, a positive coefficient denotes dollar buying or known as foreign currency selling and consequently, a negative coefficient represents dollar selling or foreign currency buying. It can be implied that the exchange rate will tend to upsurge when the foreign currency weakens. All foreign exchange rates are transformed especially for the determination of foreign currency per US dollar. Therefore, a drop in foreign exchange rate indicates the consequence of the foreign currency, which is correlated with the US dollar, being strengthened.

Additionally, weekly nominal exchange rates and a set of macroeconomic and financial variables cover the period of 6 years spanning from November 2, 2001 to November 11, 2007. The data is aggregated across currency pairs at a weekly frequency with the customer data divided into 4 classifications, which are real money (asset managers), leverage (hedge funds), corporate, and private clients. All macro variables are obtained from the OECD database and transformed into the logarithm form when the regression is estimated.

4.3.2 Descriptive Statistics

According to the table in appendix 4-B1 showing the descriptive statistics of exchange rate returns, it is conspicuous that the evidence of an appreciation is noticeable on the average weekly return in foreign currency for the observation period. Standard deviations of all currencies are equivalent except JPY that presents a high standard deviation compared to other currencies and in most cases, the hypothesis that the returns are normally distributed is not rejected except for the currency of NZD. In appendix 4-B2 addresses correlations between exchange rate returns and presents that all exchange rate returns are positively correlated among themselves and EUR obviously has the strong correlation with all other currencies.

In appendix 4-B3 shows the information of descriptive statistics on aggregated order flows that the order flows of EUR and JPY have the largest overall volume, while NZD, SEK and NOK contain substantially smaller volumes. Furthermore, both EUR and JPY have the most imbalance values among other currencies and the only order flow that is expressed to have a normal distribution is EUR. Order flows for most of the currencies are found to be moderately volatile by having EUR, JPY and GBP, which are known as the most traded currencies, as the highest volatile ones. Correlation coefficients for aggregated order flows are presented in appendix 4-B4 and some remarkable structures are conspicuous. It can be seen in the table that the order flow of EUR shifts in reverse from other that of other currencies with the exception of the CAD, SEK and NOK order flows moving differently. Moreover, it is noticeable that the order flows of JPY, CHF and GBP have positively correlations among themselves while being negatively correlated with most of those in other currencies. In general, there are also positive correlations among the AUD, NZD, CAD, NOK order flows, characterised as commodity currencies and the correlation between JPY and CHF, which typically have low interest rates, is in a positive sign.

Customer order flows in appendix 4-B5 are taken from the classification of real money or known as asset managers. Overall, the results show that EUR and GBP order flows are the biggest compared to others and also considered as having the most imbalance values. The order flows with smaller volume are, in general, those of CAD, NOK and NZD respectively. In addition, CAD is the closest order flow of having a normal distribution and the order flow with the highest volatility is NZD, following by GBP, which is one of the most traded currencies, and CAD. In appendix 4-B6, which is the evidence of correlation coefficients for disaggregated customer order on real money (asset manager), points out that JPY order flow is positively correlated with most other currency order flows with the exception of a negative movement for the EUR, CHF and SEK whereas CHF also have positive correlations with others except the EUR and JPY. Besides, it is found that the correlations among commodity currencies, including the AUD, NZD, CAD and NOK, are mostly positive though negative movements are also shown.

In appendix 4-B7 reports the descriptive statistics of disaggregated order flow data on the customer of corporate. The results show that EUR is the only order flow that most likely to have a normal distribution and at the same time, it is characterised to be the most imbalance order flow, followed by the CHF. Moreover, both currencies have the largest volume among other currencies and the order flows containing smaller volumes are the GBP, NZD and NOK. The high volatility is found on the AUD, CHF, CAD and NOK order flows. The correlation coefficients for disaggregated order flows on the corporate customer are expressed in appendix 2-B8. It is obviously noted from the table that the EUR shifts reversely with every other currency except the SEK order flow. On the other hand, the JPY order flow has positive correlations with all other currency order flows, excluding EUR and GBP. The correlations among CHF, GBP, and AUD noticeably shows the positive sign among themselves whereas considering among the commodity currencies (AUD, NZD, CAD and NOK), the table generally gives the evidence for positive correlations with themselves. In addition, the JPY and the CHF, which typically have lower interest rates between each other, are positively correlated.

It is exposed in appendix 4-B9, which is on the descriptive statistics of disaggregated order flows for the leverage customer, also called as hedge funds, that the EUR and JPY order flows are the most imbalance order flows and generally have the biggest volume compared with other currencies. The subsequent smaller order flows in terms of volumes are the GBP, AUD and SEK and SEK is addressed as the order flow that is the closest of having the normal distribution. Additionally, GBP, NZD and AUD are regarded from the table as the order flow with high volatility. In appendix 4-B10 shows the results on correlation coefficients for disaggregated order flows for leverage customer (hedge funds) and it reveals that the EUR order flow is in the positive motion with most order flows of other currencies apart from the JPY, CHF and GBP that move inversely. Similar to those for aggregated order flow data, it is noticeable that the JPY, CHF and GBP order flows have positive correlations among themselves and especially on the correlation between the JPY and CHF order flows that have lower interest rates that they show positive correlations with each other. Furthermore, there is also a group of positive correlation among the order flows of AUD, NZD, CAD and NOK, which are characterised as commodity currencies though some of them are in a reverse movement.

Results on descriptive statistics of disaggregated data on private client customer order flows are perceptible in appendix 4-B11. There is no order flow from any currencies having a normal distribution. The order flow with the largest imbalances falls into the EUR and generally, is also considered as the order flow with the biggest volume. The overall smaller order flow volumes are GBP, JPY, CHF and AUD respectively. In addition, most private customer order flows indicate high volatility and the NZD, SEK and NOK are regarded as the highest volatile ones. In appendix 2-B12 reports the correlation coefficients for disaggregated order flows on private client and it is addressed here that the GBP order flow is positively correlated with all other currency order flows. Likewise, the JPY, CHF and GBP order flows also have positive correlations among themselves yet tend to correlate negatively with other order flow currencies. Considering the commodity currencies including AUD, NZD, CAD and NOK, it can be seen that these currencies move positively among themselves except the relationship between the CAD and NOK order flows that have a reverse movement. Therefore, it can be noted that this specific customer order flow on private client gives a similar result as those on the aggregated data but with more positive outcomes.

4.4 Methodology

4.4.1 Constructing a Market-Wide Liquidity Measure

The feature of liquidity can be considered in many aspects; however, the aspect that is mainly concentrated in this study is the dimension relating to the exchange rate changes associated with order flows, which is originally the initiative from the studies of Evans and Lyons (2002a) and Banti et al. (2012), pointing out the statistical significance of order flows as an influential determinant of the foreign exchange returns in the currency market, and also the study of Pastor and Stambaugh (2003) on liquidity risk and expected stock returns in the stock market, where the models of the study principally count upon. The liquidity measure relies on a cross-section set of currencies and yields 5-month block periods spanning 6 years, which is suitable for the focus on the liquidity risk. A market liquidity measure is constructed as the equally weighted average of the liquidity measures of individual currencies for each 5-month block period with the use of weekly dataset.

Adjusting from the regression model of Pastor and Stambaugh (2003) for the stock market, the liquidity measure for currency i in time block t can be obtained from the ordinary least squares (OLS) estimate of $r_{i,t}$ in the regression below[3]

$$r^{e}_{i,w+1,t} = \theta_{i,t} + \varphi_{i,t} r_{i,w,t} + \gamma_{i,t} sign(r^{e}_{i,w,t}) \cdot v_{i,w,t} + \in_{i,w+1,t} \quad \text{... (1)}$$

[3] The volume signed by the exchange rate excess returns $(sign(r^{e}_{i,w,t}) \cdot v_{i,w,t})$ in the regression is used as a proxy for order flows according to the study of Pastor and Stambaugh (2003).

where: w = $1,\dots,W$

$r^{e}_{i,w+1,t}$ = $r_{i,w,t} - r_{p,w,t}$ where $r_{p,w,t}$ denotes to the London Interbank Offered Rate (LIBOR) achievable from OECD database for the calculation of the foreign exchange excess returns

$r_{i,w,t}$ = the exchange rate returns on currency i on week w in time block t

$\gamma_{i,t}$ = the liquidity measure attained from the OLS estimate

$v_{i,w,t}$ = the dollar volume for currency i on week w in time block t

The fundamental initiative is that the order flow, which denotes to the net buying weight on the currency and is addressed by deducting the number of sells from the number of buys in a currency, is expected to be associated with the returns that are supposed to have a partially contrary movement in the future when the currency is incompletely liquid. The term of order flow here is attained from the volume signed by the exchange rate changes in excess of the market, which is represented by a proxy of lagged order flows in this study.

Regarding the assumption suggested by Pastor and Stambaugh (2003) in terms of the stock market, it is noted that the higher the expected reversal for a volume is, the lower value the stock's liquidity is, implying that the liquidity measure $(\gamma_{i,t})$ tends to ordinarily perform a negative coefficient $(\gamma_{i,t} < 0)$ with the lagged order flows and be greater in value when the liquidity is lower.

The feature on the relationship between the liquidity and volume-related return reversals is initially an inspiration from Campbell, Grossman and Wang (1993). Nonetheless, Banti et al. (2012) have the investigation on the same aspect in the currency market by focusing on the currency's liquidity instead of the stock's liquidity and taking into account actual order flows. The study expects a positive coefficient in its place for the contemporaneous order flow since a positive order flow typically leads to the appreciation in the currency and consequently directs to an increase in the exchange rate, representing as the US dollar against the foreign currency, and a negative coefficient for the lagged order flow because this type of order flow has a propensity to partially invert a simultaneous appreciation of the currency.

The return in excess of the market $(r^e_{i,w+1,t})$ as shown in the regression equation (1) is taken into account as the dependent variable in order to sign volume for the intention of a better capability in segregating the individual-currency effect of volume-related return reversals. Apparently, the return in excess of the market expresses as the validity of the interest parity, inferring that the interest rate differentials are identical to forward premia under no-arbitrage, which is signified as the London Interbank Offered Rate (LIBOR) in this study. Another important independent variable is the lagged exchange rate returns $(r_{i,w,t})$, which is in the proposed aspect of overcoming the consequence caused by the lagged return that are not accompanied by the volume.

4.4.2 Estimating the Common Liquidity Measure

The OLS coefficient estimated by regression equation (1) $(\hat{\gamma}_{i,t})$ in the previous section for the liquidity measure of a currency $(\gamma_{i,t})$ is addressed to be rather vague; therefore, the common liquidity in time block t is suggested by Pastor and Stambaugh (2003) that it is considered as a more accurate estimate and calculated by averaging the individual liquidity measures for each time block. Consequently, the actual unobserved average liquidity, which is denoted as $\hat{\gamma}_t = \left(\frac{1}{N}\right)\sum_{i=1}^{N}\gamma_{i,t}$, turns out to be a more precise approach when the number of currencies (N) increases. The estimate can be approximated by

$$\hat{\gamma}_t = \left(\frac{1}{N}\right)\sum_{i=1}^{N}\hat{\gamma}_{i,t} \qquad \text{... (2)}$$

The unobserved average market-wide liquidity measure is constructed for each time block from November 2, 2001 to November 11, 2007 and leads to a small value of $(\hat{\gamma}_t)$.

Furthermore, the scaled series are proposed by Pastor and Stambaugh (2003) for the estimation to attain more homogeneity over time and estimated by $\left(\frac{p_t}{p_t}\right)\hat{\gamma}_t$, where p_t represents the total dollar value, which is noted to be measured by exchange rates, at the end of time block $(t-1)$ of the currencies comprised in the average in time block (t).

The scaled time-block difference is subsequently constructed for the estimation on the innovations in liquidity with the equation below:

$$\Delta\hat{\gamma}_t = \left(\frac{p_t}{p_1}\right)(\hat{\gamma}_t - \hat{\gamma}_{t-1}) \qquad \text{... (3)}$$

Later, $\Delta\hat{\gamma}_t$ is regressed on its lag and on the lagged value of the calculated scaled series as in this following regression equation in order to examine the commonality in the liquidity innovations across currencies in the next section.

$$\Delta\hat{\gamma}_t = a + b\Delta\hat{\gamma}_{t-1} + c\left(\frac{p_t}{p_1}\right)\hat{\gamma}_{t-1} + e_t \qquad \text{... (4)}$$

The residuals (e_t) obtained from this regression are addressed to be the unexpected factor for the common liquidity measure and serially uncorrelated. It is used for the approximation of the innovation in the aggregate liquidity (L_t), which is set by $L_t = \frac{\hat{e}_t}{100}$

4.4.3 Is there a Liquidity Risk Premium?

This section mainly captures on the question whether the expected foreign exchange returns are associated with the sensitivity of its returns to the innovation in the aggregate liquidity (L_t). Specifically, the sensitivity is represented by the liquidity beta (β). Two techniques by Pastor and Stambaugh (2003) and Achary and Pederson (2005) are used in this study for the estimation of the liquidity beta.

Pastor-Stambaugh Liquidity Beta Measure

The liquidity beta (β_i^L) from this approach is estimated by the coefficient on the innovation in the aggregate liquidity in a pricing regression (Pastor and Stambaugh, 2003). An ordinary portfolio-based technique is approached to form sets of portfolios containing scattered liquidity betas. Considering data on November 2nd, 2001 as an initial point, currencies are sorted, according to their predicted values of the liquidity beta (β_i^L) based on the historical sensitivities of foreign exchange returns to the liquidity risk and arranged into three portfolios based on the ranking mentioned previously. Afterwards, the returns on post-formed portfolios in the following year are connected across year with the intention of constructing an individual return series for each set of the portfolios and the excess returns on the portfolios are subsequently regressed on factors correlated with returns.

Regarding the portfolio construction according to the study of Banti et al. (2012) in the foreign exchange market , the liquidity beta (β_i^L) for currency i is achieved as the slope coefficient of the innovation in the aggregate liquidity (L_t) according to the following regression equation of quarterly foreign exchange returns on the liquidity risk approximated at the end of each year.

$$r_{i,t} = \beta_i^0 + \beta_i^L L_t + \varepsilon_{i,t} \qquad \text{... (5)}$$

where: $r_{i,t}$ = the foreign exchange return of currency i

β_i^L = the liquidity beta

L_t = the innovation in the liquidity

The liquidity beta (β_i^L) apprehends the sensitivity of each foreign exchange return to the innovation of liquidity or the co-movement of currencies with the aggregate liquidity. Moreover, the liquidity beta for any currencies is allowed to show a discrepancy through time. Banti et al. (2012) declare in their study that the portfolios containing high sensitivity of return to the liquidity risk incline to have a high excess return than those portfolios with lower sensitivity.

Achary-Pederson Liquidity Beta Measure

According to the study of Achary and Pederson (2005) that takes the modification of CAPM in order to account for liquidity risk, the definition of the liquidity risk is extended by including the covariance of individual asset liquidity and market liquidity, and the covariance of individual asset liquidity and the market return, which is a supplementary feature on the study of Pastor and Stambaugh (2003) that focuses on the covariance of an asset return and market liquidity. Therefore, the Achary-Pedersen liquidity measure is considered as a generalization of the Pastor-Stambaugh measure.

Consequently, two major extension parts in this analysis for the liquidity risk estimation are the covariance of individual currency returns and market liquidity, and the covariance of individual currencies' liquidity and market liquidity. Betas to measure systematic liquidity risk (β_j) are estimated from the following regressions:

$$r_{j,t}^{e} = \beta_j^{0} + \beta_j^{L1} L_t + \varepsilon_{j,t} \quad \text{... (6)}$$

$$\hat{r}_{j,t} = \beta_j^{0'} + \beta_j^{L2} L_t + \varepsilon'_{j,t} \quad \text{... (7)}$$

where: $r_{j,t}^{e}$ = the foreign exchange excess returns on currency j in time block t

L_t = the liquidity innovations

$\hat{r}_{j,t}$ = the individual liquidity measures on liquidity risk on currency j in time block t

Regression (6) concentrates on the liquidity innovations as the only common risk factor while regression (7) is, afterward, run to estimate the further measure of liquidity risk inspired by Achary and Pedersen (2005) by the regression of innovations in individual liquidity on innovations in aggregate liquidity.

Ultimately, the net β for the measurement of systematic liquidity risk are calculated by

$$\hat{\beta}_j = \hat{\beta}_j^{L1} - \hat{\beta}_j^{L2} \quad \text{... (8)}$$

Three portfolios are later constructed based on their predicted values of the liquidity beta. The first portfolio contains the currencies with the least sensitivities to the innovation in the aggregate liquidity while the third portfolio consists of the most sensitive currencies. In other words, the identical process as Section 4.3.1 is repeated by applying the liquidity beta measure approach suggested by Achary and Pedersen (2005).

4.5 Empirical Results

4.5.1 The Foreign Exchange (FX) Liquidity Measure

The Average Market-Wide Liquidity Measure

This section performs the results on the average market-wide liquidity measure in each time block because according to the study of Pastor and Stambaugh (2003) and Banti et al. (2012), the OLS coefficient estimated by regression equation (1) is less precise compared to this approach. The average market-wide liquidity measure is simply approximated by averaging the individual liquidity measures for each time block.

Table 4-1 shows the average market-wide liquidity measure on each time period for aggregate data and also the averaged estimation on 4 customer classifications (asset managers, corporate, hedge funds and private client) on disaggregate data. With the consideration on the results of disaggregate data, it is found that positive coefficients seem to be slightly more than negative ones. On the contrary to others, the table presents that the averaged liquidity measure results on aggregate data are noticeably in a negative direction in most of the time blocks. Moreover, the average of the average market-wide liquidity measure over 15 time blocks for each type of data are estimated and all groups of data perform negative coefficient values as initially expected but there is an exceptional positive results on the leverage (hedge fund) of disaggregate data. According to standard deviation values, both results on aggregate and disaggregate data indicate that the shapes of their distributions are approximately bell-shaped.

Table 4-1: The Average Market-Wide Liquidity Measure for each time block $(\hat{\gamma}_t)$

	Aggregate Data	Disaggregate Data			
		Real Money (Asset Manager)	Corporate	Leverage (Hedge Fund)	Private Client
Average	-0.01499	-0.00499	-0.02723	0.079475	-0.07291
Standard Deviation	0.171778	0.234471	0.694055	1.407897	1.398755

Note: The estimation is obtained by running regression on equation (1) in the dataset spanning the time period from November 2, 2001 to November 11, 2007 and consequently, the averaged estimation of 15 time blocks is calculated.

The Liquidity Innovation

After the average market-wide liquidity measure for each time block is calculated in the previous section, the scaled series $\left(\frac{p_t}{p_t}\right)\hat{\gamma}_t$ suggested by Pastor and Stambaugh (2003) are constructed in order to obtain more homogeneity over time.

Consequently, the procedure is pursued by the calculation of scaled time-block difference $\Delta\hat{\gamma}_t$ for the innovation estimation in liquidity as in equation (3). Results presented in Table 4-2 are attained from running the regression (4), which captures the ability of the common liquidity measure. All coefficients on the lagged value of the scaled series express negatively and mostly statistically significant under 1% and 5% significance levels except that of leverage (hedge fund) in disaggregate data, which gives a statistically-significant positive estimate. In contrast with the results on the coefficients of the lagged value of the scaled series, the coefficients on the scaled time-block difference generally show significant and positive results whereas only those of the corporate in disaggregate data as reports negatively. Additionally, each of the regressions contains an R^2 exceeding 35 percent. Therefore, the common liquidity measure estimated in this section can be used to commonly explicate movements in the liquidity of currencies.

Table 4-2: Regression Results on $\Delta\hat{\gamma}_t$

	b	c	R^2
Aggregate Data	0.297685 (t =1.481321)	-0.276646 (-1.316073)	0.535842
Disaggregate Data	b	c	R^2
AM	0.453843*** (2.027335)	-0.220773 (-1.087028)	0.355351
CORP	-0.148970 (-0.767496)	-0.768012* (-4.066950)	0.600614
HF	0.348505* (2.775823)	0.587218* (3.621465)	0.801314
PC	0.158723 (0.651813)	-0.830915** (-2.540048)	0.505718

Note: Regression results are estimated from running regression (4) and t-statistics are reported in the parentheses. *, ** and *** indicate statistical significance at the 1%, 5% and 10% significance level respectively.

The innovation in the aggregate liquidity (L_t) is subsequently estimated by dividing the fitted residuals (d_t) obtained from regression (4), the unexpected factor for the common liquidity measure, with 100. The residual values estimated are found to be very small, which can be indicated that they have a good fit to the model. In other words, predicted values are not very different from the actual value of the dependent value, which is the scaled time-block difference $(\Delta\hat{\gamma}_t)$ for the innovation estimation in liquidity in this case.

4.5.2 Liquidity Beta and Portfolios

This section essentially investigates whether there is a relationship between the expected foreign exchange returns and the sensitivity of its returns to the innovation in the liquidity (L_t), known as the liquidity beta (β)

Pastor-Stambaugh Liquidity Beta and Portfolios

Liquidity beta (β_i^L) from this technique is estimated by the coefficients of the innovation in the liquidity. Three portfolios are later constructed based on the ranking of the sensitivity of foreign exchange returns to the liquidity risk or, in other words, according to their predicted values of the liquidity beta. The least sensitive currencies to liquidity risk are presented in the first portfolio while the most sensitive currencies are contained in the third portfolio.

The tables in appendix 4-C1 report the results on the Pastor-Stambaugh liquidity beta with the ranking for aggregate data and disaggregate data including 4 classifications. The liquidity betas from this technique are obtained by running the regression in equation (5) over the sample period of 2nd November, 2001 to 23rd November, 2007. For aggregate dataset, NOK has the lowest liquidity beta value (-1.805397) whereas AUD has the highest liquidity beta value (4.900376). Furthermore, for disaggregate data, it is found that JPY has the lowest liquidity beta (-1.412847) for real money (asset manager) while CAD is the currency with the lowest value of liquidity beta for other three classifications of disaggregate data (0.411128 for corporate, -0.665765 for leverage/hedge fund and -0.399237 for private client). At the same time, though the currency has lowest values in other disaggregate classifications, the liquidity beta of CAD in real money (asset manager) remarkably performs the highest value (1.551843) among other currencies. On the other hand, corporate, leverage/hedge fund, and private client has NOK as the currency holding the highest liquidity beta with the value of 1.593241, 0.081688 and 0.075196 respectively.

The post-ranking liquidity betas of three portfolios, which are based on the ranking, are reported in Table 4-3 that the post-ranking liquidity betas enlarge across portfolios in accordance with the sorting approach based on the ranking of the liquidity betas. Overall liquidity betas for aggregate data and 4 classifications of disaggregate data, which consists of real money (asset manager), corporate, leverage (hedge funds) and private client, are 4.447115 (t = 2.618173), 1.740123 (t = 2.652173), 0.681629 (t = 1.569293), 0.633838 (t = 3.120670) and 0.351379 (t = 2.227793) respectively. Moreover, it is noticeable that overall results are statistically significant except that of the corporate.

Table 4-4 presents some descriptive statistics for the excess returns of three post-ranking portfolios, which are sorted by the sensitivity of foreign exchange returns to the innovation in the liquidity. The first portfolio is composed of currencies with the least sensitivity to liquidity risk while the third portfolio comprises those with the most sensitivity to liquidity risk. The spread '3 – 1' is constructed by taking a short position on the first portfolio and a long position on the third portfolio. Accordingly, the excess returns for each portfolio are assembled by taking into account the excess returns of currencies contained in each portfolio. Specifically, an excess return for each portfolio is approximated by getting the excess returns in each time block connected. It is initially expected that higher sensitivity to liquidity risk are associated with a higher return. The results show that only corporate and leverage (hedge fund) classifications of disaggregate data report as initially anticipated.

According to the assumption given by Banti, Phylaktis and Sarno (2012), the portfolios with more sensitive currencies (Portfolio 3) have a propensity to present well in good liquidity states and contain the most depreciation consistent with a bad liquidity shock and a contrary assumption on portfolios with less sensitive currencies (Portfolio 1). In contrast, real money (asset manager), which is also one of the disaggregate data types, performs an opposite movement showing that the higher sensitivity to liquidity risk is, the less exchange rate return carries out. Results on aggregate data and private client cannot be certainly explained because of their fluctuation of the consequences displayed.

Table 4-3: Portfolios Sorted on Predicted Pastor-Stambaugh Liquidity Betas

Portfolio	1	2	3	3 – 1
Aggregate Data	-1.155524 (-0.399733)	0.650073 (0.257892)	3.291592 (1.548546)	4.447115* (2.618173)
Disaggregate Data				
Real Money (Asset Manager)	-0.666967 (-0.661621)	0.335618 (0.307038)	1.073155 (1.156579)	1.740123* (2.652173)
Corporate	0.763263 (1.557665)	1.149714** (2.430753)	0.002454 (0.003648)	0.681629 (1.569293)
Leverage (Hedge Funds)	-0.575263*** (-2.023173)	-0.247493 (-0.871724)	0.058575 (0.179857)	0.633838* (3.120670)
Private Client	-0.332124*** (-1.673529)	-0.156311 (-0.733802)	0.019255 (0.094351)	0.351379** (2.227793)

Note: The sample data are sorted, at each time block, into 3 portfolios in consistent with predicted liquidity betas covering the time period from November 2, 2001 to November 11, 2007. T-statistics are presented in the parentheses and *, ** and *** indicate statistical significance at the 1%, 5% and 10% significance level respectively.

The difference between the average sensitivity of currencies in portfolio 1 and 3 betas for aggregate data and 4 classifications of disaggregate data, which consists of real money, corporate, leverage, private client, is approximately 0.521485, -1.092232, -0.507398, 0.762843 and -0.481505 respectively. It means portfolios in leverage (hedge funds) data ensemble with the assumption primarily expected. Because of the limitation of the data, researchers might be interested in further analysis using broader ranges of dataset to get more accurate results.

Table 4-4: Descriptive statistics for excess returns of the three liquidity-sorted portfolios, based on Pastor-Stambaugh liquidity beta measure, on both aggregate data and disaggregate data, including 4 classifications

Portfolio	1	2	3	3 – 1
Aggregate Data				
Mean	-0.725847	-1.472323	-0.204362	0.521485
Median	-0.637940	-1.429775	0.021420	0.390688
Standard Deviation	0.431203	0.166197	0.452384	0.379523
Disaggregate Data: Real Money (Asset Manager)				
Mean	-0.188892	-0.932516	-1.281124	-1.092232
Median	-0.041831	-0.936664	-1.217043	-1.175212
Standard Deviation	0.455167	0.338857	0.186681	0.286137
Disaggregate Data: Corporate				
Mean	-0.204362	-1.486410	-0.711760	-0.507398
Median	0.021420	-1.439490	-0.659780	-0.472401
Standard Deviation	0.452384	0.135153	0.441945	0.344481
Disaggregate Data: Leverage (Hedge Funds)				
Mean	-1.070596	-1.024183	-0.307753	0.762843
Median	-1.124196	-1.013193	-0.183348	0.870324
Standard Deviation	0.230271	0.322862	0.456234	0.254842
Disaggregate Data: Private Client				
Mean	-1.070596	0.220166	-1.552101	-0.481505
Median	-1.124196	0.456891	-1.563149	-0.472290
Standard Deviation	0.230271	0.599522	0.175773	0.088420

Note: Portfolios are sorted according to the sensitivity of exchange rate returns to the innovation in the liquidity. Portfolio 1 contains the currencies with the lowest sensitivities to liquidity risk, while portfolio 4 contains the currencies with the highest sensitivity. The '3-1' column is constructed by taking a short position on the first portfolio and a long position on the third portfolio.

Achary-Pederson Liquidity Beta and Portfolios

The results on the liquidity beta estimated by Achary-Pederson measure with the ranking details for aggregate data and 4 types of disaggregate data is presented in the table in appendix 4-C2. The regressions in equation (6) and (7) are run over the sample period from 2nd November, 2001 to 23rd November, 2007 and equation (8) is calculated for the liquidity betas. For aggregate dataset, SEK contains the lowest liquidity beta value of (-0.401905) while CHF has the highest liquidity beta value (12.068305). It is found, for the disaggregate data, that SEK still holds the lowest liquidity beta (-1.517398) for real money (asset manager) whereas NOK is the currency with the lowest value of liquidity beta for corporate and leverage (hedge fund) (-2.017745 and -2.20257 respectively), and NZD for private client with the value of (-0.247548).

The liquidity beta of NOK in private client data notably presents as the one with the highest value (6.536925) among other currencies while showing the lowest values in corporate data and leverage (hedge fund) data. For aggregate data and corporate data, it is shown that CHF is the currency holding the highest liquidity beta with the value of 12.068305 and 2.325933 respectively, and JPY with the liquidity beta value of 5.636513 and 0.597071 performs as the currency with the highest value for real money (asset manager) and leverage (hedge fund) correspondingly.

Table 4-5 reports the post-ranking liquidity betas of three portfolios, sorted by the ranking according to their predicted values of the liquidity beta. The results indicate that the post-ranking liquidity betas increase across portfolios in accordance with the sorting approach. Overall liquidity betas for aggregate data and 4 classifications of disaggregate data, containing real money (asset manager), corporate, leverage (hedge funds) and private client, are 9.980069 (t = 1.630100), 4.452284 (t = 1.138551), 2.638123 (t = 1.907574), 1.217811 (t = 0.840438) and 3.832411 (t = 0.840438) respectively. In addition, the table shows that portfolios with higher sensitivity to liquidity risk have higher returns. However, only those of corporate dataset are significant at 5% and 10% significance level.

Descriptive statistics for the excess returns of three post ranking portfolios, which are sorted according to the sensitivity of foreign exchange returns to the innovation in the liquidity or known as liquidity beta, are presented in table 4-6. The first portfolio denotes the currencies with the least sensitivity to liquidity risk while the third portfolio composes those with the most sensitivity to liquidity risk. The spread '3 – 1' is constructed by taking a short position on the first portfolio and a long position on the third portfolio. Consequently, the excess returns for each portfolio are assembled in consistent with the excess returns of currencies that are in each portfolio. Particularly, an excess return for each portfolio is estimated by connecting the excess returns across time blocks. The results remarkably show the evidence supporting the initial assumption that higher sensitivity to liquidity risk is associated with a higher return except those of real money (asset manager) data.

Table 4-5: Portfolios Sorted on Predicted Acharya-Pedersen Liquidity Betas

Portfolio	1	2	3	3 – 1
Aggregate Data	0.021594 (t = 1.414000)	3.278321 (1.615764)	10.00166 (1.634315)	9.980069 (1.630100)
Disaggregate Data				
Real Money (Asset Manager)	-0.65311 (1.087498)	0.750243 (1.213642)	3.799179 (1.433220)	4.452284 (1.138551)
Corporate	-0.4361** (2.603225)	1.092376*** (1.825460)	2.202025** (2.198541)	2.638123*** (1.907574)
Leverage (Hedge Funds)	-0.79078 (-0.686084)	0.083601 (0.245517)	0.427035 (0.449970)	1.217811 (0.840438)
Private Client	0.014844 (1.565735)	0.38177 (1.502081)	3.847255 (0.592665)	3.832411 (0.085213)

Note: The sample data are sorted, at each time block, into 3 portfolios in consistent with predicted liquidity betas covering the time period from November 2, 2001 to November 11, 2007. T-statistics are presented in the parentheses and *, ** and *** indicate statistical significance at the 1%, 5% and 10% significance level respectively.

Table 4-6: Descriptive statistics for excess returns of the three liquidity-sorted portfolios, based on Acharya-Pedersen liquidity beta measure, on both aggregate data and disaggregate data, including 4 classifications

Portfolio	1	2	3	3 – 1
Aggregate Data				
Mean	-1.54344	-1.2241	0.365002	1.90844
Median	-1.48316	-1.1328	0.509262	1.99242
Standard Deviation	0.125242	0.194252	0.650875	0.541276
Disaggregate Data: Real Money (Asset Manager)				
Mean	-1.3986	-1.41049	0.40656	1.805162
Median	-1.34711	-1.35933	0.659265	1.896329
Standard Deviation	0.253776	0.151878	0.641805	0.543947
Disaggregate Data: Corporate				
Mean	-1.49027	-1.34296	0.430693	1.920962
Median	-1.48697	-1.27432	0.590299	2.147724
Standard Deviation	0.164748	0.201166	0.617238	0.480924
Disaggregate Data: Leverage (Hedge Funds)				
Mean	-1.33677	-1.2241	0.158333	1.495101
Median	-1.26863	-1.1328	0.374153	1.507333
Standard Deviation	0.250402	0.194252	0.613522	0.540882
Disaggregate Data: Private Client				
Mean	-1.51054	-0.8566	-0.03539	1.475151
Median	-1.48838	-0.7931	-0.03343	1.431746
Standard Deviation	0.178279	0.357805	0.498746	0.418326

Note: Portfolios are sorted according to the sensitivity of exchange rate returns to the innovation in the liquidity. Portfolio 1 contains the currencies with the lowest sensitivities to liquidity risk, while portfolio 4 contains the currencies with the highest sensitivity. The '3-1' column is constructed by taking a short position on the first portfolio and a long position on the third portfolio.

The Comparison between Pastor-Stambaugh Liquidity Measure and Achary-Pederson Liquidity Measure

Following the investigation on the question whether the liquidity risk is priced in currency returns (Banti, Phylaktis and Sarno, 2012), an alternative liquidity beta measure proposed by Acharya and Pedersen (2005) is suggested. The Achary-Pedersen measure is theoretically different and developed from the Pastor-Stambaugh measure, which is primarily used in this study, on the extension of the liquidity risk definition. The covariance of individual asset liquidity and market liquidity, and the covariance of individual asset liquidity and the market return are taken into account for the Achary-Pedersen measure, which the regression of innovations in individual liquidity on liquidity innovations is comprised, whereas the Pastor-Stambaugh presents a single covariance of an asset return and market liquidity. Besides, the Capital Asset Pricing Model (CAPM)[4] is improved for an additional consideration on liquidity risk.

Remarkably, portfolios sorted on predicted liquidity betas, which are estimated by the Achary-Pedersen liquidity measure, exceed those of the Pastor-Stambaugh measure according to results in tables 3 and 5. It is also noticeable that the liquidity beta values estimated by the Achary-Pedersen measure increase through from portfolios 1 to 3 after all portfolios are sorted and the regression estimations are recurred with only the significant results lean on corporate data. Instead, the Pastor-Stambaugh liquidity beta values show more significant results with an unstable movement on corporate data.

Furthermore, concerning tables 4-4 and 4-6, descriptive statistics for excess returns of all three liquidity-sorted portfolios on both aggregate data and disaggregate data of the Achary-Pedersen measure surpass those of the Pastor-Stambaugh approach. Nevertheless, a significant evidence found from the results estimated by the Achary-Pedersen measure pursue the initial assumption inspired

[4] Capital Asset Pricing Model (CAPM) is a model explaining the relationship between risk and expected return with the concentration on the terms of time value of money and risk. It is usually used in pricing the risky securities.

by Banti et al. (2012) that the portfolios with high sensitivity to liquidity risk tend to have high excess return than those with low sensitivity except the results on real money (asset manager) data. On the other hand, only the evidence on leverage (hedge funds) data regarding the expected assumption is reported with the results by the Pastor-Stambaugh liquidity beta technique. One possibility that can be approached for future work is to investigate on larger dataset.

4.6 Conclusion

The study mainly investigates on the dimension relating to the exchange rate changes associated with the order flows, which receives a high inspiration from the initiative study of Pastor and Stambaugh (2003) on liquidity risk and expected stock returns in the US stock market. The aspect on the question whether the expected foreign exchange return is related to the sensitivity of its returns to the innovation in the aggregate liquidity, denoted by the liquidity beta, is also captured.

A unique dataset used in the study consists of a set of order flows including 9 currencies, weekly nominal exchange rates and a set of macroeconomic and financial variables covering the time period from November 2, 2001 to November 11, 2007. The order flow data is aggregated across currency pairs at a weekly frequency, which can be divided into 4 classifications of customer order flows; real money (asset managers), leverage (hedge funds), corporate, and private clients.

The results on the average market-wide liquidity for 15 time blocks show that the positive coefficients exceed the negative ones in the disaggregate data whereas the negative coefficients are noticeably found in the aggregate data. Furthermore, the average of the liquidity measure over all time blocks for each type of data performs a negative movement as primarily expected, implying that the larger is the expected reversal for a volume, the lower value is the liquidity. However, an exception lies on the leverage (hedge fund) disaggregate data performing a positive movement.

Moreover, the study also explores whether there is a relationship between the expected foreign exchange returns and the sensitivity of its returns to the innovation in the liquidity, denoted as the liquidity beta. Three portfolios are, afterwards, constructed based on the ranking of the sensitivities of foreign exchange returns to the liquidity risk, which are estimated by two significant measures motivated by Pastor and Stambaugh (2003) and Acharya and Pedersen (2005). The first portfolio contains currencies with the least sensitivity while the third portfolio holds currencies with more sensitivity. It is found that the liquidity betas estimated in post-ranking portfolios increase through from portfolio 1 to portfolio 3 in all dataset as earlier expected, excluding those of corporate of the Pastor-Stambaugh measure. It is also noticeable that overall liquidity beta values calculated by the Acharya-Pedersen exceed those of the Pastor-Stambaugh measure. An interest point may be explained by the Achary-Pedersen measure that takes into account an additional attention on the liquidity risk with an adjustment on the Capital Asset Pricing Model (CAPM). Additionally, the measure considers the covariance of individual asset liquidity and market liquidity, and the covariance of individual asset liquidity and the market return in the estimation, which is a further feature extending from the Pastor-Stambaugh measure.

Another imperative assumption following the study of Banti, Phylaktis and Sarno (2012) is that the portfolios with more sensitive currencies tend to perform well in good liquidity states and contain the most depreciation and vice versa, which implies that the portfolios with high sensitivity to liquidity risk incline to have high excess return than those with low sensitivity. The evidence is perceptibly supported by the Achary-Pedersen results except those on real money (asset manager) data. On the contrary, for the Pastor-Stambaugh measure, real money (asset manager), one of the disaggregate data, reports a reverse movement showing that the higher sensitivity to liquidity risk is, the less exchange rate return carries out. Results on aggregate data and private client cannot be obviously concluded due to its fluctuation of the consequences. An essential reason goes to the limitation of the dataset. Therefore, in the future, one direction is that researchers might be interested in doing a further analysis using broader ranges of dataset to get more accurate results for the Pastor-Stambaugh measure. Additionally, other financial markets can be taken into the consideration whether the systematic liquidity risk is priced, such as fixed income markets or international equity markets, which is also suggested by Pastor and Stambaugh (2003).

Chapter 5

Common Risk Factors

In Currency Markets

Abstract

According to the study by Lustig, Roussanov and Verdelhan (2011), which shows that the large co-movement among exchange rates of different currencies can explain a risk-based view of exchange rate determination. The investigation on identifying a slope factor in exchange rate changes is taken place. The main assumption of their study is that the exchange rates of high interest rate currencies load positively on this slope factor while there is the negative loading of low interest rate currencies on the factor. The study starts by constructing monthly portfolios of currencies, which are sorted on the basis of their forward discounts. The lowest interest rate currencies are contained in the first portfolio and the highest interest rate currencies are in the last. The results performs that portfolios with higher forward discounts incline to contain higher real interest rates in overall by considering the first portfolio and the last portfolio though the fluctuation occurs.

5.1 Introduction

According to the study by Lustig, Roussanov and Verdelhan (2011), which shows that the large co-movement among exchange rates of different currencies can explain a risk-based view of exchange rate determination. The investigation on identifying a slope factor in exchange rate changes, which is the key estimation, is taken place. The main assumption of their study is that the exchange rates of high interest rate currencies load positively on this slope factor while there is the negative loading of low interest rate currencies on the factor.

The study starts by constructing monthly portfolios of currencies, which are sorted on the basis of their forward discounts. The lowest interest rate currencies are contained in the first portfolio and the highest interest rate currencies are in the last. The study also states two most important components of the currency portfolio returns, which give a considerable explanation for the time-series variation in currency returns. The most significant point of this study is similar to that of Lustig, Roussanov and Verdelhan (2011); considering the common factor in exchange rates sorted by interest rates, which are indicated as major factor in the clarification of carry trade returns with a risk-based point of view.

This study is ordered as followed. Section 2 performs an overview of previous relevant literatures, which are related to the common risk factors. In Section 3 the information on the data used in the study, including the description of the data and descriptive statistics is presented. How the currency portfolios are constructed together with the information and results on returns to currency speculation for a US investor and the comparison between average and currency interest rate difference are acknowledged in Section 4 and on the common factor in currency returns in Section 5. Section 6 concisely assesses the conclusions and proposes some useful suggestions for future research.

5.2 Literature Review

The literature review of this study starts with the results from the study of Lustig, Roussanov and Verdelhan (2011), which shows that the large co-movement among exchange rates of different currencies can explain a risk-based view of exchange rate determination. This aspect leads to the investigation on identifying a slope factor in exchange rate changes, which is the key estimation of this study. The assumption is primarily placed as that the exchange rates of high interest rate currencies load positively on this slope factor at the same time as the negative loading of low interest rate currencies on it. The returns on the currency carry trade[1], known as the average returns between baskets of high and low interest rate currencies, are explicated by the co-variation with this slope factor

In integrated capital markets, risk is defined as exposure to some common or global factor, which has performed a significant role and is intimately associated with changes in volatility of equity markets around the world (Poirson and Schmittmann, 2013). The study of Lustig, Roussanov and Verdelhan (2011) also presents that the slope factor in exchange rates grants an accurate measure of the global risk factor. The factor is constructed from currency portfolios and can also clarify the variation in the country-level returns. Therefore, a constructed no-arbitrage model of interest rates and exchange rates with two state variables, which are country-specific and global risk factors, is taken into account.

Initially, the study of Lustig, Roussanov and Verdelhan (2011) begins by constructing monthly portfolios of currencies, which are sorted on the basis of their forward discounts. The lowest interest rate currencies are contained in the first portfolio and the highest interest rate currencies are in the last. The study

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[1] Carry Trade is an approved strategy in which an investor borrows in currencies with relatively low interest rates (funding currencies) and concurrently lending in currencies with high interest rates (investment currencies) (Corte, Riddiough and Sarno, 2013) . A trader using this strategy attempts to capture the difference between the rates, which can often be substantial, depending on the amount of leverage used.

also states two most important components of the currency portfolio returns, which give a considerable explanation for the time-series variation in currency returns. The first main component is called a level factor, which accounts for the average excess return on all foreign currency portfolios (the dollar risk factor, RX). In addition, the second primary component is a slope factor whose loadings decrease monotonically from positive to negative and from high to low interest rate currency portfolios. This component is also entitled as the carry trade risk factor (HML_{FX}) for high interest rate currencies minus the low ones. The most significant point of the study of Lustig, Roussanov and Verdelhan (2011) is that the aspect of considering the common factor in exchange rates sorted by interest rates, which are indicated as major factor in the clarification of carry trade returns with a risk-based point of view.

The comparable research is, presently, explored by Corte, Riddiough and Sarno (2013) on a currency risk factor, or called as the global imbalance risk factor, which account exposure to countries' external imbalances. This factor is addressed with the basis on global imbalances describing the average excess return between baskets of high and low interest rate currencies, and, in addition, gives a risk-based explanation on carry trade returns. It is stated that, by employing the carry trade strategy, the investors achieve a positive excess return on average, which is contrary to an assumption of the uncovered interest rate parity (UIP)[2] condition.

Originally, the research of Backus, Foresi and Telmer (2001), which reports that heterogeneity in exposure to the country-specific risk can distribute negative UIP slope coefficients for individual currency pairs; however, it cannot expound the cross-section of carry trade returns. The perception for the investor to obtain the

[2] Uncovered interest rate parity (UIP) refers to the interest rate parity that lacks of a forward contract to hedge risk in the exchange rate market. The condition of interest rate parity is when the domestic interest rate equals to the sum of foreign interest rate plus the expected change of the exchange rates. (Aggarwal S, 2013)

carry trade premium is basically by going long in baskets of high interest rate currencies and short in baskets of low interest rate currencies.

Afterwards, the further study, produced by Lustig, Roussanov and Verdelhan (2011), shows that heterogeneity in exposure to common risk can both describe the carry trade returns and generate the negative uncovered interest rate parity (UIP)[3] slope coefficients. They give some evidence that temporary heterogeneity in exposure to common risk captures the conditional deviations from UIP, implying that currencies with currently high interest rate can generate higher returns. On the other hand, permanent differences in exposure to common risk corresponds with the unconditional deviations from UIP, which means currencies with, on average, high interest rates distribute higher returns.

Various literatures have pointed out the failure of uncovered interest rate parity (UIP) in the time series. Examples of papers regarding this feature begin with the study of Hansen and Hodrick (1980) and Fama (1984), which both confirm that higher than usual interest rates direct to further appreciation, and investors are likely to obtain more returns by holding bonds in currencies with interest rates that are higher than usual.

Subsequently, in terms of the cross-section, the studies of Lustig and Verdelhan (2005, 2007), which construct currency portfolios in the forward contracts with the basis on forward discounts, report the failure of uncovered interest rate parity (UIP) although developing currencies are taken into account. The study performs that investors receive more excess returns by carrying bonds from currencies with interest rates that are currently high.

[3] Uncovered interest rate parity (UIP) refers to the interest rate parity that lacks of a forward contract to hedge risk in the exchange rate market. The condition of interest rate parity is when the domestic interest rate equals to the sum of foreign interest rate plus the expected change of the exchange rates. (Aggarwal S, 2013)

Furthermore, Bansal and Dahlquist (2000) and Lustig, Roussanov and Verdelhan (2011) addresses their further evidence that the interest rate is stated to be one of the characteristics defining returns.

5.3 Data

The main data of this study are end-of-month series built spot and forward exchange rates in US dollar, which are originally computed from the daily mid spot and one-month forward exchange rate raw data by Professor Craig Burnside, used in the study of Lustig and Verdelhan (2007). The data covers the time period from January 1976 to December 2010 and can be obtained from Datastream, collected by Barclays and Reuters/WMR. The description of the dataset is provided in table 1. Lustig et al. (2011) assumed that net excess returns are taken placed at bid-ask quotes, which from Reuters are approximately twice the size of inter-dealer ones; therefore, the transaction cost estimates are stated to be conservative. The dataset used for this study comprises 20 different currencies; Austrian Schilling, Belgian Franc, Canadian Dollar, Danish Krone, French Franc, German Mark, Irish Punt, Italian Lira, Japanese Yen, Dutch Guilder, Norwegian Krone, Portuguese Escudo, Spanish Peseta, Swedish Krona, Swiss Franc, UK Pound, Euro, Australia Dollar, NZ Dollar and S.African Rand. Moreover, a slightly smaller set of data containing 18 currencies from developed countries excluding Euro and S.African Rand is studied for a robustness check.

Abbreviation	Currencies	Sample
ATS	Austrian Schilling	1976:1-1998:12
BEF	Belgian Franc	1976:1-1998:12
CAD	Canadian Dollar	1976:1-2010:12
DKK	Danish Krone	1976:1-2010:12
FRF	French Franc	1976:1-1998:12
DEM	German Mark	1976:1-1998:12
IEP	Irish Punt	1979:4-1998:12
ITL	Italian Lira	1976:1-1998:12
JPY	Japanese Yen	1978:6-2010:12
NLG	Dutch Guilder	1976:1-1998:12
NOK	Norwegian Krone	1976:1-2010:12
PTE	Portuguese Escudo	1976:1-1998:12
ESP	Spanish Peseta	1976:1-1998:12
SEK	Swedish Krona	1976:1-2010:12
CHF	Swiss Franc	1976:1-2010:12
GBP	UK Pound	1976:1-2010:12
EUR	Euro	1998:12-2010:12
AUD	Australian Dollar	1984:12-2010:12
NZD	NZ Dollar	1984:12-2010:12
ZAR	S.African Rand	1983:10-2010:12

Table 5-1: The description of spot and forward exchange rates used in the study.

Credit: Professor Craig Burnside

Source:

1) Daily GBP mid spot and one-month forward exchange rates from Reuters/WMR

2) Daily USD mid spot and one-month forward exchange rates from Reuters/WMR

3) Daily USD mid spot and one-month forward exchange rates from Barclays

5.4 Currency Portfolio

Forward and spot currency markets are mainly concentrated in the study. Currency portfolios comprise both emerging market and developed countries. According to Lustig and Verdelhan (2005, 2007), all currencies are ranked by their interest rates and allocated into portfolios. Nevertheless, monthly currency excess returns are computed in this study as suggested by Lustig, Roussanov and Verdelhan (2011) with the use of spot and forward exchange rates, differently from what those previous researchers used, which was T-bill yields for the estimation of annual currency excess return.

5.4.1 Building Currency Portfolio

Currency Excess Returns

The log excess return on buying a foreign currency in the forward market and selling it in the spot market after one month can be defined as

$$rx_{t+1} = f_t - s_{t+1}$$

Where: rx = the log of currency excess return

f = the log of the forward exchange rate

s = the log of the spot exchange rate

Both values of the log of the forward exchange rate (f) and the spot exchange rate (s) are in units of foreign currency per U.S. dollar. Moreover, it can be implied that an increase in s indicates an appreciation of the home currency.

The log currency excess return can also be identified as the log forward discount deducted by the change in the spot rate:

$$rx_{t+1} = f_t - s_t - \Delta s_{t+1}$$

As stated in the study of Lustig, Roussanov and Verdelhan (2011), in normal conditions, forward discount rates are along the lines of the covered interest rate parity condition, referring that the forward discount is equivalent to the interest rate differential:

$$f_t - s_t \approx i_t^* - i_t$$

Where: i^* = the foreign nominal risk-free rates over the maturity of the contract

i = the domestic nominal risk-free rates over the maturity of the contract

Transaction Costs

The investor's actual realized excess return net of transaction costs can be calculated as a consequence of that spot and forward contracts contain bid-ask quotes. In the investment of going long in foreign currency, the investor buys the foreign currency (sells dollars) at the bid price (f_t^b) in period t, and sells the foreign currency (buys dollars) at the ask price (f_{t+1}^a) in period $t+1$. The net log currency excess return is estimated by

$$rx_{t+1}^l = f_t^b - s_{t+1}^a$$

The investment of going short in foreign currency (long in the dollar) has a comparable approach. The net log currency excess return is computed by

$$rx_{t+1}^{s} = f_t^{b} - s_{t+1}^{a}$$

Portfolio

All currencies in the sample are assigned into 5 portfolios according to their forward discounts $(f - s)$ at the end of period t. The ranking runs from low interest rate to high interest rate, implying that portfolio 1 includes the currencies with the lowest interest rate or the lowest forward discount values while the currencies with the highest interest rate or the highest forward discount values are in portfolio 4. The log currency excess return (rx_{t+1}^{j}) for portfolio j can be calculated by estimating the average of the log currency excess returns in each portfolio j. Furthermore, an assumption was made by Lustig et al. (2011) that the investors go short on all the foreign currencies in the first portfolio and long on all other foreign currencies for the estimation of the net returns of bid-ask spreads.

5.4.2 Returns to Currency Speculation for a US Investor

Both table 5-2 and table 5-3, using the data on all countries and developed countries in the sample respectively, contain a general summary of the five currency portfolios from the perspective of a US investor. The table provides the results, for each portfolio j, on the average change in log spot exchange rates (Δs^{j}), the average log forward discounts $(f^{j} - s^{j})$, the average log excess return without bid-ask spreads (rx^{j}), the average log net excess return with bid-ask spreads (rx_{net}^{j}), the average return on the high-minus-low strategy without bid-ask spreads $(rx^{j} - rx^{1})$, the average return on the high-minus-low strategy with bid-ask spreads $(rx_{net}^{j} - rx_{net}^{1})$, and the real interest rate differential $(r^{j} - r)$. The average log returns are reported due to the reason that they are the summation of the average change in log spot exchange rates and the average log forward discounts. It is noted that exchange rates and returns shown in table 5-2 and table 5-3 are in the US dollar unit. Additionally, the mean is annualized by multiplying the monthly data by 12 and $\sqrt{12}$ is used to multiply with the standard deviation monthly data to be annualized.

Using the data on all countries in the sample, table 5-2 shows, in the first panel, the average rate of depreciation for all currencies in each portfolio j. In accordance with the standard UIP condition, the average rate of depreciation $[E_T(\Delta s^j)]$ of currencies in portfolio j is expected to be equivalent to the average forward discount on those currencies $[E_T(f^j - s^j)]$ as shown in the second panel.

However, as reported in table 5-2, currencies in the first portfolio are traded at an average forward discount of approximately -7.10 basis points as shown in the second panel, while the appreciation on average is at 10.18 basis points as reported in the first panel. These apparently combine to a log currency excess return of -17.28 basis points on average with the Sharpe ratio of -0.3139 as shown in the third panel. Similarly for the last portfolio, the currencies in the last portfolio are traded at an average discount of 2.33 basis points but the depreciation is at 2.07 basis points on average. Therefore, they are totalled up to around 4.40 basis points on average with the Sharpe ratio of 0.1980 for a log currency excess return. It is indicated correspondingly for other portfolios in the table.

Considering the fourth panel in table 5-2, the average log currency excess returns net of transaction, which takes into account the bid-ask spreads costs are reported. The average return on the first portfolio goes up to -324.69 basis points with the Sharpe ratio of -15.1556 and the average return on the fourth portfolio to -16.78 basis points with the Sharpe ratio of -11.8517.

Portfolio	1	2	3	4
Spot Change: (Δs^j)				
Mean	0.1018	0.0116	0.0266	-0.0207
Std	0.5498	0.1138	0.1408	0.2208
Forward Discount: $(f^j - s^j)$				
Mean	-0.0710	-0.0229	-0.0127	0.0233
Std	0.0167	0.0072	0.0078	0.0078
Excess Return (without b-a): $(rx^j = -\Delta s^j + f^j - s^j)$				
Mean	-0.1728	-0.0345	-0.0393	0.0439
Std	0.5502	0.1148	0.1411	0.2218
SR	-0.3139	-0.3003	-0.2787	0.1980
Net Excess Return (with b-a): (rx^j_{net})				
Mean	-3.2469	-0.0248	-0.1055	-0.1678
Std	0.2142	0.0022	0.0093	0.0142
SR	-15.1556	-11.0526	-11.3582	-11.8517
High-Minus-Low (without b-a): $(rx^j - rx^1)$				
Mean		0.1382	0.1334	0.2166
Std		0.5414	0.4809	0.6858
SR		0.2553	0.2773	0.3158
High-Minus-Low (with b-a): $(rx^j_{net} - rx^1_{net})$				
Mean		3.2221	3.1414	3.0791
Std		0.2136	0.2125	0.2184
SR		15.0867	14.7823	14.0984
Real Interest Rate Differential: $(r^j - r)$				
Mean		-0.5114	0.8763	0.0252
Std		1.2627	1.1569	1.4528

Table 5-2: Using all countries in the sample, this table shows the results on the average change in log spot exchange rates (Δs^j), the average log forward discount $(f^j - s^j)$, the average log excess return without bid-ask spreads (rx^j), the average log net excess return with bid-ask spreads (rx^j_{net}), the average return on the high-minus-low strategy without bid-ask spreads $(rx^j - rx^1)$, the average return on the high-minus-low strategy with bid-ask spreads $(rx^j_{net} - rx^1_{net})$, and the real interest rate differential $(r^j - r)$ for each portfolio j. All estimates are annualized and reported in percentage. Sharpe ratios are also reported for excess returns. The portfolios are sorted into 4 groups. The ranking is based on the forward discount rates. The first portfolio consists of currencies with the lowest forward discount rates while the last portfolio contains those currencies with the highest rates. Data cover the period of January 1976 to December 2010.

In addition, returns on zero-cost strategies that go long in the high interest rate portfolio and short in the low interest rate portfolio without and with bid-ask spreads are reported in the fifth and sixth panels respectively. The spread between the net returns on the first and the fourth portfolio is at only 21.66 basis points with the Sharpe ratio of 31.58 and at 307.91 basis points carrying out the Sharpe ratio of 14.0984 after taking into account bid-ask spread. It is shown in the last panel that portfolios with higher forward discounts incline to contain higher real interest rates in overall by considering the first portfolio and the last portfolio though the fluctuation occurs.

Considering results on the developed countries in the data sample, table 5-3 reports similar to those in table 5-2. The second panel of table 5-3 shows that currencies in the first portfolio are traded at an average forward discount of approximately -5.41 basis points in the second panel and the appreciation on average is at 12.99 basis points as reported in the first panel. Obviously, those sum up to a log currency excess return of roughly -18.40 basis points on average with the Sharpe ratio of -0.3390 as shown in the third panel. Comparable results take place in the last portfolio, the currencies are traded at an average discount of 1.64 basis points and they depreciate at 0.82 basis points on average. Consequently, they are combined to approximately 2.46 basis points on average with the Sharpe ratio of 0.1553 for a log currency excess return. It is indicated correspondingly for other portfolios in the table.

The average log currency excess returns net of transaction, which takes into account the bid-ask spreads cost are reported in the fourth panel in table 5-2. The average return on the first portfolio goes up to -274.54 basis points with the Sharpe ratio of -14.1010 and the average return on the fourth portfolio to -14.11 basis points with the Sharpe ratio of -11.9501. Furthermore, returns on zero-cost strategies, which go long in the high interest rate portfolio and short in the low interest rate portfolio without and with bid-ask spreads are reported in the fifth and sixth panels respectively. The spread between the net returns on the first and the fourth portfolio is at only 20.86 basis points with the Sharpe ratio of 0.3493 and at 260.43 basis points with the Sharpe ratio of 13.2820 after taking into account bid-ask spread. It is noticeably reported in the last panel that portfolios with higher forward discounts incline to contain higher real interest rates.

Portfolio	1	2	3
Spot Change: (Δs^j)			
Mean	0.1299	0.0105	-0.0082
Std	0.5429	0.1220	0.1580
Forward Discount: $(f^j - s^j)$			
Mean	-0.0541	-0.0171	0.0164
Std	0.0149	0.0080	0.0069
Excess Return (without b-a): $(rx^j = -\Delta s^j + f^j - s^j)$			
Mean	-0.1840	-0.0277	0.0246
Std	0.5425	0.1229	0.1590
SR	-0.3390	-0.2250	0.1553
Net Excess Return (with b-a): (rx_{net}^j)			
Mean	-2.7454	-0.0953	-0.1411
Std	0.1947	0.0090	0.0118
SR	-14.1010	-10.5678	-11.9501
High-Minus-Low (without b-a): $(rx^j - rx^1)$			
Mean		0.1563	0.2086
Std		0.4853	0.5971
SR		0.3220	0.3493
High-Minus-Low (with b-a): $(rx_{net}^j - rx_{net}^1)$			
Mean		2.6501	2.6043
Std		0.1041	0.1961
SR		13.6502	13.2820
Real Interest Rate Differential: $(r^j - r)$			
Mean	-0.1840	0.0513	0.1327
Std	1.5589	1.1952	1.3544

Table 5-3: Considering developed countries covering from January 1976 to December 2010, the table shows the average change in log spot exchange rates (Δs^j), the average log forward discount $(f^j - s^j)$, the average log excess return without bid-ask spreads (rx^j), the average log net excess return with bid-ask spreads (rx^j_{net}), the average return on the high-minus-low strategy without and with bid-ask spreads $(rx^j - rx^1)$, $(rx^j_{net} - rx^1_{net})$, and the real interest rate differential $(r^j - r)$ for each portfolio j . All estimates are annualized and reported in percentage. Sharpe ratios are also reported for excess returns. The portfolios are sorted into 3 groups based on the forward discount rates. The lowest forward discount currencies are in the first portfolio while the highest ones are contained in the last portfolio.

5.4.3 Average vs. Currency Interest Rate Difference

The question in this section is whether the investors are compensated for investing in high interest rate currencies or for investing in currencies with currently high interest rates. By sorting currencies on the basis of average forward discounts in the first half of the sample and on the realized excess returns in the second part of the sample, this investment strategy is investigated.

Table 5-4 reports the results from four portfolios, which are constructed by sorting on the basis of average one-month-forward discounts on the first half of the sample shown in the top panel and by sorting on the current one-month-forward discount on the second half of the sample shown in the bottom panel. This different sorting strategy monotonically gives similar results in excess returns that those currencies with higher average interest rates incline to produce higher average returns.

In the top panel of table 5-4, before taking into account the bid-ask spreads, the unconditional carry trade premium is earned at 18.69% while a decline of 10.24% on conditional carry trade premium occurs instead. After taking into account the bid-ask spreads, the numbers change to 270.31% and a decline of 28.94% respectively. Therefore, the conditional carry trade premium explains approximately 54.79% of the total carry trade premium before transaction costs and 10.71% of the total carry trade premium after transaction costs. Surprisingly, the strategy constructed by sorting currencies based on current interest rates performs much less Sharpe ratios than those results gained from the unconditional strategy. A Sharpe ratio of the unconditional strategy is at 1.9643 whereas that of the conditional strategy is at -1.9422. Hence, it can be indicated that the compensation for unconditional carry trade strategy contains much higher risk.

Portfolio	1	2	3	4
Sorts on Mean Forward Discounts (Half Sample)				
Excess Return (without b-a): $(rx^j = -\Delta s^j + f^j - s^j)$				
Mean	-0.1463	-0.0434	-0.0162	0.0406
Std	0.3931	0.1375	0.0891	0.2276
SR	-0.1074	-0.0912	-0.0524	0.0515
Net Excess Return (with b-a): (rx^j_{net})				
Mean	-2.9222	-0.0181	-0.0673	-0.2191
Std	0.3942	0.0015	0.0052	0.0107
SR	-2.1400	-3.4661	-3.7284	-5.9265
High-Minus-Low (with b-a): $(rx^j_{net} - rx^1_{net})$				
Mean		2.9041	2.8549	2.7031
Std		0.3933	0.3914	0.3972
SR		2.1316	2.1056	1.9643
Real Interest Rate Differential: $(r^j - r)$				
Mean	-1.7329	-0.1546	1.4331	0.4544
Std	1.7162	1.5439	1.1147	1.8578
Sorts on Current Forward Discounts (Half Sample)				
Excess Return (without b-a): $(rx^j = -\Delta s^j + f^j - s^j)$				
Mean	-0.0210	-0.0037	-0.1480	-0.1234
Std	0.1046	0.0993	0.4608	0.3527
SR	-0.0579	-0.0108	-0.0927	-0.1010
Net Excess Return (with b-a): (rx^j_{net})				
Mean	-0.2428	-0.0370	-2.8183	-0.5322
Std	0.0136	0.0019	0.1464	0.0435
SR	-5.1657	-5.7474	-5.5571	-3.5326
High-Minus-Low (with b-a): $(rx^j_{net} - rx^1_{net})$				
Mean		0.2058	-2.5755	-0.2894
Std		0.0127	0.1489	0.0430
SR		4.6666	-4.9940	-1.9422
Real Interest Rate Differential: $(r^j - r)$				
Mean	-0.1587	-0.4694	0.4864	0.1417
Std	1.3266	0.8632	0.7893	1.1262

Table 5-4: By using the data on all countries in the sample, the table reports the average log excess return without bid-ask spreads (rx^j), the average log net excess return with bid-ask spreads (rx^j_{net}), and the real interest rate differential $(r^j - r)$ for each portfolio j. All estimates are annualized and reported in percentage. Sharpe ratios are also reported for excess returns. The portfolios are sorted into 4 groups. The ranking is based on the forward discount rates. The first portfolio consists of currencies with the lowest forward discount rates while the last portfolio contains those currencies with the highest rates. In the top panel, the portfolios are sorted by the average one-month- forward discount (nominal interest rate differential) over the first half of the sample (01/1976-06/1993) while in the bottom panel, the portfolios are constructed by sorting the currencies on the basis of current one-month-forward discounts on the second half of the sample (07/1993-01/2011).

The unconditional strategy on sorting currencies appears to deliver essentially variation in average real interest rates across currencies as reported in the top panel of table 5-4 that currencies in the first portfolio enclose -173.29 basis points and 45.44 basis points in the last portfolio.

With the consideration on developed countries in the sample, the results from four portfolios, sorted on the basis of average one-month-forward discounts on the first half of the sample shown in the top panel and by sorting on the current one-month-forward discount on the second half of the sample shown in the bottom panel in table 5-5. This sorting strategy performs slightly different results in excess returns because currencies with higher average interest rates tend to produce lower average returns in the second of the sample; however, similar results with the previous carry trade strategy are reported in the first half.

In the top panel of table 5-5, before transaction costs, the unconditional carry trade premium is earned at 21.79% while a decrease of 7.32% on conditional carry trade premium occurs instead. After taking into account the bid-ask spreads, the numbers adjust to 270.60% and a decline of 51.85% respectively. Consequently, the conditional carry trade premium explicates about 33.59% of the total carry trade premium before transaction costs and 19.16% of the total carry trade premium after transaction costs. Similar to the results on using the data on all countries in the sample in table 5-4, the strategy constructed by sorting currencies based on current interest rates presents less Sharpe ratios than those results gained from the unconditional strategy. A Sharpe ratio of the unconditional strategy is at 6.8816 whereas that of the conditional strategy is at -2.8900. It is apparently presented in the table that the risk on compensating for unconditional carry trade strategy contains much higher risk, which is comparable to the results on all countries in the sample.

The results from the unconditional strategy on sorting currencies show the variation in average real interest rates across currencies. It is reported in the top panel of table 5 that currencies in the first portfolio deliver average real interest rate differentials of -76.07 basis points and of 47.62 basis points in the last portfolio.

Portfolio	1	2	3
Sorts on Mean Forward Discounts (Unconditional) (Half Sample)			
Excess Return (without b-a): $(rx^j = -\Delta s^j + f^j - s^j)$			
Mean	-0.1819	-0.0183	0.0360
Std	0.4724	0.1090	0.1983
SR	-0.1112	-0.0484	0.0524
Net Excess Return (with b-a): (rx_{net}^j)			
Mean	-2.8897	-0.0553	-0.1837
Std	0.3909	0.0041	0.0089
SR	-2.1342	-3.9076	-5.9575
High-Minus-Low (with b-a): $(rx_{net}^j - rx_{net}^1)$			
Mean		2.8344	2.7060
Std		0.3885	0.3932
SR		7.2958	6.8816
Real Interest Rate Differential: $(r^j - r)$			
Mean	-0.7607	0.2845	0.4762
Std	1.6319	0.8850	1.7807
Sorts on Current Forward Discounts (Conditional) (Half Sample)			
Excess Return (without b-a): $(rx^j = -\Delta s^j + f^j - s^j)$			
Mean	-0.0085	-0.1004	-0.0817
Std	0.0728	0.3091	0.3003
SR	-0.0336	-0.0937	-0.0786
Net Excess Return (with b-a): (rx_{net}^j)			
Mean	-0.1918	-2.0505	-0.7103
Std	0.0111	0.1211	0.0503
SR	-4.9961	-4.8861	-4.0785
High-Minus-Low (with b-a): $(rx_{net}^j - rx_{net}^1)$			
Mean		-1.8587	-0.5185
Std		0.1224	0.0516
SR		-4.3841	-2.8900
Real Interest Rate Differential: $(r^j - r)$			
Mean	0.4506	0.9217	-1.3723
Std	0.7166	0.8471	0.9291

Table 5-5: Considering on the data of developed countries, the table reports the average log excess return without bid-ask spreads (rx^j), the average log net excess return with bid-ask spreads (rx^j_{net}), and the real interest rate differential $(r^j - r)$ for each portfolio j. All estimates are annualized and reported in percentage. Sharpe ratios are also reported for excess returns. The portfolios are sorted into 3 groups. The ranking is based on the forward discount rates. The first portfolio consists of currencies with the lowest forward discount rates while the last portfolio contains those currencies with the highest rates. In the top panel, the portfolios are sorted by the average one-month- forward discount (nominal interest rate differential) over the first half of the sample (01/1976-06/1993) while in the bottom panel, the portfolios are constructed by sorting the currencies on the basis of current one-month-forward discounts on the second half of the sample (07/1993-01/2011).

5.5 Common Factor in Currency Returns

This section displays that the relationship between the considerable currency excess returns estimated in the previous section and co-variances with risk factors.

The main methodology used in this study is the principal component analysis model, which is a result of the assumption that this approach predicts that average returns on a cross-section of assets can be attributed to risk premiums associated with their exposure to a small number of risk factors (Lustig, Roussanov and Verdelhan, 2011). Regarding the arbitrage pricing theory (APT) by Ross (1976), the risk factors can describe common variation in individual asset returns.

According to the principal component analysis of the currency portfolios, the results concentrating on two groups of data; all countries and developed countries in the sample, are reported in table 5-6 including both the loadings of the currency portfolios on each of the principal components and the fraction, in percentage, of the total variance of portfolio returns inclining each principal component. Considering all countries in the sample in panel I, two factors interpret over 81% of the variation in returns on four currency portfolios while the results on developed countries are reported in panel II that two factors explain approximately 89% of the variation in returns on three currency portfolios, which is higher than that of the previous panel.

Considering each component on both panels; the samples of all countries and developed countries, the first component defines approximately 47% of the common variation in portfolio returns, and is expressed as a level factor because of the reason that most portfolios load equivalently on it compared to others. The second principal component is clarified as a slope factor.

Panel I: All Countries				
Portfolio	1	2	3	4
1	0.6359	-0.2153	0.1056	0.7336
2	0.3324	0.6600	-0.6738	0.0026
3	0.6157	0.2274	0.5244	-0.5425
4	-0.3257	0.6829	0.5099	0.4094
% Var.	47.82	34.12	10.70	7.37
Panel II: Developed Countries				
Portfolio	1	2	3	
1	0.7148	-0.2383	0.6575	
2	0.6977	0.3070	-0.6472	
3	-0.0476	0.9214	0.3857	
% Var.	51.84	37.21	10.96	

Table 5-6: The table displays the principal component coefficients of the currency portfolios as shown in table 5-1 and 5-2 using all countries in the sample and the data on the developed countries respectively. The share of the total variance explained by each common factor is reported in percentage in the last row of each panel on all countries and developed countries. Data cover the period of January 1976 to December 2010.

Panel I: All Countries				
Portfolio	1	2	3	4
1	1.0000			
2	0.1804	1.0000		
3	0.5885	0.4447	1.0000	
4	-0.4853	0.2614	-0.1227	1.0000
Panel II: Developed Countries				
Portfolio	1	2	3	
1	1.0000			
2	0.5540	1.0000		
3	-0.2146	0.1820	1.0000	

Table 5-7: The table reports the correlations on each portfolio both for the data on all countries and the developed countries as shown in panel I and II respectively. Data cover the period of January 1976 to December 2010.

5.6 Conclusions

According to the study by Lustig, Roussanov and Verdelhan (2011), which shows that the large co-movement among exchange rates of different currencies can explain a risk-based view of exchange rate determination. The investigation on identifying a slope factor in exchange rate changes, which is the key estimation, is taken place. The main assumption of their study is that the exchange rates of high interest rate currencies load positively on this slope factor while there is the negative loading of low interest rate currencies on the factor.

The study starts by constructing monthly portfolios of currencies, which are sorted on the basis of their forward discounts. The lowest interest rate currencies are contained in the first portfolio and the highest interest rate currencies are in the last. The study also states two most important components of the currency portfolio returns, which give a considerable explanation for the time-series variation in currency returns.

Using the data on all countries and developed countries in the sample respectively, the result shows a general summary of the five currency portfolios from the perspective of a US investor containing the information on the average change in log spot exchange rates (Δs^j), the average log forward discounts $(f^j - s^j)$, the average log excess return without bid-ask spreads (rx^j), the average log net excess return with bid-ask spreads (rx^j_{net}), the average return on the high-minus-low strategy without bid-ask spreads $(rx^j - rx^1)$, the average return on the high-minus-low strategy with bid-ask spreads $(rx^j_{net} - rx^1_{net})$, and the real interest rate differential $(r^j - r)$. The results performs that portfolios with higher forward discounts incline to contain higher real interest rates in overall by considering the first portfolio and the last portfolio though the fluctuation occurs.

Another question in this study is whether the investors are compensated for investing in high interest rate currencies or for investing in currencies with currently high interest rates. By sorting currencies on the basis of average forward discounts in the first half of the sample and on the realized excess returns in the second part of the sample, this investment strategy is investigated.

Surprisingly, the strategy constructed by sorting currencies based on current interest rates performs much less Sharpe ratios than those results gained from the unconditional strategy. Therefore, it can be indicated that the compensation for unconditional carry trade strategy contains much higher risk.

With the consideration on developed countries in the sample, the results from four portfolios, sorted on the basis of average one-month-forward discounts on the first half of the sample shown in the top panel and by sorting on the current one-month-forward discount on the second half of the sample shown in the bottom panel in table 5-5. This sorting strategy performs slightly different results in excess returns because currencies with higher average interest rates tend to produce lower average returns in the second of the sample; however, similar results with the previous carry trade strategy are reported in the first half.

The results from the unconditional strategy on sorting currencies show the variation in average real interest rates across currencies. It is reported in the top panel of table 5 that currencies in the first portfolio deliver average real interest rate differentials of -76.07 basis points and of 47.62 basis points in the last portfolio.

Moreover, according to the principal component analysis of the currency portfolios, the results concentrating on two groups of data; all countries and developed countries in the sample. Considering all countries in the sample in panel I, two factors interpret over 81% of the variation in returns on four currency portfolios while the results on developed countries are reported in panel II that two factors explain approximately 89% of the variation in returns on three currency portfolios, which is higher than that of the previous panel.

Chapter 6
Conclusion

As initially stated, this research concentrates on a closer investigation on some important issues in the area of some important econometric models in foreign exchange market. This includes exchange rate pass-through into import prices, liquidity risk and expected returns in the currency market, and the common risk factors in currency markets.

First, exchange rate pass-through (ERPT) is considered to be on of the significant issues in the field of financial economics, since the price of all traded products can respond to its movement. Some studies concentrated on emerging market economies such as Byrne, Chavali and Kontonikas (2010) who explored the nature of ERPT on import prices with models containing import prices, nominal effective exchange rates, foreign marginal cost measures, domestic demand measures and the locally available import substitute goods price index as variables. Barhoumi (2005) looked at the ERPT equation of developing countries, taking into account the multi-country framework, panel unit root tests, non-stationary panel estimation methods and panel cointegration tests.

According to previous literature, ERPT can be considered by three types of panel data of emerging countries, developed countries and combined countries to investigate and compare the different natures in the short and long-term of each economy. The sample data were collected annually covering the period 1970 – 2009. This study analysed a model consisting of four variables; the import price index or the import unit value in the domestic currency as a measure for the import prices (P_t), the nominal effective exchange rate (E_t) index, the producer price index or the wholesale price index, which is replaced as a proxy for the foreign marginal costs (M_t) and the domestic mark-up factor (G_t) depending on the domestic demand condition of the Gross Domestic Product (GDP) as a proxy (Barhoumi, 2005). All variables were later transformed by the natural logarithm. However, there was a limitation on the data availability, therefore a combination of different sources was obtained to ensure the appropriate coverage.

Initially, the unit root test identifying whether the panel data were stationary of the individual variables in each panel was taken into account. In general, the results showed that the panel regressions did not suffer from a spurious regression problem and could be continued to the estimation of the degree of ERPT.

The study was followed by the pooled mean group estimation (PMGE). The advantage of this approach allows the short-term coefficients and error variance to differ across cross-sections, while constraining long-term coefficients as homogeneous across countries. In the short-term, the estimation of the three panel groups indicated negative error correction coefficients in all groups, denoting that the import prices will decrease and there was a slow rate adjustment of the import prices at approximately 9.18, 1.62 and 3.06% respectively, significant at the 5% significance level. The exchange rate had a positive effect on import prices in both emerging and developed countries in both the short and long-term, but was insignificant on the emerging panel in the long-term. Thus, there was not sufficient evidence to explicitly indicate whether a depreciation in the domestic currency (a rise in the exchange rate) would lead to a higher import price for the importing country. However, for the developed countries the results showed a positive significant effect on import prices. Therefore, higher import prices would be a consequence of domestic currency depreciation and a rise in the exchange rate. In contrast, the results on the combined country panel expressed that the exchange rate performed a negative and significant effect on import prices, indicating that a domestic currency appreciation was associated with a rise in import prices. Nonetheless, the results generally noted that import prices reacted positively, but incompletely to the exchange rate. Further investigation of other appropriate approaches to the degree of ERPT is required for more accurate results and comparisons.

Secondly, the following study investigated the dimension relating to exchange rate changes associated with order flows. Pastor and Stambaugh (2003) studied liquidity risk and expected stock returns in the US stock market. They investigated whether the expected foreign exchange return was related to the sensitivity of its returns to the innovation in the aggregate liquidity, denoted by the liquidity beta, is also captured.

The unique dataset used in the study consisted of a set of order flows including nine currencies, weekly nominal exchange rates and a set of macroeconomic and financial variables covering the period from November 2, 2001 to November 11, 2007. The order flow data was aggregated across currency pairs at a weekly frequency, and divided into four classifications of customer order flows; real money (asset managers), leverage (hedge funds), corporate and private clients.

The results of the average market-wide liquidity for 15 time blocks showed that the positive coefficients exceeded the negative ones in the disaggregate data, whereas negative coefficients were mainly found in the aggregate data. Furthermore, the average of the liquidity measures over all the time blocks for each type of data performed a negative movement as primarily expected, implying that the larger the expected reversal for a volume, the lower the value of liquidity. However, an exception was the leverage (hedge fund) disaggregate data which performed a positive movement.

Moreover, the study also explored whether there was a relationship between the expected foreign exchange returns and the sensitivity of the returns to innovation in the liquidity, denoted as the liquidity beta. Three portfolios were constructed based on the ranking of the sensitivities of foreign exchange returns to the liquidity risk. The portfolios were estimated by two significance measures proposed by Pastor and Stambaugh (2003) and Acharya and Pedersen (2005). The first portfolio contained currencies with the least sensitivity while the third portfolio held currencies with the most sensitivity. It was found that the liquidity betas estimated in post-ranking portfolios increased from portfolio 1 to portfolio 3 in all datasets as expected by the Pastor-Stambaugh measure, excluding those of corporations. It was also noticeable that overall liquidity beta values calculated by the Acharya-Pedersen method exceeded those of the Pastor-Stambaugh measure. These results may be explained because the Acharya-Pedersen measure takes into account additional attention on the liquidity risk with an adjustment on the Capital Asset Pricing Model (CAPM). Additionally, the measure considers the covariance of individual asset liquidity and market liquidity, and the covariance of individual asset liquidity and the market return in the estimation, which is a further feature extending from the Pastor-Stambaugh measure.

Another imperative assumption following the study of Banti, Phylaktis and Sarno (2012) is that portfolios with more sensitive currencies tend to perform well in good liquidity states and contain the most depreciation and vice versa, which implies that portfolios with high sensitivity to liquidity risk are inclined to have higher excess return than those with low sensitivity. The evidence was perceptibly supported by the Acharya-Pedersen results except for those on real money (asset manager) data. On the contrary, for the Pastor-Stambaugh measure, real money (asset manager), one of the disaggregate data, reported a reverse movement showing the higher sensitivity to liquidity risk for less exchange rate return carried out. Results on aggregate data and private clients cannot be obviously concluded due to its fluctuation of the consequences. One essential reason was the limitation of the dataset. Therefore, future research should use a broader dataset to obtain more accurate results for the Pastor-Stambaugh measure. Additionally, other financial markets can be considered for systematic liquidity risk pricing, such as fixed income markets or international equity markets. This was also suggested by Pastor and Stambaugh (2003).

Lastly, the third study in this research inspected on the findings by Lustig, Roussanov and Verdelhan (2011) in their research. It was shown that the large co-movements among the exchange rates of different currencies can explain a risk-based view of exchange rate determination and identified a slope factor in exchange rate changes as the key estimation. Their main assumption was that exchange rates of high interest rate currencies load positively on this slope factor, with the negative loading of low interest rate currencies. They constructed monthly portfolios of currencies, sorted on the basis of their forward discounts. The lowest interest rate currencies were in the first portfolio with the highest interest rate currencies in the last. They also stated two most important components of currency portfolio returns which can explain time-series variation in currency returns.

Using data from all countries and developed countries in the sample respectively, their results showed a general summary of five currency portfolios from the perspective of a US investor, containing information on the average change in log spot exchange rates (Δs^j), the average log forward discounts $(f^j - s^j)$, the average log excess return without bid-ask spreads (rx^j), the average log net excess return with bid-ask spreads (rx^j_{net}), the average return on the high-minus-low strategy without bid-ask spreads $(rx^j - rx^1)$, the average return on the high-minus-low strategy with bid-ask spreads $(rx^j_{net} - rx^1_{net})$ and the real interest rate differential $(r^j - r)$. The results indicated that portfolios with higher forward discounts were inclined to contain higher overall real interest rates considering the currency fluctuations.

Another question was whether the investors were compensated for investing in high interest rate currencies or for investing in currencies with currently high interest rates. By sorting currencies on the basis of average forward discounts in the first half of the sample and on the realised excess returns in the second part, this investment strategy was investigated.

Surprisingly, the strategy constructed by sorting currencies based on current interest rates gave reduced Sharpe ratios than the results from the unconditional strategy. Therefore, it was deduced that the compensation for unconditional carry trade strategy contained much higher risk.

For developed countries, the results from the four portfolios were sorted on the basis of average one-month-forward discounts on the first half of the sample shown in the top panel and on the current one-month-forward discount on the second half of the sample shown in the bottom panel of Table 5-5. This sorting strategy gave slightly different results in excess returns because currencies with higher average interest rates tended to produce lower average returns in the second half of the sample. However, similar results with the previous carry trade strategy were reported in the first half.

The results from the unconditional strategy on sorting currencies showed variation in average real interest rates across currencies. The top panel of Table 5 showed that currencies in the first portfolio delivered average real interest rate differentials of -76.07 basis points with 47.62 basis points in the last portfolio. Moreover, according to the principal component analysis of the currency portfolios, the results concentrated on only two groups of data; all countries and developed countries. Considering all countries in the sample in panel I, two factors interpreted over 81% of the variation in returns on four currency portfolios while the results on developed countries, reported in panel II showed that two factors explained 89% of the variation in returns on three currency portfolios, higher than that of the previous panel.

Appendice

Chapter 3
Exchange Rate Pass-Through into Import Prices

Appendix 3-A: Derivation

Foreign firm profits are

$$\pi_t^f = E_t^{-1} P_t Q_t - C_t(Q_t, W_t) \qquad \text{... (a)}$$

To maximise the equation with respect to the import price, the first order condition can be reached by taking the partial derivative.

$$\frac{\partial \pi_t^f}{\partial P_t} = E_t^{-1} Q_t + E_t^{-1} P_t \left(\frac{\partial Q_t}{\partial P_t} \right) - \left(\frac{\partial C_t(Q_t, W_t)}{\partial Q_t} \right) \left(\frac{\partial Q_t}{\partial P_t} \right) = 0 \qquad \text{... (b)}$$

By multiplying and dividing the first term of equation (b) with $\left(\frac{\partial Q_t}{\partial P_t} \right) P_t$, we have

$$\frac{E_t^{-1} Q_t P_t}{P_t} \left(\frac{\partial Q_t}{\partial P_t} \right) \left(\frac{\partial P_t}{\partial Q_t} \right) + E_t^{-1} P_t \left(\frac{\partial Q_t}{\partial P_t} \right) - \left(\frac{\partial C_t(Q_t, W_t)}{\partial Q_t} \right) \left(\frac{\partial Q_t}{\partial P_t} \right) = 0 \qquad \text{... (c)}$$

Then, we factor out the common term, which is $\left(\frac{\partial Q_t}{\partial P_t}\right)$.

$$\left(\frac{\partial Q_t}{\partial P_t}\right)\left[E_t^{-1}P_t\left(\frac{Q_t}{P_t}\left(\frac{\partial P_t}{\partial Q_t}\right)\right)+E_t^{-1}P_t-\left(\frac{\partial C_t(Q_t,W_t)}{\partial Q_t}\right)\right]=0 \qquad \text{... (d)}$$

Since $\left(\frac{\partial C_t(Q_t,W_t)}{\partial Q_t}\right)$ is the inverse term of the elasticity of the output (Q_t) with respect to the import price (P_t) and $\eta_t=-\left[\frac{P_t}{Q_t}\left(\frac{\partial Q_t}{\partial P_t}\right)\right]$, the inverse of the elasticity can be indicated as $\left(-\frac{1}{\eta_t}\right)$.

$$\left(\frac{\partial Q_t}{\partial P_t}\right)\left[-\frac{E_t^{-1}P_t}{\eta_t}+E_t^{-1}P_t-\left(\frac{\partial C_t(Q_t,W_t)}{\partial Q_t}\right)\right]=0 \qquad \text{... (e)}$$

Factoring out again the common term $(E_t^{-1}P_t)$ in equation (e) gives

$$\left(\frac{\partial Q_t}{\partial P_t}\right)\left[E_t^{-1}P_t\left(1-\frac{1}{\eta_t}\right)+E_t^{-1}P_t-\left(\frac{\partial C_t(Q_t,W_t)}{\partial Q_t}\right)\right]=0 \qquad \text{... (f)}$$

Because $\left(G_t = \dfrac{\eta_t}{(\eta_t - 1)}\right)$, which is the mark-up factor in the domestic country over the marginal cost, therefore

$$\left(\frac{\partial Q_t}{\partial P_t}\right)\left[\frac{E_t^{-1}P_t}{G_t} - \left(\frac{\partial C_t(Q_t,W_t)}{\partial Q_t}\right)\right] = 0 \qquad \text{... (f)}$$

$$\frac{E_t^{-1}P_t}{G_t} - \left(\frac{\partial C_t(Q_t,W_t)}{\partial Q_t}\right) = 0 \qquad \text{... (g)}$$

$$P_t = E_t G_t \left(\frac{\partial C_t(Q_t,W_t)}{\partial Q_t}\right) \qquad \text{... (h)}$$

Where: $\dfrac{\partial C_t(Q_t,W_t)}{\partial Q_t}$ expresses the marginal cost (M_t)

Eventually, we get $P_t = E_t M_t G_t$ that is equation (3) in the main text.

Appendix 3-B: Data and Tables

Table 3-B1: Descriptive statistics of logarithm values in import prices (p_t), nominal effective exchange rates (e_t), foreign marginal costs (m_t) and domestic mark-up factors (g_t) for emerging countries

Country	Obs	log Import Prices		log Nominal Effective Exchange Rate		log Foreign Marginal Costs		log Domestic Mark-Up Factors	
		Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.
Brazil	40	3.750510	0.867708	-4.673867	11.12611	-9.215756	12.45677	3.938813	1.878652
Colombia	40	5.002552	0.496308	6.669302	1.791550	2.237190	2.082482	2.802828	0.594633
India	40	4.394421	0.352940	3.661705	0.836372	3.574690	0.846806	1.916471	0.639448
Jordan	40	4.135453	0.412854	4.152638	0.476970	3.672354	1.486846	1.033429	1.022083
Morocco	40	4.092916	1.011658	4.816243	0.342644	3.852000	0.918407	1.301663	0.983627
Pakistan	40	3.912158	0.808292	3.548592	0.912568	3.356455	1.037578	2.152811	0.557736
Thailand	40	4.025324	0.604434	4.108106	0.353336	3.925493	0.576499	1.400420	0.750530

Note: There are only 39 observations on the mark-up factors for Jordan.

Table 3-B2: Descriptive statistics of logarithm values in import prices (p_t), nominal effective exchange rates (e_t), foreign marginal costs (m_t) and domestic mark-up factors (g_t) for developed countries

Country	Obs	log Import Prices		log Nominal Effective Exchange Rate		log Foreign Marginal Costs		log Domestic Mark-Up Factors	
		Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.
Australia	40	4.251911	0.480537	4.714629	0.270192	4.006585	0.636789	1.449240	0.940073
Canada	40	4.248825	0.420195	4.598576	0.134739	4.152240	0.494190	1.273308	0.758595
Denmark	40	4.181706	0.447396	4.514757	0.188056	4.183636	0.478776	1.329617	0.891204
Finland	40	4.206032	0.438796	4.686758	0.092925	4.193650	0.511965	1.319570	1.006530
Germany	40	4.307901	0.428030	4.394683	0.270575	4.344436	0.262420	0.742915	0.994695
Greece	40	4.028381	0.551275	5.440661	0.853206	3.095963	1.527836	2.210070	0.900764
Hungary	40	4.218955	0.367071	5.450408	0.734231	3.186366	1.090520	1.853816	0.925348
Ireland	40	4.240806	0.453663	4.688866	0.166894	4.234479	0.588777	1.651023	0.852721
Israel	40	4.223420	0.462747	7.759302	3.742908	1.094576	4.179872	2.513105	1.792556
Italy	40	4.080432	0.515927	4.905157	0.366349	3.980462	1.525236	4.432039	0.178661
Japan	40	4.217759	0.504411	4.215654	0.448838	4.597726	0.185123	0.433950	1.238558
Netherlands	40	4.345126	0.409948	4.443777	0.207141	4.275696	0.300018	1.008926	0.869688

New Zealand	40	4.247013	0.395077	4.619652	0.319756	3.875134	0.809121	1.405688	1.130014
Norway	40	4.404877	0.343460	4.594397	0.154811	3.626032	1.435349	1.547732	0.865184
Republic of Korea	40	4.364740	0.366003	5.027809	0.462827	3.954455	0.723635	1.904025	0.980763
Spain	40	4.306564	0.3722313	4.838383	0.255860	3.936841	0.738370	1.874528	0.744368
Sweden	40	4.144205	0.461606	4.765901	0.260294	4.069170	0.603156	1.359537	0.989441
United Kingdom	40	4.191208	0.496271	4.637960	0.148446	4.060784	0.632860	1.600965	0.772561
United States	40	4.231339	0.470443	4.680455	0.119450	4.151810	0.426677	1.214009	0.595537

Table 3-B3: Exchange Rate Pass-Through for all panels of data

Emerging Countries		
Short Run	Coefficients	t-values
e_t	0.068214	0.260473*
m_t	0.081325	2.604371
g_t	0.332252	0.630107*
Error Correction	(-0.091848857)	0.336434286
Long Run	Coefficients	t-values
e_t	0.010657	1.122769
m_t	-0.068107	-1.965814*
g_t	0.072953	0.072953*

Developed Countries		
Short Run	Coefficients	t-values
e_t	0.01505	-0.18421*
m_t	0.090214	1.491394*
g_t	-0.00374	-0.48413*
Error Correction	(-0.016173368)	-0.334073684
Long Run	Coefficients	t-values
e_t	0.436565	97.38482*
m_t	0.476013	126.5942*
g_t	-0.054263	-26.73641*

Note: The asterisks (*) identify significance at the 5% significance level.

Combined Countries		
Short Run	Coefficients	t-values
e_t	0.027046	-0.12189*
m_t	0.092351	2.024739
g_t	0.089279	-0.18231*
Error Correction	(-0.0305775)	-0.046470769
Long Run	Coefficients	t-values
e_t	-0.025013	-7.318604*
m_t	0.086791	9.462267*
g_t	-0.041371	-9.086164*

Note: The asterisks (*) identify significance at the 5% significance level

Chapter 4

Liquidity Risk and Expected Returns in the Currency Market

Appendix 4-A: Abbreviations for the Sample Currencies

	Abbreviation	Currency
1	CAD	Canadian Dollar
2	CHF	Swiss Frank
3	EUR	Euro
4	AUD	Australian Dollar
5	NZD	New Zealand Dollar
6	GBP	UK Pound Sterling
7	JPY	Japanese Yen
8	NOK	Norwegian Krone
9	SEK	Swedish Krone

Appendix B: Tables on the Sample Data

Table 4-B1: Descriptive Statistics of Exchange Rate Returns

	EUR	JPY	CHF	GBP	AUD	NZD	CAD	SEK	NOK
Mean	-0.0014	-0.0425	-0.0006	-0.0017	-0.0026	-0.0019	-0.0108	-0.0137	-0.0034
Median	-0.0021	-0.0050	-0.0011	-0.0019	-0.0046	-0.0030	-0.0179	-0.0224	-0.0070
Maximum	0.0317	3.8800	0.0190	0.0465	0.0692	0.0436	0.3315	0.2962	0.1137
Minimum	-0.0270	-4.9800	-0.0164	-0.0489	-0.0480	-0.0298	-0.2753	-0.3149	-0.0801
Std. Dev.	0.0106	1.5078	0.0065	0.0177	0.0198	0.0130	0.1023	0.1086	0.0265
Skewness	0.3549	-0.3878	0.2790	0.152122	0.5897	0.3337	0.4368	0.2274	0.6466
Kurtosis	2.9507	3.4238	2.9552	2.7149	3.4275	3.1215	3.3040	2.9634	4.2962
Jarque-Bera	6.6652	10.2861	4.1272	2.2891	20.7220	6.0603	11.2634	2.7421	44.1395
Probability	0.0357	0.0058	0.1270	0.3184	0.0000	0.0483	0.0036	0.2538	0.0000
Observations	316	316	316	316	316	316	316	316	316

Note: The sample period covers from November 2, 2001 to November 11, 2007 presenting exchange rate returns for nine sample currencies.

Table 4-B2: Correlation between Exchange Rate Returns

	EUR	JPY	CHF	GBP	AUD	NZD	CAD	SEK	NOK
EUR	1.0000								
JPY	0.5147	1.0000							
CHF	0.7292	0.4176	1.0000						
GBP	0.94445	0.5580	0.6978	1.0000					
AUD	0.5705	0.3162	0.4909	0.4788	1.0000				
NZD	0.4799	0.2400	0.3511	0.4016	0.5837	1.0000			
CAD	0.8164	0.4408	0.6078	0.7984	0.4911	0.4262	1.0000		
SEK	0.8550	0.4372	0.6592	0.8049	0.5401	0.4652	0.7637	1.0000	
NOK	0.5011	0.2342	0.4581	0.4168	0.795875	0.4372	0.4377	0.4680	1.0000

Note: Correlations between exchange rates are calculated in pairs among nine currencies and the sample period is from November 2, 2001 to November 11, 2007.

Table 4-B3: Descriptive Statistics of Aggregate Order Flows

	EUR	JPY	CHF	GBP	AUD	NZD	CAD	SEK	NOK
Mean	0.2776	-0.2398	-0.1291	-0.0050	-0.0007	0.0138	-0.0158	-0.0072	0.0097
Median	0.1955	-0.2127	-0.0616	0.0283	-0.0114	0.0042	-0.0130	-0.0156	0.0018
Maximum	11.2448	5.9420	2.8313	2.1229	1.7887	0.7533	1.8294	0.8787	0.6217
Minimum	-7.2396	-3.7869	-3.1992	-7.9905	-1.1982	-0.5837	-0.9653	-0.4637	-0.4451
Std. Dev.	1.4664	0.8267	0.7519	0.8083	0.3028	0.1146	0.2522	0.1460	0.1104
Skewness	0.9422	0.7963	-0.3557	-3.9550	0.8727	1.3133	0.9140	1.5832	0.8870
Kurtosis	13.9482	13.6404	5.7714	36.9453	8.9394	16.0772	12.2413	11.2783	10.0943
Jarque-Bera	1630.084	1528.923	108.1333	16046.19	506.1859	23.49.917	1172.146	1037.600	706.3242
Probability	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Observations	317	317	317	317	317	317	317	317	317

Note: The sample period covers from November 2, 2001 to November 11, 2007 presenting aggregate order flows for nine sample currencies.

Table 4-B4: Correlation Coefficients for Aggregate Order Flows

	EUR	JPY	CHF	GBP	AUD	NZD	CAD	SEK	NOK
EUR	1.0000								
JPY	-0.2200	1.0000							
CHF	-0.3148	0.1353	1.0000						
GBP	-0.3075	0.2296	0.0730	1.0000					
AUD	-0.040378	0.0095	-0.0175	-0.1717	1.0000				
NZD	-0.0717	-0.0128	-0.0128	0.0605	0.0202	1.0000			
CAD	0.1034	-0.1006	-0.0586	-0.0134	0.0461	-0.0367	1.0000		
SEK	0.0843	-0.0786	-0.1681	-0.3379	0.1669	0.0355	0.0491	1.0000	
NOK	0.0691	-0.1346	-0.1445	0.0344	0.1212	-0.0468	0.1191	0.0595	1.0000

Note: Correlations coefficients for aggregate order flows are calculated in pairs among nine currencies and the sample period is from November 2, 2001 to November 11, 2007.

Table 4-B5: Descriptive Statistics of Disaggregate Order Flows: Real Money (Asset Manager)

	EUR	JPY	CHF	GBP	AUD	NZD	CAD	SEK	NOK
Mean	-0.045417	-0.098482	-0.060786	-0.044553	-0.004788	-0.000700	0.008042	-0.003826	0.003642
Median	-0.026793	-0.066875	-0.037681	0.007509	0.000904	0.000872	0.002796	-0.002927	0.000116
Maximum	3.618794	4.364329	1.860987	2.108414	0.822063	0.625573	1.354187	0.600551	0.531509
Minimum	-4.230491	-2.575146	-2.306571	-5.701655	-1.050019	-0.574971	-0.672363	-0.454793	-0.523706
Std. Dev.	0.949107	0.635931	0.501724	0.669147	0.200897	0.073355	0.185131	0.114209	0.081556
Skewness	0.176668	0.706592	-0.028192	-3.929819	-0.212107	0.097562	1.670004	0.457163	0.109521
Kurtosis	5.627478	12.67411	7.220151	30.76291	7.401179	32.03473	16.19112	8.552206	15.18677
Jarque-Bera	92.83463	1262.525	235.2781	10996.64	258.2273	11135.33	2445.672	418.2153	1962.301
Probability	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
Observations	317	317	317	317	317	317	317	317	317

Note: The sample period covers from November 2, 2001 to November 11, 2007 presenting disaggregate order flows on real money (asset manager) for nine sample currencies.

Table 4-B6: Correlation Coefficients for Disaggregate Order Flows: Real Money (Asset Manager)

	EUR	JPY	CHF	GBP	AUD	NZD	CAD	SEK	NOK
EUR	1.0000								
JPY	-0.14696	1.0000							
CHF	-0.31185	-0.05843	1.0000						
GBP	-0.15228	0.064773	0.038402	1.0000					
AUD	0.114632	0.007731	0.121473	-0.03881	1.0000				
NZD	-0.06743	0.064439	0.096863	0.310197	-0.10492	1.0000			
CAD	0.101099	0.09546	0.090784	-0.10653	0.143553	-0.1136	1.0000		
SEK	-0.07493	-0.0541	0.022873	-0.28762	-0.0077	-0.13919	-0.05351	1.0000	
NOK	-0.02223	0.017108	0.014321	-0.10187	0.215792	-0.10926	0.217321	-0.15612	1.0000

Note: Correlations coefficients for disaggregate order flows on real money (asset manager) are calculated in pairs among nine currencies and the sample period is from November 2, 2001 to November 11, 2007.

Table 4-B7: Descriptive Statistics of Disaggregate Order Flows: Corporate

	EUR	JPY	CHF	GBP	AUD	NZD	CAD	SEK	NOK
Mean	0.191678	-0.048475	5.01E-05	0.010492	-0.015120	0.005160	-0.025818	-0.013077	-0.004327
Median	0.155134	-0.045060	0.011588	0.003050	-3.58E-05	0.004022	-0.016934	-0.008153	2.07E-05
Maximum	2.651307	0.529257	3.749944	0.738197	0.303742	0.109597	0.272565	0.214204	0.117625
Minimum	-1.751193	-0.787649	-1.541648	-1.176955	-0.856148	-0.089207	-0.618346	-0.177451	-0.187438
Std. Dev.	0.460564	0.145959	0.421986	0.190762	0.101324	0.020233	0.076119	0.046982	0.024278
Skewness	0.751229	-0.579266	1.981805	-0.401468	-3.948526	0.398991	-1.955733	0.054362	-1.218295
Kurtosis	7.098452	5.971172	22.73535	9.526445	30.04136	11.70160	16.62938	6.637216	15.77784
Jarque-Bera	251.6807	134.3296	5351.942	571.1177	10482.11	1008.517	2655.663	174.8936	2234.985
Probability	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
Observations	317	317	317	317	317	317	317	317	317

Note: The sample period covers from November 2, 2001 to November 11, 2007 presenting disaggregate order flows on corporate for nine sample currencies.

Table 4-B8: Correlation Coefficients for Disaggregate Order Flows: Corporate

	EUR	JPY	CHF	GBP	AUD	NZD	CAD	SEK	NOK
EUR	1.0000								
JPY	-0.26979	1.0000							
CHF	-0.4866	0.067425	1.0000						
GBP	-0.07943	-0.0738	0.086261	1.0000					
AUD	-0.0216	0.069439	0.030034	0.009876	1.0000				
NZD	-0.01566	0.050717	-0.0605	-0.06072	0.077517	1.0000			
CAD	-0.08027	0.191561	-0.11024	-0.04785	0.074561	-0.01153	1.0000		
SEK	0.036909	0.023376	-0.00615	-0.02805	-0.0033	0.006148	-0.13762	1.0000	
NOK	-0.17314	0.108092	0.087024	-0.17924	-0.07259	0.027034	0.07373	-0.04369	1.0000

Note: Correlations coefficients for disaggregate order flows on corporate are calculated in pairs among nine currencies and the sample period is from November 2, 2001 to November 11, 2007.

Table 4-B9: Descriptive Statistics of Disaggregate Order Flows: Leverage (Hedge Funds)

	EUR	JPY	CHF	GBP	AUD	NZD	CAD	SEK	NOK
Mean	0.198670	-0.078341	-0.086693	0.024737	0.016108	0.007786	-0.000619	0.008181	0.007770
Median	0.182190	-0.049947	-0.043540	0.021848	-0.007582	0.000000	0.006635	0.000730	0.000473
Maximum	4.272531	2.171398	1.877200	1.389043	1.278837	0.442658	0.621769	0.388950	0.290316
Minimum	-2.762272	-2.683165	-2.392898	-2.880352	-1.076347	-0.238645	-0.733572	-0.227267	-0.254747
Std. Dev.	0.915587	0.583679	0.554840	0.398398	0.202024	0.070637	0.187284	0.080541	0.063365
Skewness	0.332715	-0.850557	-0.633909	-1.123102	0.494968	1.517560	-0.315350	1.040458	0.594374
Kurtosis	4.493454	6.432379	5.100357	12.86177	10.40274	10.81871	5.530887	7.572373	8.216697
Jarque-Bera	35.30854	193.8324	79.49912	1351.211	736.7682	929.1292	89.85857	333.3361	378.1156
Probability	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
Observations	317	317	317	317	317	317	317	317	317

Note: The sample period covers from November 2, 2001 to November 11, 2007 presenting disaggregate order flows on leverage (hedge funds) for nine sample currencies.

Table 4-B10: Correlation Coefficients for Disaggregate Order Flows: Leverage (Hedge Funds)

	EUR	JPY	CHF	GBP	AUD	NZD	CAD	SEK	NOK
EUR	1.0000								
JPY	-0.13943	1.0000							
CHF	-0.12256	0.208819	1.0000						
GBP	-0.04029	0.183268	0.101985	1.0000					
AUD	0.007037	0.140323	0.021576	-0.03121	1.0000				
NZD	0.066674	-0.15525	-0.03862	-0.13186	0.143926	1.0000			
CAD	0.025012	0.035403	-0.12261	-0.10633	0.044151	0.053199	1.0000		
SEK	0.022399	-0.179	-0.09923	-0.09975	0.025681	0.174567	-0.01329	1.0000	
NOK	0.005243	-0.0892	0.062654	0.102165	-0.05937	-0.02028	-0.05361	0.053457	1.0000

Note: Correlations coefficients for disaggregate order flows on leverage (hedge funds) are calculated in pairs among nine currencies and the sample period is from November 2, 2001 to November 11, 2007.

Table 4-B11: Descriptive Statistics of Disaggregate Order Flows: Private Client

	EUR	JPY	CHF	GBP	AUD	NZD	CAD	SEK	NOK
Mean	-0.067335	-0.014537	0.018359	0.004357	0.003058	0.001548	0.002573	0.001530	0.002638
Median	-0.043420	-0.031629	0.032329	-0.007298	0.003905	0.000202	0.000787	0.000354	-0.000310
Maximum	3.013756	1.083868	0.984524	1.487487	0.590034	0.393480	0.412460	0.235591	0.234912
Minimum	-3.337991	-0.915453	-0.770733	-0.939936	-0.361748	-0.225070	-0.234051	-0.102108	-0.103868
Std. Dev.	0.585329	0.237843	0.237301	0.240048	0.103661	0.039236	0.066001	0.024223	0.029681
Skewness	-0.138887	0.421590	-0.150685	1.120866	0.401364	2.590771	0.617644	2.602721	2.591915
Kurtosis	8.041652	5.521821	4.506989	10.67230	7.301620	38.70732	9.175156	33.96088	20.96558
Jarque-Bera	336.7519	93.39001	31.19597	843.8745	252.9172	17195.41	523.8226	13019.10	4618.083
Probability	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
Observations	317	317	317	317	317	317	317	317	317

Note: The sample period covers from November 2, 2001 to November 11, 2007 presenting disaggregate order flows on private client for nine sample currencies.

Table 4-B12: Correlation Coefficients for Disaggregate Order Flows: Private Client

	EUR	JPY	CHF	GBP	AUD	NZD	CAD	SEK	NOK
EUR	1.0000								
JPY	-0.07249	1.0000							
CHF	0.219084	0.102991	1.0000						
GBP	0.239532	0.119395	0.087132	1.0000					
AUD	0.209304	-0.00429	-0.03143	0.335654	1.0000				
NZD	-0.03082	0.081208	0.048802	0.059069	0.201163	1.0000			
CAD	0.161078	-0.04796	0.081983	0.158803	0.1123	0.119926	1.0000		
SEK	-0.24534	0.099645	-0.07735	0.198511	0.099153	0.286392	-0.09016	1.0000	
NOK	-0.16575	-0.00944	-0.15383	0.034265	0.088996	0.039366	-0.00848	0.13543	1.0000

Note: Correlations coefficients for disaggregate order flows on private client are calculated in pairs among nine currencies and the sample period is from November 2, 2001 to November 11, 2007.

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