Essays on exchange rate exposure and exchange rate pass-through

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A Thesis Submitted for the Degree of Doctor of Philosophy in Finance

Essex Business School

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December 2015

Acknowledgments

I would like to express my deepest gratitude and sincerest thanks to my supervisors, Professor Andrew Woods and Dr. Stuart Snaith, for their excellent support throughout my Ph.D. study. I am sincerely grateful to them for sharing their research experiences and mentoring throughout; their suggestions and guidance on my thesis have been priceless. Without their supervision, this thesis would not have been possible. I am certain that I am one of luckiest Ph.D. students for having supervisors who are not only very patient but also who have always devoted much of their time to guide me through this thesis. I am indebted to them and thank you for all of their help. I owe my future success to them. I would also like to thank Professor Mario Cerrato and Professor Neil Kellard for their comments and suggestions on this thesis.

I would also like to thank all my friends in the UK and Thailand who have always been a great support and encouraged me every day. Words cannot express how grateful I am to my parents for their constant support and love throughout my studies.

Last but not least, I would like to thank Srinakharinwirot University, my sponsor, for giving me a life-changing opportunity to study at the University of Essex. Thanks to you, I have been able to follow my dream in further academic study and develop my skills and knowledge.

Abstract

This thesis examines the effect of exchange rates on stock returns and domestic prices. Specifically, it comprises three essays which are two essays on exchange rate exposure and one essay on exchange rate pass-through.

In Chapter Two the first essay presents a comprehensive treatment of exchange rate exposure across a large sample of 3,015 firms from 5 ASEAN economies for the period 2002 – 2012. We adopt the OLS framework of Jorion (1990) as a benchmark model and the GMM approach of Chue and Cook (2008), with the latter having the advantage of abstracting from the effects of the wider macroeconomic environment. Estimated by the OLS method, our findings yield country specific results with regards to firm value confirming the prevailing view that the value of Asian firms decreases when their local currency depreciates. However, on application of the GMM approach the average exchange rate exposure of nonbank and bank in Indonesia and Thailand overturn the OLS results yielding positive coefficients. Also, the one-lagged exchange rate can explain exchange rate exposure in some cases; this effect is likely to be country specific. According to the different business characteristics, a bank sub-dataset indicates that the foreign exposure of Asian banks shows a greater degree of exposure than nonbank companies do.

In Chapter Three the second essay examines transaction and economic exchange rate exposure, and contributes by adopting a transformed regression method that is robust to the econometric problem of data overlapping. The transformed regression method is combined with rolling-window regression in order to examine the time variation in exchange rate exposure in four main industrialised economies during the period of 1990 – 2012. We find evidence that the firms that are significantly exposed to long-run exchange rate movements reduce by approximately seventy percent at a horizon of 5 years when estimated by the transformed

regression method. Our findings also show the effect of the recent global financial crisis on the relationship between exchange rates and firm returns.

In Chapter Four the final essay investigates the effect of inflation targeting on the rate of exchange rate pass-through (ERPT). Our ERPT model is based on new open-economy macroeconomics theory but is extended using the nonlinear and asymmetric distributed lags (NARDL) framework, which is suitable in examining asymmetric ERPT under different inflationary regimes. After an adoption of inflation targeting, our evidence reveals that the asymmetric zero pass-through is mainly captured in the long-run, particularly, in emerging countries. By contrast, symmetric zero pass-through is robust for all countries in the short-run. This suggests that asymmetries of depreciation and appreciation have no noticeable impact on consumer prices after central banks pursue inflation targeting. This phenomenon might be explained by the effectiveness of inflation targeting implementation.

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Chapter 1 Introduction

Given the widespread use of floating exchange rate regimes and the trend towards globalisation and liberalisation it is important to examine the role for currency movements affecting the evolution of firm returns and domestic prices. Gaining understanding of these relationships has clear value to both practitioners and central bankers alike in the form of currency hedging decisions and policy implementations respectively. This thesis therefore investigates the impact of exchange rate fluctuations in terms of exchange rate exposure to firm returns and exchange rate pass-through to domestic prices.

The two theories under scrutiny in this thesis are the theory of exchange rate exposure and exchange rate pass-through. The former refers to the sensitivity of firm returns to unanticipated changes in exchange rate. The latter by contrast occurs when changes in the exchange rate impacts on domestic prices such as export prices, import prices, or consumer prices (inflation). Common to both notions is that they are looking at the effect of exchange rate variations, albeit on different areas of the economy. Further, common to both is that while there is a clear theoretical link between these measures, it has proven difficult to reconcile theory with empirical evidence. The two notions used in this thesis are described more details in section 1.1 and 1.2. Section 1.3 provides a preview of this thesis.

1.1 Exchange rate exposure

Exchange rate exposure arises when exchange rate changes affect firms' profitability, cash flow, or value. Shapiro (1975), Levi (1994), and Stulz and Williamson (1996) categorise the firm's exchange rate exposure into transaction exposure, economic exposure (or operating exposure) and translation exposure (or accounting exposure). Transaction exposure refers to a specific international transactions or activities that firms have been obligated in foreign currencies. As firms cannot predict the exchange rate, firms are *exposed* to this uncertainty. However, this uncertainty can be alleviated by derivative instruments used for hedging. When the present value of firms is affected by unanticipated changes in exchange rate through their sales volume, prices or costs, this is known as an economic exposure. The economic exposure has an impact on a firm's value as well as its competitive position. Stulz and Williamson (1996) also identify the transaction exposure and economic exposure by determining exposure horizons. If firm's international obligations can be offset within a year, this is called transaction exposure. The economic exposure is known when the international obligations is longer than one year and might affect firm's cash flow in the long-run. Meanwhile, translation exposure is totally different from the first two exposures. This exposure occurs when subsidiaries which have to consolidate foreign currency financial statements with financial statements of local headquarters. In this thesis, only transaction and economic exposure are examined.

In early work investigating exchange rate exposure Alder and Dumas (1984) measure the firm's exposure by regressing the firm's returns on exchange rate variations. The beta coefficient obtained from the Alder and Dumas (1984) regression measures the total exposure. Next, Jorion (1990) extends the Alder and Dumas's framework by adding market returns where the beta coefficient obtained by the Jorion's regression is called the residual exposure as the market returns are able to control for the macroeconomic effects of changes in the exchange rate. In Jorion's model, if the exchange rate exposure equals to zero it does not imply that firm returns are not impacted by exchange rate variations but rather that the firm returns is impacted by the exchange rate variations to the same degree as the market index.

However, previous empirical research has found no or little evidence of statistically significant exchange rate exposure (see, for example, Jorion (1991), He and Ng (1998), Bodnar and Gentry (1993), Allayannis and Ofek (2001), among others) as mentioned by the theory. This situation is known as "the exchange rate exposure puzzle". The possible explanation for this puzzle are examined and explained by industry effect on exchange rate exposure, hedging decision on exchange rate exposure, and time-varying exchange rate exposure.

1.2 Exchange rate pass-through

The exchange rate pass-through relationship indicates the degree of sensitivity in domestic prices to changes in the exchange rate. The degree of exchange rate pass-through to prices ranges between zero (no pass-through) to one (complete pass-through), where values in this interval are referred to as incomplete or partial pass-through. The pass-through relationship can be analysed with respect to a variety of prices, though two of the most examined are import prices and domestic prices. In the case of the former the import price is the price observed "at the dock" and used for examining behaviour of export or import prices. In the case of the latter the domestic consumer price is broader in definition and recommends itself given the obvious links to monetary policy.

The degree to which variations in exchange rate pass-through to price plays an important role to central bank and policymakers because understanding a link between nominal exchange rate changes and price stability policy will help them effectively conduct the appropriate monetary policy and domestic inflation under circumstances of exchange rate variations. For instance, a depreciation of domestic currencies enables import input prices increase, which eventually raises domestic consumer price and inflation of importing countries; this situation makes a difficulty for importing countries to control and attain a target of inflation. The degree of pass-through is also important for forecasting inflation and for deciding to what extent to tighten monetary policy in response to an increase in inflation. In the presence of a deprecation, the lower the degree of ERPT the smaller the interest rate adjustment required to maintain the inflation target; thus monetary policy becomes more effective.

1.3 Chapter preview

This thesis comprises three substantive essays - two essays on exchange rate exposure and one essay on exchange rate pass-through. The first two essays focus exclusively on the impact on exchange rate changes on firm returns. The final essay provides a broad picture of impact of exchange rate fluctuations on domestic prices. The details in each chapter are summarised below.

Chapter Two examines firm-level exchange rate exposure in five major ASEAN economies yielding a total of 3,015 firms comprising 2,794 nonbank companies and 221 bank and financial companies. The exchange rate exposure of ASEAN firms is of interest to researchers because of the rapid growth in real and financial sectors in this region, combined with increasing internationalisation of these countries. The estimation of exchange rate exposure starts with a widely acknowledge residual exposure model of Jorion (1990) and is implemented via OLS. Then, the residual exposure is compared with total exposure proposed by Chue and Cook (2008) and estimated via GMM in order to explain the endogeneity effect of exchange rate changes. Finally, the Chue and Cook approach is extended to investigate whether a delay in absorbing financial information exists in the exposure relationship. Having measured exposure, the second part of Chapter Two examines the determinants of this exposure. Firm-specific as well as country-specific variables are used to estimate in the second-step regression. Common financial ratios which are debt-to-equity ratio, earnings per share, market capitalisation, and stock turnover represent the firm's financial decision, hedging policy, and liquidity. The ratio of international debt to GDP and the ratio of country's openness which exhibit the international activities of country represent the country-specific variables.

The results show that an average exchange rate exposure of nonbanks and banks in ASEAN economies is negative when estimated by the OLS. This indicates a negative impact on firm's value as a result of local currency depreciation. Abstracting out the effects of the wider economic environment via the GMM estimation, the percentage of firms with significant exposure drops dramatically in both nonbanks and banks. Crucially, on application of the GMM approach the average exchange rate exposure of nonbank and bank in Indonesia and Thailand overturn the OLS results yielding positive coefficients. In other words these companies tend to benefit from a depreciation of local currency. These findings are supported by the international transactions of these two countries which indicate that they are not only net export countries but also they have a low level of international debt to GDP compared to other ASEAN countries in the sample. The extension version of Chue and Cook by adding one-lagged exchange rate does in some cases yield more evidence of exposure (Philippines, Singapore, and Thailand) suggesting that more attention should be given to the way in which information is impounded into the price across markets when looking at the exchange rate exposure relationship. The results in the second-step regression indicating determinants of exchange rate exposure reveal that international debt to GDP and the ratio of country's openness are robust country-specific estimators for explanation of nonbank and bank's exposure. For firm-specific variables, only firm size is able to determine the degree of nonbank's exposure and the sign of this coefficient depends on types of firms (those with negative exposures or positive exposures). Interestingly financial ratios are less able to determine the level of exchange rate exposure for banks as compared to nonbank companies.

Chapter Three also investigates an exchange rate exposure at firm-level focusing on the relationship across a range of maturities to examine both transaction and economic exposure. The sample consists of 887 firms from the US, the UK, Canada, and Japan from 1990-2012. In case of economic (long-horizon) exposure, overlapping data complicates statistical inference as this induces strong serial correlation in the error term. Ignoring this problem can induce a lower level of standard errors and lead to overrejction of the null hypothesis.[1] Chapter Three therefore contributes to the correction of the inference on both transaction and economic exposure by adopting the transformed regression method (TRF) introduced by Britten-Jones et al. (2011). This main distinction of this transformation framework is to abstract part of strong serial correlation induced by the overlapping data.

The main finding of this chapter is that there is clear evidence that the literature has overestimated the level of economic exposure to date. Approximately seventy percent of significant long-horizon exposures estimated by OLS disappear at a 5-year horizon when the TRF method is applied with the Newey-West covariance matrix. This suggests a worsening of the exchange rate exposure puzzle, which has to date been largely convinced to transaction exposure. Additionally, the exchange rate exposure of individual firms are also grouped and analysed in 10 industries. The results are confirmed that the degree of exposure and percentage of firms with significant exposure vary across industry. Finally, the TRF method is extended by the concept of rolling regression in order to investigate a time variation in exchange rate exposure. An evolution of exchange rate exposure is therefore confirmed by this rolling regression framework with 10-year rolling window. More than 4 million regression results across all four economies are estimated and the exposure coefficients are plotted and exhibited a clear

[1] Chow et al. (1997a, 1997b), Chow and Chen (1998), Nguyen and Faff (2003), among others find an increase in significant exchange rate exposure when overlapping returns are used.

variation during the latest subprime crisis in 2007-2008. The findings show a time variation in exchange rate exposure of all economies according to the global financial turmoil. Based on the TRF-HAC estimation, each countries presents a different picture of the impact of financial crisis on exchange rate exposure. For example, the movement of exposure in US and UK displays large swing with four big jumps across sample periods, which is consistent to the movement on the trade weighted exchange rates of US dollar and British Pounds. The movement on percentage of Canadian firms with significant exposure displays two big jumps according to the US dollar appreciation in the early periods and the periods of subprime crisis, respectively. The subprime crisis had less impacted on Japanese firms than Asian crisis since this percentage of firms with significant economic exposure during subprime crisis is less than that of firms with significant economic exposure during Asian crisis.

Chapter Four departs from exchange rate exposure, instead focusing on exchange rate pass-through. The main focus of this chapter is to examine the impact of inflation targeting on the degree of exchange rate pass-through. The relationship between the degree of exchange rate pass-through and inflation targeting is of interest for many researchers and policy makers as the degree of pass-through could tell us the effectiveness of central bank in implementing inflation targeting. To estimate this pass-through relationship this chapter adopts a nonlinear autoregressive distributed lag (NARDL) framework of Shin et al. (2013). This is an extension of the symmetric ERPT model based on new open-economy macroeconomic models introduced by Choudhri and Hakura (2006). The approach we adopt can be used to measure asymmetric exchange rate pass-through under different price stability regimes and therefore we can examine the asymmetric impact of changing inflation policy. The sample includes twelve countries (six developed countries and six emerging countries). All countries in the sample pursue inflation targeting as a main monetary policy at some point in the sample.

In this chapter a number of key findings emerge. Abstracting from inflation targeting and estimating with the full dataset, there is strong evidence of asymmetric long-run pass-through in developed countries but symmetric long-run pass-through in emerging countries. For the period before inflation targeting, most countries experience symmetric pass-through in the long-run. For the period after inflation targeting, emerging countries tend to experience more asymmetric long-run pass-through whereas developed countries much more experience symmetric long-run pass-through. The degree of long-run exchange rate pass-through after inflation targeting is explicitly smaller than that before inflation targeting. It might be assumed that this reduction is a direct consequence of an adoption of inflation targeting. In short-run analysis, exchange rate pass-through is robust for symmetry for full sample and subsamples. Asymmetric pass-through exhibits in some cases such as full sample in Norway, Brazil, and Hungary.

Further, each pass-through coefficient is tested for the null hypothesis of zero or complete pass-through. For full sample, there is strong evidence of complete pass-through in developed countries and zero pass-through in emerging countries. Meanwhile, the relationship between domestic consumer price and exchange rate fluctuations is mixed up and has no particular pattern before inflation targeting. Most countries experience zero pass-through after inflation targeting, this suggests an unnoticeable impact of exchange rate fluctuations on domestic consumer prices and therefore a smaller interest rate adjustment required to attain a target of country's inflation. In addition, depreciations pass through more strongly than appreciations do when asymmetric pass-through is found.

Chapter Five concludes the thesis and provides the direction of future research in the area of exchange rate exposure and exchange rate pass-through.

Chapter 2 The firm-level exchange rate exposure of bank and nonbank companies in ASEAN economies

2.1 Introduction

It is important for firms to have an understanding of the effect of the exchange rate on firm value as exchange rate variability is a major source of macroeconomic uncertainty in an open economy setting. Recent trends towards greater liberalisation of financial markets and increased globalisation makes the importance of understanding such exposure even more acute. So how does the exchange rate affect the firm? The answer to this will vary depending on the type of firm considered. In the simplest sense when the domestic currency appreciates, on the one hand import products become relatively cheaper; on the other hand, competition in domestic markets from foreign competitors increases. Conversely when there is depreciation, the cost of import products increases but provides there is an opportunity for exporting firms to compete more favourably abroad.

This chapter contributes to the literature by examining the foreign exchange rate exposure of a large sample of 3,015 individual firms in five major countries in ASEAN economies, which are Indonesia, Malaysia, the Philippines, Singapore, and Thailand.[1] All these five ASEAN countries are selected because they are the top five largest economies in the region. In addition, there exists a voluminous literature on exposure in many developed markets, yet

[1] ASEAN (Association of Southeast Asian Nations) economies include 10 member countries, which are Brunei Darussalam, Cambodia, Indonesia, Lao PDR, Malaysia, Myanmar, Philippines, Singapore, Thailand and Vietnam.

comparatively little has been done for Asian economies.[2] This is no doubt due to the difficulties in obtaining sufficient data which we suggest is now less of an issue given the passage of time. Data aside, the Southeast Asian market is of particular interest given the strength of the export and import markets within the region. Moreover, examining the exchange rate exposure of Asian countries is important given (i) the rapid growth in real and financial sectors in the region (ii) the increasing internationalisation of these countries. From the Southeast Asian perspective a clear understanding of foreign exchange exposure is warranted in the aftermath of the Asian crisis in 1997. This crisis had a widespread impact on currency valuations, with many of the countries' currencies declining markedly in value during this period.[3] On the flipside, the recent financial crisis in 2008-2010 also caused a large capital flow from the United States, the United Kingdom and the Eurozone to the Asian financial markets, particularly, in Southeast Asia. This may also have affected the value of Asian currencies.

Much of the existing literature observes exchange rate exposure only in multinational firms which have an extensive involvement in international activities and might be influenced by exchange rate fluctuations.[4] However, there is also evidence that domestic firms can also be directly or indirectly affected. Bartov and Bodnar (1994) point out that domestic firms having no direct international activities may be exposed to exchange rate changes since exchange rate variations normally impact the domestic interest rate and domestic price, which finally impacts

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[2] See, for example, Dominguez and Tesar (2006), Muller and Verschoor (2007), Chue and Cook (2008), and Lin (2011).

[3] Allayannis et al. (2003) document that the Baht immediately devaluated by about 20% since The Bank of Thailand decided to float the Baht on 2 July 1997. Moreover, the Thai Baht, Malaysian ringgit, Indonesia rupiah, South Korea won, and Philippines peso depreciate more than 30% against the US dollar by the end of 1997.

[4] Jorion (1990), Jorion (1991), Bartov and Bodnar (1994), He and Ng (1998), Williamson (2001) among others investigate exchange rate exposure only in multinational firms. They select sample based on firms who explicitly have foreign activities measuring by export ratio or foreign sale ratio.

on firm value. Aggarwal and Harper (2010) examine only exchange rate exposure of domestic nonbank US companies and finds that domestic US firms also experience exchange rate exposure just as multinational firms do. Hutson and Stevenson (2010) also argue that firms face exchange rate exposure depending on the degree of country openness, not just because of their domestic or foreign activities. They show that firms in open-economies are more exposed to exchange rates than firms in close-economies. Consequently, for all corporations unanticipated changes in the exchange rate generate risk regardless of whether their main operations are domestic or international. Thus, our sample includes both domestic and international firms comprising 3,015 firms for the period 2002 – 2012.

A number of studies have documented that industries are affected differentially by exchange rate exposure.[5] In particular the finance sector has noteworthy characteristics in this respect. Banks and financial companies have different asset and liability structures; they also have a greater quantity of international transactions and relatively easy access hedging instruments that have implications for exchange rate exposure. Banks and financial institutions are therefore more likely to hedge but evidence such as that provided by Chamberlain et al. (1997) and Choi and Elyasiani (1997) also show that exchange rate exposure is still an important source of risk for the American and Japanese banking sectors. Thus, this chapter further contributes by examining how a subset of our data, financial firms, is affected by exchange rate exposure.

We estimate total exchange rate exposure by adopting the GMM approach of Chue and Cook (2008). Chue and Cook's estimation is extended in terms of different countries sample, sample size, sample periods and also by adding lagged exchange rate returns in order to

[5] See, for example, Bodnar and Gentry (1993), He and Ng (1998), Hutson and O'Driscoll (2010), among others.

investigate whether or not a delay in absorbing financial information affects the exchange rate exposure of firms. The exposure coefficients obtained from the first-step regression are also modelled for determinants in a second-step regression with the GMM approach. Two groups of variables, the firm-specific and country-specific variables, are used to estimate the determinant regressions. For firm-specific variables, we use financial ratios which are annually reported and represent the firm's financial decision, including their hedging and liquidity. From the common financial ratios we are able to infer the motivation and ability of firms to hedge and impact on firms' exposure. The country-specific variables exhibit the government and central bank's policy which might affect the exchange rate exposure of firms. International debt to GDP and the ratio of country's openness represent the country-specific variables and are used to identify the extent to which each country involves in international transactions.

The results show that most Asian nonbank firms experience negative exchange rate exposure when we estimate by the OLS. That is, they will earn negative (positive) returns when their local currency depreciates (appreciates). However, the results are different when the data set are measured by the GMM method. The GMM findings suggest that there is a substantial fraction of the Asian firms with negative significant exchange rate exposure and the percentage of banks with significant exposure in Asian countries is greater than the percentage of nonbank companies with significant exposure in Asian countries. The estimation by OLS shows a larger amount of firms with significant exchange rate exposure, compared to other methods. Nonetheless, the instrument variables can control for the effect of country-level macroeconomic shocks; this causes the percentage of firms with significant exposure to decrease and we can confirm the efficiency of instrumental variables by using the Cragg-Donald F-statistic. In addition, considering one-lagged exchange rate could explain exchange rate exposure in some cases (Philippine, Singapore, and Thailand) suggesting that a potential delay in information being reflected from exchange rates into stock price is likely to be country specific. Finally, the size of firms is robust to identify nonbank companies' exposure but this ratio is not suitable to determine Asian banks' exposure. The ratio of international debt to GDP and the degree of country's openness are robust country-specific estimators for explanation of nonbank companies' exposure whereas these variables can explain banks' exposure only in some cases.

The rest of the paper proceeds as follows. The next section focuses on the theories, models, and the causes and findings reported in the literature related to the exchange rate exposure puzzle. Section 2.3 presents the methodology and data. Section 2.4 reviews the determinants of exchange rate exposure and the model for estimation. The empirical results and analysis are described in section 2.5. Section 2.6 concludes.

2.2 Literature reviews

2.2.1 The notions of exchange rate exposure

Alder and Dumas (1984) suggest that the foreign exchange exposure of a firm can be quantified by measuring the sensitivity of equity returns to exchange rate changes. They also highlight the difference between currency risk and exposure. Currency risk is to be identified with statistical quantities which summarise the probability that the actual domestic purchasing power of home or foreign currency on a given future date will differ from its originally anticipated value. In contrast, exposure should be defined as the relationship between excess returns and the change in the exchange rate. Levi (1996) defines the foreign exchange exposure as the sensitivity of changes in the real domestic currency value of assets, liabilities, or operating incomes to unanticipated changes in exchange rates. Stulz and Williamson (1996) decompose the overall impact of exchange rate movements on firm value into three types – transaction exposure, operating exposure, and accounting exposure. Transaction exposure is the exposure that a firm is facing regarding all its specific commercial transactions that have already been obligated. Operating exposure, also called economic exposure, competitive exposure, or strategic exposure, measures the change in the present value of the firm resulting from any change in future operating cash flows of the firm caused by an unexpected change in exchange rates. The change in value depends on the effect of the exchange rate change on future sales volume, prices, and costs. Accounting exposure or translation exposure is the exposure that the firm is affected by translating foreign currency financial statements of foreign subsidiaries into a single reporting currency in order to prepare worldwide consolidated financial statements. To sum up, the 'exchange rate exposure' occurs when the exchange rate changes and it affects firms' profitability, cash flow, or value.

2.2.2 The development of model in exchange rate exposure: from theory to empiricism

Following Muller and Verschoor (2006), the conceptual framework of exchange rate exposure is critically categorized in two perspectives. Firstly, a theoretical perspective defines exchange rate fluctuations as an important source of macroeconomic uncertainty. In this perspective, researchers try to explain sources of exchange rate variations on firm value towards firm's activities, its import and export structure, its involvement in foreign operations, the currency denomination of its competition and the competitiveness of its input and output markets. Shapiro (1975) initiates a theoretical so called two-country model, investigating a relation between firm value and exchange rate variations. The model indicates that a depreciation in the domestic exchange rate is likely to increase the value of the local firm and simultaneously decrease the value of its foreign competitors. Dumas (1978) investigates trading firms and suggests that their total exchange rate exposure is determined by future exchange rate changes, macroeconomic linkages, and the responsive behaviour of the firm including the optimal hedging decision in the presence of bankruptcy costs and market segmentations. Hodder (1982) extends the two-country model by formulating the effect of exchange rate variation through a firm's assets and liabilities and its international distribution. He suggests that foreign monetary position is not the only source of a firm's exposure. In line with the idea of Shapiro (1975), Dumas (1978) and Hodder (1982), Levi (1994) examines the foreign exchange exposure from a microeconomic point of view by looking at the financial characteristics of the firm. Levi's multi-currency model takes the tax rate and opportunity cost of capital into account and reveals that these two factors have inversely impacted on exchange rate variations. Next, Allayannis and Ihrig (2001) develop a theoretical model and apply a Taylor series expansion of the firm's value in order to estimate exchange rate exposure through the three main channels: the competitive structure of the market, the export share and the industry structure, and the import share as well as the competitive structure of the imported input market. This framework is consistent with Bodnar et al. (2002) who find that the role of market structure or mark-up is a major determinant of exchange rate exposure. Secondly, an empirical perspective fundamentally documented a relationship between contemporaneous exchange rates and stock returns. This perspective is much more profound but the statistically significant relationship between these two variables is still ambiguous.[6] From the notion of exchange rate exposure defined by Alder and Dumas (1984), the model of total exchange rate exposure is formulated as follows

$$R_{i,t} = \beta_{0,i} + \beta_{1,i}R_{x,t} + \eta_{i,t} \tag{2.1}$$

where $R_{i,t}$ is the rate of common stock's return of firm *i*, $R_{x,t}$ is the rate of change in exchange rate, and $\eta_{i,t}$ is the error term. Then, $\beta_{1,i}$ captures the total exchange rate exposure of firm *i*. Since the macroeconomic factors which possibly occur together with exchange rate and stock return has been ignored in Alder and Dumas's model, Jorion (1990) introduces the firm-specific

[6] The causes and findings of the exchange rate exposure puzzle are documented in more detail in section 2.2.3.

exchange rate sensitivity, called 'residual exchange rate exposure' model, in excess of the market's reaction to exchange rate movements. Jorion's specification is appropriate if changes in stock prices and exchange rates are essentially unanticipated. The market index ($R_{m,t}$) is added in the Equation (2.1) in order to control for the macroeconomic effects of changes in the exchange rate. If the exchange rate exposure is zero, it does not imply that exchange rate movement does not impact on firm return. It rather concludes that the firm value was influenced by the exchange rate changes to the same degree as the market portfolio changes. This residual exchange rate exposure model by Jorion (1990) has become a widely accepted model to measure a firm's level of exchange rate exposure.[7]

The residual model has been developed into other forms in order to precisely capture the exchange rate exposure of firm. For example, Jorion (1991) attempts to price exchange rate exposure in the stock market, using a modified version of the capital asset pricing model (CAPM) or arbitrage pricing theory (APT). Within a two-factor pricing model, stock returns are a function of a market return in excess of risk free rate and a trade weighted exchange rate. A multi-factor specification is described by the value-weighted stock market return, the industrial production growth, the change in expected inflation, unexpected inflation, the risk premium, and the term structure. Chow and Chen (1998) replace the market index ($R_{m,t}$) by dividend yield and term premium since these two variables better represent business conditions and do not confound macroeconomic events. Gao (2000) use six macroeconomic variables which are the unemployment rate, producer price index, money supply, energy price index, aggregate wage index, and industry-specific wage index instead of the market index.

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[7] See, for example, Bodnar and Gentry (1993), He and NG (1998), Chue and Cook (2008), and Hutson and O'Driscoll (2010), among others.

Other studies consider the lagged change in exchange rate variable when examining exchange rate exposure since investors are supposed to be delayed in absorbing the financial information. For example, Bartov and Bodnar (1994) add the lagged exchange rate as another variable in a residual exposure model and reveal that the lagged dollar exchange rate better explains US stock returns than the contemporaneous exchange rate. Shin and Soenen (1999) and El-Masry (2006) confirm a significant relationship between lagged exchange rate and firm value. He and Ng (1998), Nydahl (1999), and Krishnamoorthy (2001) however fail to document a significant correlation between lagged exchange rate and stock returns. The evidence for exchange rate exposure with a lagged effect is ambiguous and requires further study, particularly in Asian countries where we believe markets are less efficient.

2.2.3 The causes and findings of the exchange rate exposure puzzle

Despite the theoretical justification for believing that exchange rate movements affect the value of firms, evidence for such an effect has been inconclusive. Previous empirical research has revealed that firms typically produce fewer statistically significant exposures than expected. This phenomenon is known as “the exchange rate exposure puzzle”. Explanations for this phenomenon are as follows

2.2.3.1 Industry

One possible explanation for this insignificant impact is that exchange rate exposure can be captured only in some industries. According to the level of involvement in foreign competition, firm’s foreign sales or input prices, and firm’s foreign assets and liabilities, the degree of exposure is likely to vary among industry. For example, Jorion (1991) estimates a model for US multinational firms and finds that significant exchange rate exposures are only captured in industries which have a substantial proportion of export sales and import inputs. He and Ng

(1998) examine the foreign exchange exposure of Japanese multinationals and find that only 25 percent of 171 Japanese multinational firms have exposure to exchange rate fluctuations during the period January 1979 to December 1993. Furthermore, Japanese multinationals with significant exposure are concentrated in just three industries: electric machinery, precision equipment, and transport equipment sectors. Bodnar and Gentry (1993) examine the relation between exchange rate fluctuations and industry portfolio returns in Canada, Japan, and the USA. Their empirical findings reveal that industry-level exchange rate exposure has been significant in all three countries. Further, industry characteristics (traded or non-traded, import or export, and use of internationally-priced inputs or assets) are also examined in association with industry exposure. The results show a significant relation between industry exposure and industry characteristics for all three countries, indicating industry characteristics strongly influence industry exposure. Krishnamoorthy (2001) extends previous studies by segregating the sample into globally competitive or oligopolistic industries and consumer-oriented or institutionally-oriented industries. The results are that globally competitive industries are more significantly exposed to foreign exchange exposure than oligopolistic industries. Likewise, industries that are consumer oriented are more sensitive to exchange rate than industries which are institutional oriented. The results confirm the industry-level exposure depending on the characteristic of industry.

In a recent study, Bredin and Hyde (2011) assess the sources of exchange rate exposure at the industry level in G7 economies, decomposing exposure into cash flow as well as discount rate effects. Their results reveal that only some industries are significantly exposed to exchange rate movements in specific country. For example, basic materials are significant only in Canada, Germany, and Italy and utilities are significant only in Italy and Japan. All in all, the above empirical findings confirm that exchange rate variations affect only certain industries or firms.

Different industries moreover have different degrees of sensitivity to exchange rate fluctuations. Some industries are not exposed to exchange rate fluctuations according to their business characteristics. Therefore, this may explain why previous studies show little evidence of statistically significant exposure.

2.2.3.2 Hedging

Another potential explanation of the puzzle is that firms are aware of their currency exposures and use financial hedging strategies to mitigate their losses. Theoretically, Smith and Stulz (1985) suggest that firms have a motivation to hedge because of corporate tax benefits; a reduction in costs of financial distress; and a managerial risk aversion. The use of derivatives for hedging is therefore a reason why researchers find economically significant exchange rate exposures of firms in many countries. For example, He and Ng (1998) empirically test whether there are significant differences in the hedging behaviour between a group of affiliated firms (keiretsu) and unaffiliated firms (nonkeiretsu). The results provide evidence of significant differences in the hedging behaviour between the two types of multinational firms. They find that unaffiliated multinational firms which have high financial leverage are more likely to hedge and, hence, are less exposed to exchange rate risk than affiliated firms. Allayannis and Ofek (2001) examine US nonfinancial firms with the impact of using currency derivatives on firm foreign exchange exposure. The results show a strong significant inverse relationship between the use of foreign currency derivative and US firm exchange rate exposure. In addition, Crabb (2002) mainly focuses on the use of foreign currency derivatives in order to mitigate exchange rate exposure of US multinational firms. The results reveal that: (i) foreign operations and financial hedging strategies are significant variables in explaining the exchange rate exposure of US multinational firms; and (ii) the exchange rate exposure of large US multinational firms is significant but that hedging activities by firms reduce such risk. Both Allayannis and Ofek (2001) and Crabb (2002) link this to the observation that many previous studies found little significant exchange rate exposure of US multinational firms as a consequence of using financial hedging strategies.

2.2.3.3 Time variation

Many empirical studies find variation in exchange rate exposure across time. A possible explanation for this is if firms find themselves highly exposed to currency movements during a given period they are likely to adopt hedging strategies going forward into the next period. It is suggested that this is one reason why many studies fail to find significant exchange rate exposure. For example, Jorion (1990) analyses the exchange rate exposure of 287 firms in three sub-periods and finds that the exposure coefficients have been varying over time. The number of firms with significant exposure is only five during 1971-1975, increasing to 16 during 1976-1980 and 15 during 1981-1987. Dominguez and Tesar (2006) also examine exchange rate exposure of non-US firms in three sub-periods and report results that are consistent with those of Jorion (1990), with exchange rate exposure varying over time. Williamson (2001) investigates the exchange rate exposure of US and Japanese firms in globally competitive automotive industries. The results reveal that the exchange rate exposure of firms in both countries is insignificant during 1973-1980 and 1981-1988 but significantly during 1989-1995. Williamson (2001) explains this time variation in exchange rate exposure according to changes in the competitive environment within the industry. Next, Hutson and O'Driscoll (2010) examine 1154 European firms from 11 countries, which are seven Eurozone member and four non-Eurozone countries. Both firm-level and market-level exchange exposure in two sub-periods, the pre-euro period (January 1990 to December 1998) and the post-euro period (January 1999 to January 2008), are investigated. The results reveal that exchange rate exposure of firms in Eurozone increases but that of firms in non-Eurozone decreases after the adoption of euro currency. Hence, a time variation is another factor that causes previous literature unfolds an insignificant exchange rate exposure in some periods.

2.2.4 Exchange rate exposure: evidence from Asian economies

During the past decade, studies of exchange rate exposure have mainly concentrated on developed countries such as the United States, United Kingdom, or Japan and within those have mainly focused on large multinationals. There have been a limited number of studies examining the exchange rate exposure of individual emerging markets at either the firm or industry level. In this section, some key papers that test for exchange rate exposure in Asian emerging countries are reviewed. For example, Dominguez and Tesar (2006) mainly study firm- and industry-level exchange rate exposure in industrialized economies but they also include 389 Thai firms in the sample. They use a trade-weighted exchange rate, US dollar, or currency major trading partner, for estimating exchange rate exposure with the OLS approach. The empirical results for Thai firms reveal that approximately 15 percent of Thai firms are exposed to all types of exchange rate during 1980-1999 and 79 percent of those have negative exposure coefficients, indicating that Thai firms' value decrease when the Thai Baht depreciates. This could be a result of the large amount of debt denominated in foreign currencies before Thailand floated the Baht in 1997.[8] Muller and Verschoor (2007) examine firm- and industry-level exchange rate exposure in allowing for different return horizons using a sample of 3634 Asian internationally active firms from seven countries: Indonesia, South Korea, Hong Kong, Malaysia, the Philippines, Singapore, and Thailand. The results show that approximately 25 percent of these firms negatively exposed to change in the US dollar and 22.5 percent of these firms negatively exposed

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[8] See Allayannis et al. (2003)

to change in the Japanese yen during 1993 – 2003. Moreover, Asian firms with insignificant exposure are only found in specific industries such as petroleum refining, pharmaceuticals, media services, retail and other industrials. Using GMM, Chue and Cook (2008) investigate exchange rate exposure of 900 firms in 15 emerging markets, including countries in East Asia and Latin America, during 1999-2006. Their empirical results show that negative exchange rate exposure is found in most Asian countries such as Korea, Taiwan, and Thailand, suggesting that firm's values are likely to decrease when its local currency depreciates. There are substantially more firms with negative exchange rate exposure during the period of January 1999-June 2002 than during the recent period of July 2002-June 2006. Specifically, the empirical findings of Chue and Cook (2008) are consistent with those of Muller and Verschoor (2007), indicating that Indonesian, Philippine and Thai firms' value decreases when the Indonesian rupiah, Philippine peso, and Thai baht depreciates, respectively. Lin (2011) studies the market- and firm-level exchange rate exposure in the six Asian emerging markets – India, Indonesia, Korea, the Philippines, Taiwan, and Thailand over the period July 1997-November 2010. Three sub-periods are examined; the 1997 Asian crisis period (from July 1997 to July 1999), the tranquil period (from August 1999 to February 2008), and the 2008 crisis period (from March 2008 to November 2010). Because inflation is often larger and more volatile emerging markets, the real exchange rates are used in their estimations instead of nominal exchange rates. The empirical findings reveal three main findings. First, even though all these Asian emerging countries implement a managed float exchange rate regime which central bank can intervene in a favourable direction, there is evidence of significant transaction exposure during the period July 1997-November 2010 and it also varies among sub-periods. Second, the magnitude of exchange exposure became larger and more apparently significant during the Asian crisis in 1997 and Global crisis in 2008 when there is strong evidence of large variation in the foreign currency reserves implying the central banks' intervention during the crisis periods. This infers a failure of central banks' intervention during the crisis periods. Finally, the results also suggest firms with a greater degree of exposure during the crisis period to decrease their exposure by minimising their export ratio or their dollar asset holding.

2.3 Methodology and data

2.3.1 Methodology

In this chapter, we adopt the framework of Chue and Cook (2008) in estimating total exchange rate exposure as follows

$$R_{i,t} = \beta_{0,i} + \beta_{1,i}R_{x,t} + \beta_{2,i}R_{m,t} + \eta_{i,t} \tag{2.2}$$

where $R_{i,t}$ is the excess return on the stock of firm *i*, which is calculated by the difference between the local return for firm i and the domestic short term interest rate, $R_{x,t}$ is the change in trade-weighted exchange rate index of country x, measured as the currency of country x against a basket of foreign currencies (a positive value of $R_{x,t}$ indicates a depreciation of country x's currency), and $R_{m,t}$ is the excess return on the world stock market index, which is S&P500 in excess of the 3-month US Treasury bill rate. $\eta_{i,t}$ is the error term.

To obtain exposure coefficients from Equation (2.2), we begin the estimation with the Ordinary Least Squares (OLS) method, which is widely used in the related literature. Then, $\beta_{1,i}$ is interpreted as the total exchange rate exposure of firm *i*.[9] That is, a negative value of $\beta_{1,i}$ indicates that the firm's value decreases when a local currency depreciates or foreign currency

[9] The $\beta_{1,i}$ seems to capture residual exchange rate exposure since $R_{m,t}$ is added to control macroeconomic effects according to Jorion (1990). However, Chue and Cook (2008) point out that the size of emerging markets is very tiny relative to the world stock market so the $\beta_{2,i}$is possibly ignored. See Chue and Cook (2008) in more details.

appreciates. However, this model is only appropriate if the error term $(\eta_{i,t})$ is not systematically related to the regressors, $R_{x,t}$ and $R_{m,t}$. or we can say that $R_{x,t}$ and $R_{m,t}$ are truly exogenous.

Since the trade weighted exchange rate and the US T-bill used in Equation (2.2) are usually endogenous which violates the OLS assumption, instrumental variables as proxy variables for the suspect stochastic regressors to produce consistent estimators of the true regression coefficients are added to a regression model. The Generalized Method of Moments (GMM) approach is also used to estimate the exposure coefficients in Equation (2.2). The GMM not only solves the problem of endogeneity but also accounts for serial correlation of unknown form as well as for heteroscedasticity. According to Chue and Cook (2008)'s suggestion, the Euro/ US dollar and the Yen/US dollar are used as instrumental variables for trade weighted exchange rates and the Fed Fund rate as an instrument for the 3-months T-bill in order to exclude the influence of macroeconomic shocks. All instrumental variables therefore do not directly affect $R_{i,t}$ but indirectly impact the trade-weighted exchange rate and T-bill. Further, the Cragg-Donald F-test statistic is used to test whether or not instrumental variable estimators behave poorly in econometric inference. The null hypothesis of weak instrumental variables is tested against the alternative that instrumental variables are not weak.

Since we try to capture the effect of the delay in receiving the financial information on exchange rate exposure, Equation (2.3) is finally estimated by the GMM approach with a one-lag effect as follows[10]

$$R_{i,t} = \beta_{0,i} + \beta_{1,i}\Delta R_{x,t} + \beta_{2,i}\Delta R_{x,t-1} + \beta_{3,i}R_{m,t} + \eta_{i,t} \tag{2.3}$$

[10] Bartov and Bodnar (1994) and He and Ng (1998) point out this phenomenon but they estimate exchange rate exposure by the OLS method.

where the parameter $\beta_{2,i}$ measures the one-lagged effect of exchange rate exposure. We use one-lagged fed fund rate, Euro/dollar, and Yen/dollar as instrument variables.

2.3.2 Data

Figure 2.1 illustrates key economic indicators of the ASEAN economies such as GDP, net foreign direct investment, exports and imports of goods and services, and external debt. It is evident that Indonesia, Malaysia, Philippines, Singapore and Thailand are the top five largest economies in ASEAN and selected for investigation in this chapter. In order to estimate the exposure coefficients in Equation (2.2), our dataset includes all firm's returns, local interest rate returns, and exchange rate returns. The dataset includes the period February 2002 to February 2012, which is the period after the Asian crisis. Firms listed for fewer than 2 years are excluded from the sample.[11] Consequently, total 3,015 firms are identified, which are divided into two groups – 221 banks and finance companies and 2,794 nonbank companies, and are calculated for weekly returns. All stock returns in each country are in excess of local interest rates. They are subtracted by the local interbank rates which are local risk-free interest rates. The exchange rate data are weekly nominal effective trade-weighted exchange rates. The trade-weighted exchange rate index is used in order to avoid the problem of multicollinearlity among currencies. These indices are calculated as local currency against a basket of foreign currency, with an increase in the exchange rate index indicating a depreciation of the local currency or an appreciation of the foreign currency. As we need to compare the exchange rate exposure across countries, the excess return on the market is calculated. For the world stock market index, we use the S&P500 as a proxy, subtracting the US T-bill rate. The Fed Fund rate, the Euro/US dollar and the Yen/US dollar are instrumental variables for the GMM estimation in order to obtain consistent

[11] Appendix A presents number of firms in each country we use in this chapter.

estimates of the regressor coefficients $\beta_{1,i}$ and $\beta_{2,i}$. Since we use the same set of instruments for all regressions, the beta coefficients obtained from estimations are able to compare across countries. All data series are obtained from DataStream.

2.4 Determinants of exchange rate exposure

Factors that determine exchange rate exposure have been explored by many previous researchers during the past decade. In general, the determinants of exchange rate exposure are divided into two groups: firm-specific variables and country-specific variables. The firm-specific variables are associates with firm's international activities, their hedging decision, or the firm's financial ratios. Firstly, Jorion (1990) and He and Ng (1998) suggests foreign sales to total sales as a good proxy for international activities. Bodnar and Gentry (1993) identify trade ratios, use of internationally-priced inputs, and foreign investments as international activities in estimating determinants of exposure. The positive relationship between a firm's international activities and its exchange rate exposure is found in much of the empirical literature, indicating that the exposure will increase when the proportion of foreign sales increases.

Secondly, hedging decisions are another factor that can determine the degree of exchange rate exposure. Many papers have documented insignificant of firm's exchange rate exposure when firms decided to hedge. Crabb (2002) uses firm level data for the percentage of foreign profits to total profits, the percentage of foreign assets to total assets, and the percentage of foreign currency derivatives to total assets to explain 276 US firms' exposure coefficients in terms of the sources of exchange rate exposure. The expected sign of the coefficient of the percentage of foreign profits to total profits is positive because exchange rate changes directly impact firm value through foreign profit. Since exchange rate changes inversely impact firm value through foreign assets, the coefficient of the percentage of foreign assets to total assets is expected to be negative. The expected sign for the percentage of foreign currency derivatives to total assets depends on the unhedged exposure for firms in the sample. The results show that each of the coefficients has the expected sign and is statistically significant. However, the information about decision to hedge or not are very limited. In particular, the hedging information for firms in emerging market is scarce. Chue and Cook (2008) present the proportion of shares available to foreign investors, which are measured by the S&P investability index. This variable is a proxy for foreign and/or institutional ownership of a firm's shares. These owners may induce the firm to pursue different hedging strategies, and may also react to exchange rate movements differently. They found that this ratio is negatively related to exchange rate exposure.

Thirdly, since information about hedging strategies and the use of derivatives is not easy to access for emerging countries, common financial ratios which are obtained from financial reports and easily accessed are other acknowledge sources of determinants that can explain exchange rate exposure. Much previous literature uses financial ratios to infer the motivation of firms to hedge or not hedge. The probability to hedge normally increases when the debt to equity ratio is higher, leading Smith and Stulz (1985), Froot et al. (1993), He and Ng (1998), and Hutson and O'Driscoll (2010) to use the Debt to equity ratio as a proxy. Other ratios such as the long-term debt ratio (He and Ng, 1998), the ratio of international foreign-currency debt to a firm size (Chue and Cook, 2008), and the debt to asset ratio (Hutson and O'Driscoll, 2010) have been used as proxies for the probability of a firm being in financial distress, but the debt to equity ratio is generally used as a proxy of hedging decision and is negatively related to exchange rate exposure. As Muller and Verschoor (2007) believe that hedging activities make operational and financial costs greater than benefits for small firms, Earnings per share which is measured profitability is negatively related to hedging activities. Consequently, the earnings per share is thus positively related to exchange rate exposure. The Market capitalization is suitable for measuring a firm's size. However, there are many controversies about this variable. On one hand, some papers document that the relationship between firm's size and exchange rate exposure should be negative. The larger the firm, the less exposed to exchange rate movements. To explain this point, He and Ng (1998) pointed out that larger firms would hedge because of the advantage from economies of scale. In line with Nance et al. (1993), Chow et al. (1997) Chue and Cook (2008) and Aggarwal and Harper (2010) argue that large firms have a greater economic incentive to hedge than smaller firms because the information and transaction costs of hedging may be sufficiently lower for large firms. On the other hand, Warner (1997) found that smaller firms would hedge because they face greater bankruptcy costs. However, Warner (1997) and He and Ng (1998) find a negative relationship between firm size and exchange rate exposure. The Stock turnover is a proxy of liquidity. Chue and Cook (2008) found that liquidity is also negatively related to exchange rate exposure.

Another group of variables which can determine the exchange rate exposure is country-specific variables. Chue and Cook (2008) use various variables that represent a country's exposure to international trade such as the ratio of export to GDP, import to GDP, M2 to GDP, external debt to GDP, and foreign exchange reserves to external debt. They find that a higher ratio of export to GDP tends to have a positive effect on exchange rate exposure while imports show the opposite result. However, they also find that the coefficients on M2 to GDP and the coefficients on Foreign exchange reserves to external debt are not significant. Since the ratio of external debt to GDP represents exposure to international debt at the country level, firms in countries with higher international debt might protect their operational and financial risk in order to decrease their exposure. The sign of this ratio is therefore expected to be negative. The results of Chue and Cook reveal a negative significant relationship between debt to GDP and exposure during the period 1999-2002 but this association becomes positively significant during 2002-2006. The other country-specific variables that presented in previous literature include the ratio of countries' openness. Hutson and O'Driscoll (2010) suggest that most papers mainly focus exchange rate exposure in the United States but the United States is not a particularly open economy. They introduce the level of economic openness, measured by total exports plus total imports as a percentage of GDP, as an appropriate variable for country-specific variable. Analogous to Hutson and O'Driscoll (2010), Bredin and Hyde (2011) examine this variable and confirm that it is expected to be positively related to exchange rate exposure.

To test the cross-sectional hypothesis and to find determinants of exchange rate exposure, two sets of data are used to investigate the factors affecting the exchange rate exposure. The breadth of data types in Asian emerging countries is not as great as those available in more developed countries, but nevertheless, we are able to obtain key firm-specific variables to input into the determinant regression. After we obtain the exposure coefficients ($\beta_{1,i}$) at 5% significant level from Equation (2.2) using GMM, these are regressed on firm-specific and countries-level variables in the following equation[12]

$$\beta_{1,i} = \theta_0 + \theta_1 DE_i + \theta_2 EPS_i + \theta_3 ln(MC)_i + \theta_4 TV_i + \theta_5 DG_y + \theta_6 OP_y + \varepsilon_{i_i} \quad (2.4)$$

For firm-specific variables, DE_i is debt to equity ratio of firm *i*. EPS_i is earnings per share of firm *i*. $ln(MC)_i$ is the natural logarithm of market capitalization of firm *i*. TV_i is the stock turnover of firm *i*. For the country-specific variables, DG_y is the ratio of international debt to GDP of country *y* and OP_y is the degree of country *y*'s openness. Finally, ε_i is the error term. All

[12] Doidge et al. (2006) and Chue and Cook (2008) recommend that the exposure coefficients obtained from the first-step regression should be weighted by their inverse standard error in order to increase the accuracy of the estimation in second-step regression.

data are obtained from DataStream. According to the same set of instruments for all regressions, the beta coefficients in Equation (2.4) can be pooled across countries. Equation (2.4) is also estimated by the GMM approach since $\beta_{1,i}$ are obtained from the same methodology. For firm-specific variables, we use data ending in 2011 instrumented with data one year prior. As mentioned by Chue and Cook (2008), all country-specific variables are more suitable to average data series than using the specific point of time. We therefore average all country-specific variables from the period 2001-2011 for and instrument with averaged data from 2000-2010. Hence, the positive θ coefficients indicate a positive relation between explanatory variables and exposure whereas the negative θ coefficients indicate an inverse relation between explanatory variables and exposure.

2.5 Empirical results

In this section, the empirical results are presented and discussed. We begin with a brief overview of Southeast Asian economy by presenting key economic indicators for each country. Then, the characteristics of exchange rate exposure in each country are presented. Finally, the factors that influence exchange rate exposure of Asian firms are identified.

2.5.1 An overview of ASEAN economies

Table 2.1 presents basic descriptive statistics of selected economic indicators such as trade weighted exchange rate returns, local stock index returns, and local interest rates in Indonesia, Malaysia, Philippines, Singapore, and Thailand. During the period 2002-2012, the average trade weighted exchange rate returns of Indonesia, Malaysia, and Philippines are positive, indicating that the weekly returns of Indonesian rupiah, Malaysian ringgit, and Philippine peso have been depreciating against foreign currencies whereas the average trade weighted exchange rate returns of Singapore and Thailand are negative, indicating that the weekly returns of Singaporean dollar and Thai baht have been appreciating against foreign currencies. Due to the currency regimes in operation in Malaysia with conventional pegged during 2002-2005 and managed float from 2006 to present, the trade weighted exchange rate returns of Malaysia is the lowest in terms of absolute value, comparing to the other economies. However, the Singaporean dollar has the lowest volatility of trade weighted exchange rate returns since the Monetary Authority of Singapore (MAS) has primarily focused on the exchange rate management since 1981. The exchange rate has become an effective anti-inflation tool for the Singapore economy over the past twenty years.[13] By contrast, Indonesia has the highest volatility of trade weighted exchange rate returns due to its exchange rate flexibility policy to manage capital flows.[14]

Since we include almost all firms in each country for investigating their exchange rate exposure, local value-weighted stock index returns are representing all stock return in each market. Indonesia has the highest weekly average stock returns as well as its standard deviation during 2002-2012. Meanwhile, Singapore has the lowest weekly average stock returns and Malaysia has the lowest volatility of stock returns. The local interest rates for all country are in line with their stock returns. The highest local short term interest rate and its standard deviation is Indonesia. The lowest local short term interest rate is Singapore. Since Malaysian monetary policy focuses on interest rate targeting, this causes the interest rate volatility in Malaysia to be the lowest compared to other economies.

[Table 2.1 around here]

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[13] Monetary Policy Framework of Singapore from *www.mas.gov.sg*

[14] IMF country report No.11/309, October 2011

2.5.2 Characteristics of exchange rate exposure in ASEAN

The characteristics of exchange rate exposure of firms in ASEAN economies are presented in Table 2.2. Nonbank companies and banks (including financial institutions) are exhibited separately. The null hypothesis of $\beta_{1,i} = 0$ is tested against the alternative hypothesis of $\beta_{1,i} \neq 0$, which the $\beta_{1,i}$ is an exposure coefficient of firms estimated by Equation (2.2) with the OLS and the GMM method. The percentage of firms with negative (or positive) and significant exposure at 10%, 5%, and 1% level are also shown.

[Table 2.2 around here]

2.5.2.1 Nonbank companies

Using OLS and the GMM method, 2,794 nonbank companies in five countries are investigated over the period 2002 – 2012. Not surprisingly, using OLS there is a negative average exchange rate exposure of firms in five countries. This implies that a depreciation of the local currency has a negative impact on firms in ASEAN countries. As reported in Table 2.2, the average exchange rate exposure of Asian firms ranges from -0.3919 to -0.6561, which means that a 1% depreciation of local currency is associated with a decrease in stock returns between 0.3919% and 0.6561%. The average negative exposure of Asian firms is consistent to results reported by previous studies such as Dominguez and Tesar (2006), Muller and Verschoor (2007), and Chue and Cook (2008). This finding confirms a liability dollarization of Asian firms.[15] The average exchange rate exposure of firms in Malaysia is the greatest, followed by Singapore, Indonesia, Thailand, and Philippines, respectively. By contrast, firms' exchange rate exposure estimated by the GMM is slightly different. After we control for trade weighted exchange rates and short-

[15] A liability dollarization means a phenomenon that firms create their loans in a currency other than currency of the country in which they are held.

term interest rates using instrumental variables, we find that the average exchange rate exposure of firms in Indonesia, Philippines, and Thailand becomes positive but those for of firms in Malaysia, and Singapore remain negative. Further, Singaporean firms experience the highest exchange rate exposure. This result is in stark contrast with those garnered via the OLS. In terms of absolute value, we also find that the amount of exposure estimated using GMM is less than the amount of exposure estimated by the OLS in all countries, except for Singapore. When the Cragg-Donald F-statistic is applied to remove weak instruments from the regressions estimated by the GMM, we find that the average exchange rate exposure in all countries, except for Indonesia, slightly decreases but still exhibits the same sign.

In addition, the percentage of firms with significant exposure is reported. According to the results using OLS, 36.73% of Indonesian firms, 29.07% of Malaysian firms, 18.29% of Philippine firms, 10.96% of Singaporean firms, and 34.94% of Thai firms are the percentage of firms experiencing negative and positive exposure at 5% significant level. Specifically, the results show that Asian firms mostly experience statistically significant and negative exposure. The occurrences of statistically significant and positive exposure are minimal compared to the significantly negative exposure. It is noticeable to see that the percentage of firms that have significant exchange rate exposure drops considerably when we apply the GMM estimation. Only 4.01% Indonesian firms, 7.21% Malaysian firms, 7.00% Philippine firms, 0.31% Singaporean firms and 4.05% Thai firms, have negative and positive significant exposure at 5% significant level. After adjustment using the Cragg-Donald statistic, the percentage of firm with significant exposure slightly drops. In Singapore, firms with significant exposure are unreportable as the Cragg-Donald statistics eliminates all regressors with weak instruments. This confirms the existence of endogenous problem in estimating exposure of firms in Singapore and is able to explain why average exposure estimated by the GMM is greater than average exposure estimated by the OLS.

2.5.2.2 Banks

We now turn our attention to the exchange rate exposure of banks, including financial institutions in ASEAN countries. As before, we begin with the OLS estimation. It can be seen that exchange rate exposure of banks in Asian countries has negative value, implying that banks' returns in ASEAN countries will decrease when their local currency depreciates. This is consistent with the previous results for nonbank companies. It might be assumed that these institutions with borrowings in US Dollar or other foreign currencies and lending in local currency.[16] We moreover find that, in terms of absolute value, the average exchange rate exposure of banks in all countries, except for Indonesia, is larger than the average exchange rate exposure of nonbank companies. Banks in Singapore have the highest average exchange rate exposure, following by Malaysia, Thailand, Philippines, and Indonesia, respectively. When the GMM is applied, the exchange rate exposure of all countries, except for Indonesia, still exhibits negative signs. In terms of absolute value, the exchange rate exposure estimated by the GMM is less than the exchange rate exposure estimated by the OLS. However, the exposure of banks in Singapore is an exception. Although the results for banks are not as different as the results for nonbank companies, we can notice some significant points in estimating banks' exchange rate exposure. As presented in Table 2.1, the volatility of trade weighted exchange rate, local stock market index, and local interest rates in Indonesia are the highest. Banks in Indonesia however

[16] For example, Thai government relaxed the exchange rate policy in September 1992 and allowed 46 Thai commercial banks to set up The Bangkok International Banking Facilities (BIBF). The BIBF mainly facilitated Thai firms borrowing debt dominated in foreign currencies. By the end of 1997, Thailand had international debt approximately 110,000 million US dollar.

have the lowest exchange rate exposure, regardless any estimation methods. This may indicate that Indonesian banks have a greater concern regarding risk and take more advantage of the opportunity to hedge in order to alleviate their exposure.

Again, when OLS estimation is applied a greater proportion of banking firms experience significant exchange rate exposure: 34.33% of Indonesian banks, 54.29% of Malaysian banks, 32.00% of Philippine banks, 27.50% of Singaporean banks, and 42.59% of Thai banks are the percentage of firms experiencing negative and positive exposure at 5% significant level. The results also show that firms mostly experience a significant negative exposure. As with the results for nonbank companies, the percentage of banks with significant exposure drops considerably after we estimate using GMM. According to the GMM results, only 8.57% of Malaysian banks and 1.85% of Thai banks experience negative exposure at 5% significance level whereas there are no firms in Indonesia, Philippines, and Singapore experiencing significant negative exposure. We also notice that instruments in estimating exposure for banks in Singapore are weak as we are not able to find firms with significant exposure in Singapore.

2.5.3 The lagged effect on exchange rate exposure of firms in ASEAN economies

As we realise the advantage of the GMM approach in removing the wider macroeconomic environment, the one-lagged exchange rate exposure ($\beta_{2,i}$) of Asian firms is estimated by Equation (2.3) with the GMM in order to detect the impact of a delay in receiving the financial information on firms' exposure.

2.5.3.1 Nonbank companies

Results reported in Table 2.3 show that firms in Indonesia, Malaysia, Philippines, and Singapore have negative average lagged exchange rate exposure whereas only Thai firms have positive average lagged exchange rate exposure. Considering the percentage of firms with significant exposure at the 5% level, we find that, in Philippines, Singapore and Thailand, the percentage of firms with lagged exposure is higher than that of firms with contemporaneous exposure. However, this result does not carry through to the firms in Indonesia and Malaysia where the percentage of firms with significant exposure is less than the percentage of firms estimated by the contemporaneous exposure. The results from estimation with lagged effects show that there is a potential delay in information being reflected from exchange rates into the stock price, and that this effect is likely to be country specific. When one-lagged exchange rate and removed weak instruments are estimated, the results reveal that the percentage of firms with significant lagged-exposure in Indonesia, Malaysia, and Philippines decreases and the percentage of firms in Singapore and Thailand becomes zero.

2.5.3.2 Banks

The results show that banks in Indonesia, Malaysia, Philippines, and Singapore have negative average lagged exchange rate exposure whereas the average lagged exchange rate exposure of Thai banks are positive. These results are consistent with the nonbanks companies which we reported earlier. We find that the percentage of firms with significance at 5% level, estimating by one-lagged exposure, in Philippines and Singapore is higher than the percentage of firms with significant exposure estimating by contemporaneous exchange rate exposure. However, this result does not carry over to firms in Indonesia, Malaysia, and Thailand as the percentage of firms estimated by lagged exchange rate yields a lower percentage of significant firms vis-à-vis those estimated by contemporaneous exposure.

[Table 2.3 around here]

2.5.4 Determinants of exchange rate exposure

In this section we examine the factors that determine the exchange rate exposure in Asian companies. Specifically, raw betas obtained from Equation (2.2) are regressed on both firm-specific and country-specific variables. Absolute betas are also considered regarding to only size of exposure. Further, we estimate separate regressions for firms with positive or negative betas to see whether firms which have benefits from local currency depreciation (positive betas) have a different set of determinants as compared to firms having a negative impact from local currency depreciation (negative betas). Again, we mainly use financial ratios as proxies for firm's hedging decisions and also consider macroeconomic variables which reflect the decision of government and central bank.

2.5.4.1 Nonbank companies

After excluding nonbank companies with weak instruments and companies with missing data of financial ratios, we obtain 605 raw beta coefficients and estimate them using Equation (2.4).[17] The results are presented in Table 2.4. For raw betas, only EPS is statistically significant at the firm-level whereas both country-level variables (DG and OP) are strongly significant and show a negative relation, suggesting that a higher degree of international debt and the country's openness, a lower degree of exchange rate exposure. This might be explained by the effectiveness of hedging decision. When absolute betas are regressed on firm- and country-specific variables, the MC is negative and strongly significant, indicating that the larger firms experience less exposure. In this case, we can explain that larger firms in Asian economies have more ability in accessing the hedging instruments smaller firms do. The negative relation between MC and exposure is in line with Nance et al. (1993), Chow et al. (1997), He and Ng

[17] Since all exposure coefficients in Singapore experience a problem of weak instruments, we exclude these exposure coefficients in cross-sectional regressions.

(1998), Chue and Cook (2008) and Aggarwal and Harper (2010). Still, both DG and OP are strongly significant when absolute betas are estimated. When Equation (2.4) is estimated with only firms with only positive betas, 255 observations are regressed. Firms with positive beta have benefits when their local currency depreciates. The exposure of firms in this group can be significantly explained by MC, DG, and OP at 1% level. Therefore, DG and OP in most cases shows unexpected negative sign, suggesting that Asian firms recently much more concern about exchange rate risk from the higher degree of country's openness. Consequently, they pursue more hedging strategy to minimise this risk. By contrast, 350 observations are regressed in Equation (2.4) when firms with only negative betas are considered. Firms with negative beta have negative impact when their local currency depreciates. The exposure of firms in this group can be significantly explained by EPS and MC for firm-specific variables and only OP for country-specific variables. Unlike previous cases, OP in this case shows expected positive sign indicating that the more level of international debt and the degree of countries' openness, the greater degree of exchange rate exposure. Remarkably, MC is a robust estimator for both firms having positive and negative impact on local currency depreciation. However, the sign of MC depends on the restricted betas (positive or negative betas). The findings show an inverse relationship between MC and positive betas but positive relationship between MC and negative betas. Therefore, the relationship between firm's size and its exposure is dependent on its international business activities.

[Table 2.4 around here]

5.4.1 Banks

Table 2.5 presents the factors determining the exchange rate exposure of banks. 76 raw and absolute beta coefficients of banks are used in regression on firm-specific and country-specific variables. All explanatory variables, except for DG, are insignificant when raw betas are estimated. DG is able to explain exposure at the 5% significant level. For absolute betas, the EPS coefficient is significant but it has a negative sign as opposed to Muller and Verschoor (2007)'s expectation so we conjecture that only Asian firms with higher profit are able to allocate their budget in order to hedge. DG as well as OP are significant at 10% and 5% level, respectively. Again, 34 observations are regressed when Equation (2.4) is restricted only firms with only positive betas. The results show that only EPS can explain the degree of positive exposure. When negative betas are regressed, MC and OP are statistically significant at 10% level. Remarkably, financial ratios have less ability in determining a degree of banks' exchange rate exposure, compared to nonbank companies. However, country-specific variables are able to explain the banks' exposure in a number of cases.

[Table 2.5 around here]

2.6 Conclusion

This chapter examines whether there exists an association between Asian firm's returns and currency fluctuations, and consequently measures the level of exchange rate exposure. We use weekly data of stock returns, exchange rate movements, and the market index and apply several methods for capturing the exchange rate exposure. Even though the methodology we use in this chapter is similar to Chue and Cook (2008), there are many different aspects compared to prior paper in examining exchange rate exposure. First, we examine the firm-level exchange rate exposure only in ASEAN economies. This chapter contributes to a large sample of total 3,015 companies from the top 5 largest economies in ASEAN (Indonesia, Malaysia, Philippines, Singapore, and Thailand) from 2002-2012 which are selected for investigation and further distinguished between banks and nonbank companies. The sample in Chue and Cook's paper can explain the exchange rate exposure in ASEAN (only Indonesia, Philippines, and Thailand), which accounts for less than 5% of the sample in this chapter. Second, we also compute the Cragg-Donald statistics to remove the GMM equation with weak instruments so the exposure coefficients in this chapter are more robust and reliable. Third, the lagged exchange rates are added to examine a delay in receiving the financial information from investors.

We begin by using the OLS benchmark model from the literature finding that many banks and nonbank companies in Asian countries are negatively exposed to currency movements. That is, a depreciation of the local currency negatively affects the firm value. This is consistent with many previous papers that have given rise to the idea of 'liability dollarization'. We also find that the average exchange rate exposure of banks is higher than the average exchange rate exposure of nonbank companies. Next, we apply the GMM method in order to exclude the macroeconomic shocks in the model. The average exchange rate exposure of nonbank companies in Indonesia, Philippines, and Thailand turns positive, which means that firms' value have positive impact when local currency depreciates. This changing sign can be explained by the international transactions of these countries which are net export countries as well as having low level of international debt to GDP. Estimation by OLS, the results show that approximately 10%-37% of nonbanks companies and 28%-55% of banks are exposed to exchange rate movement at 5% significant level. When GMM is applied, the percentage of nonbank companies with significant exposure is approximately 0.3%-7% whereas the percentage of banks with significant exposure varies from 0%-9%. In general, the percentage of nonbank companies and banks with exchange rate exposure decreases substantially in all countries. Interestingly, banks in Indonesia have the lowest exchange rate exposure, regardless of the estimation methods but the volatility of trade weighted exchange rate, local stock market index, and local interest rates in Indonesia are the highest. When the Cragg-Donald F-statistic is applied for removal of equations with weak instrument, it has been noticed that the average exchange rate exposure and the percentage of firm with significant exposure decrease in many cases. In addition, the lagged exchange rate is included to capture the exchange rate exposure since it has still been critical about the efficiency of adding lagged effect. Our results reveal that the lagged exchange rate has the ability to capture more exposure only in some countries such as Philippines, Singapore and Thailand; therefore, more attention should be given to the way in which information is impounded into the price across markets when looking at the exchange rate exposure relationship.

We also explore the determinants of the exchange rate exposure with firm-specific and country-specific variables. Even though we are unable to access and analyse the hedging strategies of Asian firms, we are able to access the firm's financial ratios as proxies for their hedging decisions. We find that the firms' size is a robust estimator that can explain a cause of exchange rate exposure for nonbank companies. Notably, the sign of these variables is dependent on the firm's international transactions. That is, an inverse relationship between firms' size and firms with positive exposure and a positive relationship between firms' size and firms with negative exposure are found. For Asian banks, most explanatory variables are insignificant, indicating that all explanatory variables we used in this chapter are only suitable for nonbanks companies. For country-specific variables, the ratio of external debt to GDP and country's openness are significant variables that can explain the exchange rate exposure of both banks and nonbank companies.

In conclusion, the findings of this chapter reveal comprehensive aspects of exchange rate exposure in ASEAN economies, which help domestic as well as multinational firms understand their risk regarding to currency changes. Concerning the exchange rate exposure and its determinants is also important for them in managing their hedging strategies.

Appendix A: Number of sample in each country

Country	Bank and finance companies	Nonbank companies	Total
Indonesia	67	324	391
Malaysia	35	860	895
Philippines	25	257	282
Singapore	40	958	998
Thailand	54	395	449
Total	221	2,794	3,015

Notes: All firms in the sample are activated and firms listed fewer than 2 years are excluded from the sample.

Table 2.1 Summary characteristics of selected economic indicators in each country

	Trade weighted exchange rate changes	Local stock index returns	Local interest rates
Indonesia			
Mean	0.0325%	0.4147%	0.1623%
Median	0.0389%	0.7288%	0.1440%
Std. Dev.	1.1885%	3.5922%	0.0531%
Max.	9.2294%	20.4468%	0.3151%
Min	-7.9300%	-23.2971%	0.0617%
Malaysia			
Mean	0.0083%	0.1474%	0.0559%
Median	0.0000%	0.1879%	0.0535%
Std. Dev.	0.6436%	1.9793%	0.0088%
Max.	2.7455%	9.8472%	0.0688%
Min	-2.8075%	-8.6424%	0.0387%
Philippines			
Mean	0.0143%	0.2342%	0.0462%
Median	0.0427%	0.1437%	0.0462%
Std. Dev.	0.8189%	3.0922%	0.0138%
Max.	2.4661%	11.9275%	0.0731%
Min	-4.0532%	-16.1630%	0.0193%
Singapore			
Mean	-0.0223%	0.1042%	0.0405%
Median	-0.0373%	0.3169%	0.0269%
Std. Dev.	0.4051%	2.8519%	0.0355%
Max.	1.7923%	16.3927%	0.1113%
Min	-1.7609%	-14.8387%	0.0033%
Thailand			
Mean	-0.0141%	0.2120%	0.0550%
Median	-0.0151%	0.4709%	0.0619%
Std. Dev.	0.8616%	3.3028%	0.0212%
Max.	6.0865%	17.4438%	0.0962%
Min	-4.0430%	-19.1520%	0.0192%

Notes: All returns are calculated from weekly data series. The local stock index returns are calculated from value-weighted index; The IDX composite index for Indonesia, The FTSE Bursa index for Malaysia, The PSEi index for The Philippines, The Straits Times index for Singapore, and The SET index for Thailand. The local interest rates are the risk free interest rates and converted to weekly returns.

Table 2.2 Exchange rate exposure estimated by different methods in each country

	Non-Banks			Banks		
	OLS	GMM	GMM*	OLS	GMM	GMM*
Indonesia						
mean	-0.5435	0.1922	0.2390	-0.4575	0.2348	0.2548
std. dev.	0.6266	1.0735	1.0520	0.5559	1.2466	1.2465
neg.	81.17%	40.43%	37.65%	82.09%	44.78%	43.28%
neg. and sig.*	45.06%	2.78%	2.47%	38.81%	2.99%	2.99%
neg. and sig.**	36.73%	1.85%	1.85%	32.84%	0.00%	0.00%
neg. and sig.***	25.93%	0.00%	0.00%	20.90%	0.00%	0.00%
pos.	18.83%	59.57%	57.10%	17.91%	55.22%	53.73%
pos. and sig.*	0.62%	4.32%	4.32%	1.49%	10.45%	10.45%
pos. and sig.**	0.00%	2.16%	2.16%	1.49%	4.48%	4.48%
pos. and sig.***	0.00%	0.31%	0.31%	0.00%	2.99%	2.99%
Malaysia						
mean	-0.6561	-0.4404	-0.4378	-0.7671	-0.3620	-0.3210
std. dev.	0.7285	1.4050	1.3656	0.5625	0.7405	0.7102
neg.	86.74%	68.26%	64.88%	97.14%	80.00%	77.14%
neg. and sig.*	41.51%	13.49%	12.21%	57.14%	11.43%	8.57%
neg. and sig.**	29.07%	6.98%	6.40%	54.29%	8.57%	5.71%
neg. and sig.***	12.79%	1.63%	1.51%	34.29%	2.86%	2.86%
pos.	13.26%	31.74%	30.00%	2.86%	20.00%	20.00%
pos. and sig.*	0.23%	0.81%	0.70%	0.00%	2.86%	2.86%
pos. and sig.**	0.00%	0.23%	0.23%	0.00%	0.00%	0.00%
pos. and sig.***	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Philippines						
mean	-0.3919	0.0382	0.0332	-0.4952	-0.4913	-0.5296
std. dev.	0.7019	1.3333	1.2708	0.6115	0.7594	0.7506
neg.	76.65%	51.75%	47.08%	80.00%	76.00%	76.00%
neg. and sig.*	27.24%	7.39%	5.06%	36.00%	12.00%	12.00%
neg. and sig.**	17.90%	4.67%	2.72%	32.00%	0.00%	0.00%
neg. and sig.***	7.78%	0.39%	0.39%	24.00%	0.00%	0.00%
pos.	23.35%	48.25%	43.58%	20.00%	24.00%	20.00%
pos. and sig.*	0.78%	3.11%	2.72%	0.00%	0.00%	0.00%
pos. and sig.**	0.39%	2.33%	2.33%	0.00%	0.00%	0.00%
pos. and sig.***	0.39%	0.39%	0.39%	0.00%	0.00%	0.00%
Singapore						
mean	-0.6082	-4.2796	0.0000	-0.9049	-6.1074	0.0000
std. dev.	1.4158	13.5333	0.0000	1.0942	9.9901	0.0000
neg.	72.34%	62.00%	0.00%	80.00%	80.00%	0.00%
neg. and sig.*	16.70%	1.15%	0.00%	42.50%	0.00%	0.00%
neg. and sig.**	10.33%	0.31%	0.00%	27.50%	0.00%	0.00%
neg. and sig.***	2.92%	0.00%	0.00%	15.00%	0.00%	0.00%
pos.	27.66%	38.00%	0.00%	20.00%	20.00%	0.00%
pos. and sig.*	1.77%	0.42%	0.00%	0.00%	0.00%	0.00%
pos. and sig.**	0.63%	0.00%	0.00%	0.00%	0.00%	0.00%
pos. and sig.***	0.21%	0.00%	0.00%	0.00%	0.00%	0.00%

Table 2.2 Exchange rate exposure estimated by different methods in each country (continued)

	Non-Banks			Banks		
	OLS	GMM	GMM*	OLS	GMM	GMM*
Thailand						
mean	-0.4271	0.3069	0.2543	-0.5100	0.2691	0.1680
std. dev.	0.4666	1.1604	1.0979	0.3933	0.9350	0.9408
neg.	85.82%	41.01%	31.39%	94.44%	33.33%	29.63%
neg. and sig.*	41.27%	2.53%	1.52%	48.15%	1.85%	1.85%
neg. and sig.**	34.18%	0.76%	0.51%	42.59%	1.85%	1.85%
neg. and sig.***	12.41%	0.25%	0.25%	25.93%	0.00%	0.00%
pos.	14.18%	58.99%	42.53%	5.56%	66.67%	50.00%
pos. and sig.*	1.27%	6.58%	4.81%	0.00%	3.70%	1.85%
pos. and sig.**	0.76%	3.29%	2.03%	0.00%	0.00%	0.00%
pos. and sig.***	0.00%	0.51%	0.51%	0.00%	0.00%	0.00%

Notes: The exposure coefficients $(\beta_{1,i})$ from Equation 2.2 are estimated by the OLS method and the GMM method and then calculated mean and standard deviation. All standard errors are relying on the Newey-West covariance estimates. The GMM* is adjusted by the Cragg-Donald F-statistic at 10% significant level, which eliminates weak instrument variables from regression. Neg. (pos.) shows the percentage of firms experiences the negative (positive) exposure. neg. (pos.) and sig. show the percentage of firms with significantly negative (positive) exposure. *, **, *** denote the percentage of firms exposes to exchange rate fluctuations at 10%, 5%, and 1% significant level, respectively.

Table 2.3 Exchange rate exposure estimated by the GMM with 1-lagged effect in each country

	Non-Banks				Banks			
	$\beta_{1,t}$	$\beta_{1,t-1}$	$\beta^*_{1,t}$	$\beta^*_{1,t-1}$	$\beta_{1,t}$	$\beta_{1,t-1}$	$\beta^*_{1,t}$	$\beta^*_{1,t-1}$
Indonesia								
mean	-0.3947	-0.2929	-0.2381	-0.2254	-0.1598	-0.0506	-0.0384	0.0308
std. dev.	1.0628	1.0610	0.8952	0.9006	1.0569	0.8469	1.0348	0.8492
neg.	65.12%	61.73%	49.69%	46.60%	55.22%	46.27%	41.79%	35.82%
neg. and sig.*	12.35%	10.19%	7.10%	5.86%	7.46%	5.97%	4.48%	2.99%
neg. and sig.**	8.02%	6.48%	4.01%	3.09%	4.48%	2.99%	2.99%	2.99%
neg. and sig.***	2.78%	1.85%	0.93%	0.62%	0.00%	0.00%	0.00%	0.00%
pos.	34.88%	38.27%	29.63%	32.72%	44.78%	53.73%	44.78%	50.75%
pos. and sig.*	2.16%	2.47%	1.85%	1.85%	2.99%	1.49%	2.99%	1.49%
pos. and sig.**	0.93%	0.93%	0.62%	0.62%	2.99%	0.00%	2.99%	0.00%
pos. and sig.***	0.31%	0.31%	0.00%	0.31%	2.99%	0.00%	2.99%	0.00%
Malaysia								
mean	-0.5468	-0.3100	-1.5390	-0.2261	-0.4390	-0.2519	-0.4076	-0.2360
std. dev.	1.3358	1.0619	2.7360	1.7060	0.6987	0.5210	0.6836	0.5202
neg.	71.16%	64.53%	2.09%	1.98%	80.00%	68.57%	77.14%	65.71%
neg. and sig.*	16.98%	8.72%	0.70%	0.47%	17.14%	5.71%	14.29%	5.71%
neg. and sig.**	9.88%	5.35%	0.47%	0.23%	11.43%	0.00%	8.57%	0.00%
neg. and sig.***	3.14%	1.165%	0.47%	0.00%	5.71%	0.00%	5.71%	0.00%
pos.	28.84%	35.47%	0.93%	1.05%	20.00%	31.43%	20.00%	31.43%
pos. and sig.*	0.81%	1.74%	0.12%	0.12%	2.86%	0.00%	2.86%	0.00%
pos. and sig.**	0.23%	0.81%	0.00%	0.00%	2.86%	0.00%	2.86%	0.00%
pos. and sig.***	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Philippines								
mean	0.1268	-0.3956	0.1470	-0.3976	-0.3364	-0.3687	-0.2289	-0.2161
std. dev.	1.1525	0.9166	1.1039	0.8592	0.7764	0.8343	0.6264	0.7268
neg.	51.36%	66.54%	41.63%	57.20%	68.00%	64.00%	60.00%	48.00%
neg. and sig.*	5.45%	12.45%	3.50%	10.12%	8.00%	16.00%	4.00%	12.00%
neg. and sig.**	3.89%	7.00%	2.72%	6.23%	0.00%	12.00%	0.00%	8.00%
neg. and sig.***	0.39%	2.33%	0.39%	1.56%	0.00%	12.00%	0.00%	8.00%
pos.	48.64%	33.46%	41.63%	26.07%	32.00%	36.00%	24.00%	36.00%
pos. and sig.*	4.67%	2.33%	4.28%	1.95%	0.00%	0.00%	0.00%	0.00%
pos. and sig.**	2.72%	0.39%	2.33%	0.39%	0.00%	0.00%	0.00%	0.00%
pos. and sig.***	0.39%	0.00%	0.39%	0.00%	0.00%	0.00%	0.00%	0.00%
Singapore								
mean	-4.1371	-3.5305	0.0000	0.0000	-5.7932	-1.8019	0.0000	0.0000
std. dev.	13.9194	4.0569	0.0000	0.0000	9.8709	2.5341	0.0000	0.0000
neg.	61.06%	84.66%	0.00%	0.00%	75.00%	80.00%	0.00%	0.00%
neg. and sig.*	3.44%	26.20%	0.00%	0.00%	2.50%	20.00%	0.00%	0.00%
neg. and sig.**	0.52%	17.64%	0.00%	0.00%	0.00%	15.00%	0.00%	0.00%
neg. and sig.***	0.00%	4.38%	0.00%	0.00%	0.00%	2.50%	0.00%	0.00%
pos.	38.94%	15.34%	0.00%	0.00%	25.00%	20.00%	0.00%	0.00%
pos. and sig.*	0.73%	0.42%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
pos. and sig.**	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
pos. and sig.***	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

Table 2.3 Exchange rate exposure estimated the GMM with 1-lagged effect in each country (continued)

	Non-Banks				Banks			
	$\beta_{1,t}$	$\beta_{1,t-1}$	$\beta^*_{1,t}$	$\beta^*_{1,t-1}$	$\beta_{1,t}$	$\beta_{1,t-1}$	$\beta^*_{1,t}$	$\beta^*_{1,t-1}$
Thailand								
mean	0.2609	0.2996	-0.1352	-0.1119	0.2220	0.3422	0.1480	0.8572
std. dev.	1.0787	1.0956	0.5466	0.9942	1.0033	0.9066	0.0000	0.0000
neg.	40.25%	37.22%	2.28%	1.52%	37.04%	31.48%	0.00%	0.00%
neg. and sig.*	2.53%	3.54%	0.25%	0.00%	5.56%	3.70%	0.00%	0.00%
neg. and sig.**	1.27%	2.53%	0.00%	0.00%	1.85%	1.85%	0.00%	0.00%
neg. and sig.***	0.25%	0.00%	0.00%	0.00%	1.85%	1.85%	0.00%	0.00%
pos.	59.75%	62.78%	0.76%	1.52%	62.96%	68.52%	1.85%	1.85%
pos. and sig.*	6.58%	4.56%	0.00%	0.00%	9.26%	3.70%	0.00%	0.00%
pos. and sig.**	2.78%	2.28%	0.00%	0.00%	3.70%	0.00%	0.00%	0.00%
pos. and sig.***.	0.51%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

Notes: The exposure coefficients $(\beta_{1,i})$ and one-lagged coefficient $(\beta_{2,i})$ from Equation 2.3 are estimated by the GMM method and then calculated mean and standard deviation. All standard errors are relying on the Newey-West covariance estimates. The $\beta^*_{1,t}$and $\beta^*_{1,t-1}$ are adjusted by the Cragg-Donald F-statistic at 10% significant level, which eliminates weak instrument variables from regression. Neg. (pos.) shows the percentage of firms experiences the negative (positive) exposure. neg. (pos.) and sig. show the percentage of firms with significantly negative (positive) exposure. *, **, *** denote the percentage of firms exposes to exchange rate fluctuations at 10%, 5%, and 1% significant level, respectively.

Table 2.4 Determinants of exchange rate exposure of nonbank companies

	Raw betas	Absolute betas	Only positive betas	Only negative betas
Constant	1.4739**	3.8050***	4.5816***	-3.2114***
	(0.7503)	(0.5021)	(0.8703)	(0.9581)
DE	-0.0004	0.0004	0.0003	-0.0003
	(0.0004)	(0.0003)	(0.0006)	(0.0003)
EPS	-0.0005**	0.0002	0.0000	-0.0006**
	(0.0002)	(0.0001)	(0.0002)	(0.0003)
ln(MC)	0.0283	-0.0951***	-0.0935***	0.1012***
	(0.0274)	(0.0205)	(0.0303)	(0.0325)
TV	0.0000	0.0000*	0.0000	0.0000
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
DG	-0.0340***	-0.0171***	-0.0295***	0.0086
	(0.0075)	(0.0036)	(0.0063)	(0.0076)
OP	-0.0065***	-0.0075***	-0.0107***	0.0048**
	(0.0017)	(0.0011)	(0.0021)	(0.0019)
Obs.	605	605	255	350
R^2	14.03%	6.73%	18.71%	3.46%
Adjusted R^2	13.17%	5.80%	16.74%	1.77%

Notes: The exposure coefficients $(\beta_{1,i})$ obtained from Equation (2.2) are weighted by the inverse of standard error and estimated by Equation (2.4). Standard errors are relying on the Newey-West covariance estimates and shown in parentheses. *, **, *** denote the significant level at 10%, 5%, and 1%, respectively.

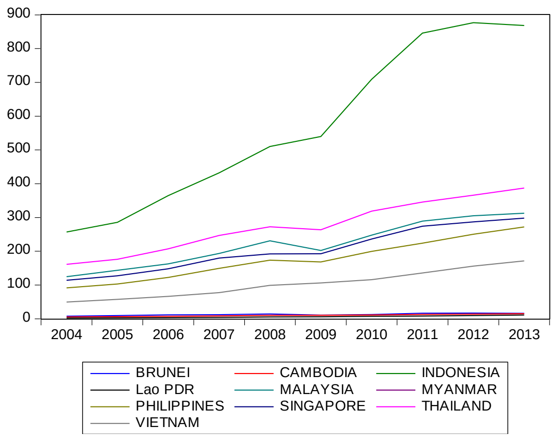
Table 2.5 Determinants of exchange rate exposure of banks

	Raw betas	Absolute betas	Only positive betas	Only negative betas
Constant	1.6540	3.2224**	3.9030	-3.0987*
	(2.0355)	(1.2825)	(3.5150)	(1.5278)
DE	-0.0010	0.0000	-0.0005	-0.0004
	(0.0008)	(0.0004)	(0.0008)	(0.0006)
EPS	-0.0004	-0.0005**	-0.0006**	0.0005
	(0.0004)	(0.0002)	(0.0003)	(0.0012)
ln(MC)	0.0120	-0.0562	-0.0617	0.0794*
	(0.0736)	(0.0501)	(0.0887)	(0.0438)
TV	0.0000	0.0000	0.0000	0.0000
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
DG	-0.0317**	-0.0217*	-0.0273	0.0140
	(0.0148)	(0.0117)	(0.0274)	(0.0181)
OP	-0.0064	-0.0067**	-0.0100	0.0053*
	(0.0042)	(0.0027)	(0.0089)	(0.0027)
Obs.	76	76	34	42
R^2	14.08%	6.69%	7.10%	22.10%
Adjusted R^2	6.61%	1.43%	1.36%	8.74%

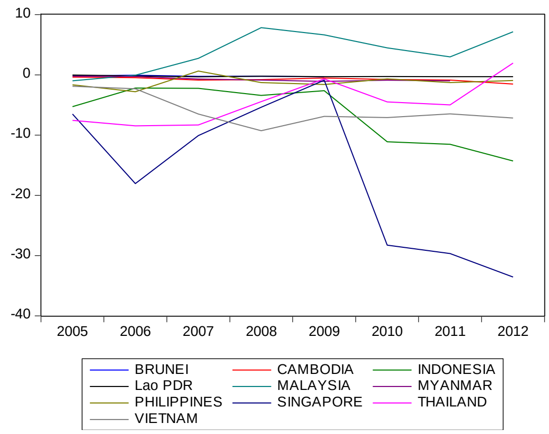
Notes: The exposure coefficients $(\beta_{1,i})$ obtained from Equation (2.2) are weighted by the inverse of standard error and estimated by Equation (2.4). Standard errors are relying on the Newey-West covariance estimates and shown in parentheses. *, **, *** denote the significant level at 10%, 5%, and 1%, respectively.

Figure 2.1 Economic indicators of the ASEAN economies

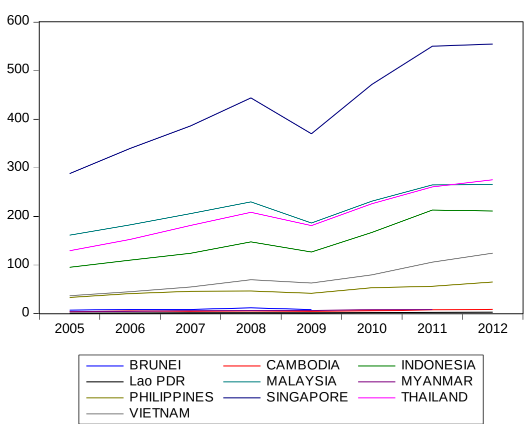
GDP (bn$US)



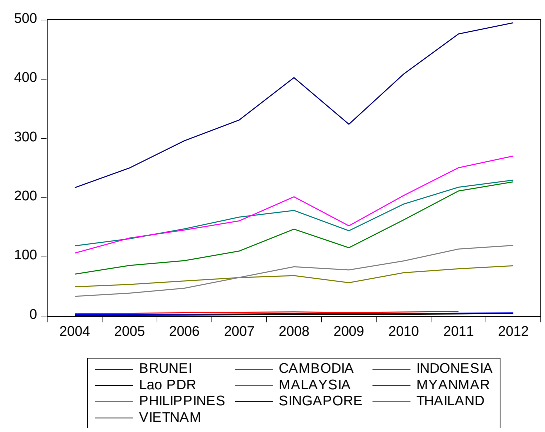
Net foreign direct investment (bn$US)



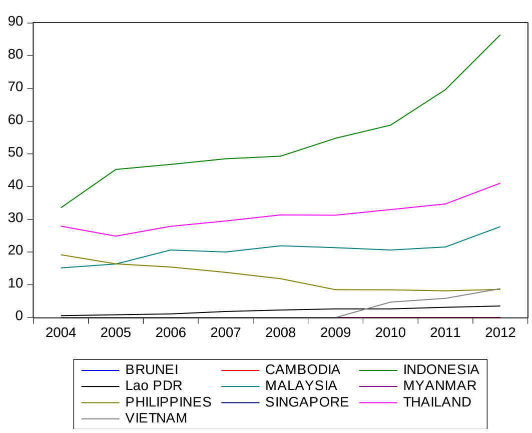
Exports of goods and services (bn$US)



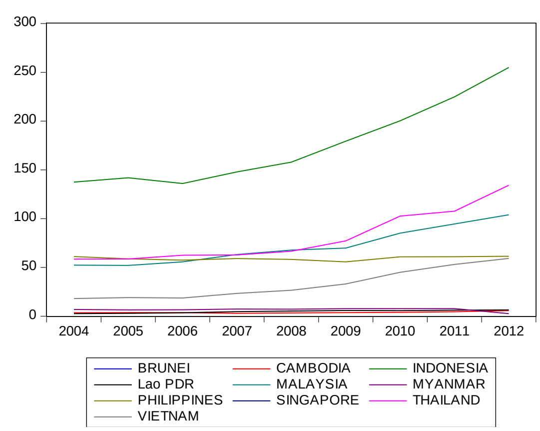
Imports of goods and services (bn$US)



Private nonguaranteed external debt (bn$US)



Total external debt (bn$US)



Notes: All data series are provided by The World Bank and all graphs are compiled by the author.

Chapter 3 The overvaluation of economic exchange rate exposure

3.1 Introduction

After the collapse of Bretton Woods agreements in 1971, the major currencies in the world began to float against each other. This became a source of risk for both multinational and domestic corporations. Furthermore, as the emergence of economic globalisation and liberalisation opens the doors for companies to compete globally, this becomes another factor that enables either a company's cash flow or firm value to be influenced by exchange rate fluctuations. Understanding this exchange rate exposure is important as it can inform investors as well as policy makers regarding their portfolio choice or risk management. Over past decades, researchers have put much effort into studying this exposure and suggested that the exchange rate exposure is, conventionally, classified into 3 main types – transaction exposure, economic exposure, and translation exposure.[1]

Much of the literature focuses on transaction exposure by estimating short-horizon regressions, with results showing that there are only small proportions of firms producing significant exposure due to their effectiveness of short-term transaction exposure hedging.[2] In contrast, the literature studying economic exposure is scant with notable studies including Chow et al. (1997a), Chow et al. (1997b), and Chow and Chen (1998). They argue that short-horizon returns in estimating transaction exposure contain errors because they are not fully reflecting in

[1] These three types of exchange rate exposure are explained in greater detail in Section 3.2.1.

[2] For example, He and Ng (1998), Allayannis and Ofek (2001), and Crabb (2002) found little significant exchange rate exposure of firms as a result of using financial hedging instruments.

the long-term effects of current exchange rate movements. They also apply a long-horizon regression with overlapping observations for exchange rate exposure estimation and find that the statistical significance of exchange rate exposure increases with the return-horizon. The comparative case with which it is possible to find evidence of economics exposure as opposed to transaction exposure has almost become something of a stylised fact in empirical work.[3] However, the presence of overlapping observations can induce serial correlation into the error term and thus may invalidate the standard inference used in these studies.[4]

This chapter fills a gap in the literature by examining the exchange rate exposure across a range of maturities capturing both transaction exposure and economic exposure. This is achieved using a dataset that comprises 887 large firms from 4 major industrialised countries (US, UK, Canada, and Japan) from the 1990 – 2012. The major contribution of this paper is to provide a robust treatment to solve the problem of data overlapping by applying the transformed regression proposed by Britten-Jones et al. (2011). This transformed regression improves on standard inference techniques on both transaction and economic exposures of firms across 4 economies and thus providing the most accurate presentation to date on the evolution of the exchange rate exposure puzzle as a function of maturity. Building on this initial contribution we examine the stability of our results by implementing a 10-year rolling regressions and examine exposure by industry.

Results indicate that using the transformed regression with the Newey-West (1987) variance estimator we are able to overturn the standard OLS support for economic exposure, and instead find minimal support for exposure at longer horizons. This suggests that the effects of data-overlapping on the inference of long-horizon exchange rate exposure results are likely to

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[3] See, for example, Chow et al. (1997a), Chow et al. (1997b), Chow and Chen (1998).

[4] See section 3.2.3 for a discussion of overlapping problems when long-horizon regressions are estimated.

be significant. This striking result represents the main finding of this chapter and indicates that the puzzle extends to longer horizons with prior research on exchange rate exposure tending to overestimate economic exposure.

This paper is organized as follows: Section 3.2 discusses the key aspects of the transaction and economic exposure literature, as well as outlining an econometric methodology in order to improve inference in the presence of overlapping observations. Section 3.3 presents the transformed regression and outlines how it can be applied to long-horizon exchange rate exposure estimation. Section 3.4 presents data and sample and Section 3.5 reports the results and discussion. A final section concludes.

3.2 Literature review

3.2.1 Distinguishing between transaction exposure and economic exposure

Exchange rate changes can impact upon a firms' profitability, cash flows or stock returns, and the extent to which this occurs is called the exposure. The effects of exchange rate changes on firms' value are ordinarily classified as transaction exposure, economic (or operating) exposure, and translation exposure. Transaction exposure occurs when the company enters into a contract such as a trading account or debt obligations in terms of foreign currencies. The value of these existing obligations still has been changing as a result of exchange rate movements. The currency gains or losses are usually realised when the contract account is settled and, eventually, the transaction exposure of companies will terminate. The transactions or obligations we considered as transaction exposures are conventionally less than 1 year. Examples of transaction exposure are an account receivable or account payable denominated in foreign currency, as well as a short-term investment or borrowing denominated in a foreign currency. According to these short term obligations, this exposure is relatively easy to assess and derivative instruments used for hedging such as forward, future, and options are reasonably effective in offsetting this currency risk. We therefore do not expect to find significant exchange rate exposure of firms in the short-horizon. This is consistent with much previous research that failed to detect short-horizon exposure (e.g. Jorion, 1990; Bodnar and Gentry, 1993; Bartov and Bodnar, 1994; among others). Another important explanation for this phenomenon is that short-horizon stock returns contain errors which are made by investors in predicting the long-term effects of current currency movements (Chow et al., 1997a). In other words, short-horizon stock returns do not instantaneously reflect to change in contemporaneous exchange rate returns. This may cause an insufficiency in pricing the firm's exposure.

When a company's transactions engaging in foreign currencies are longer than one year, cash flows of the company (including its foreign investments and earnings) are not only impacted by its own policies but also by decisions influenced by its competitors such as changes in the selling prices, sales volume, or costs of sales. The economic exposure or operating exposure, in other words, has an impact on a firm's value as well as its competitive position. Therefore, not only company strategies but also competitor reactions are important factors that the company should consider before making decisions. For example, local firms tend to reduce the selling price in domestic currency in order to maintain the equivalent foreign currency price when the local currency appreciation. The future operating cash flow, including the firms' value, will certainly change after making these decisions.

In measuring exchange rate exposure of firms, either firm's operating cash flow or firm's stock return is conventionally using. On one hand, a firm's cash flow horizon is used to determine the types of exposure and investigate these exposures separately. The transaction exposure is measured by the (operating) cash flow of a firm in the short-run which typically settled in 1 year. The economic exposure is the risk for firms that their long-term future cash flow will be altered as a result of exchange rate fluctuations. Stulz and Williamson (1996), Bartov and Bodnar (1994) and Martin and Mauer (2003) define economic exposure as the situation when a company's cash flows are rather sensitive to longer lagged exchange rate movements, not to the contemporaneous exchange rate. They estimate this long-run exposure by regressing operating income as a proxy for cash flows of firm on lagged exchange rate movements. On the other hand, Chow et al. (1997a, 1997b), and Chow and Chen (1998) use the short (long)-horizon of stock returns in estimating transaction (economic) exposure. As they mentioned earlier that short-horizon or contemporaneous exchange rate returns contain errors and are inadequate to assess firm's value, long-horizon stock returns are more appropriate for detecting long-term exchange rate effects on firm value. Therefore, long-horizon stock returns are regressed on corresponding long-horizon exchange rate movements.

Meanwhile, the translation exposures directly bound up with an accounting policy in terms of foreign currency translation, which is not associated with a company's cash flow or stock returns.[5] Hence, only the transaction and economic exposure of firms are considered in this chapter.

3.2.2 Estimating long-horizon exchange rate exposure

The market-based model is a conventional and widely acknowledged method in empirically assessing exchange rate exposure of firms.[6] Over the last decade, many previous studies

[5] Translation exposure occurs when foreign subsidiaries have to report and translate their financial statements in terms of their own currency to their parent company with another currency. The exchange rate gain (or loss) may appear after consolidation and company should record them in the financial statements.

[6] This method is first introduced by Alder and Dumas (1984) whose model theoretically measures the contemporaneous relationships between stock returns and exchange rates. They assume that an exchange rate is only one factor that correlates to stock returns. This model sometimes is referred to as the 'total exposure'. Later, the model is extended by adding a market reaction as another factor since other macroeconomic variables may help

followed the Jorion's model and predominantly documented on transaction exposure using short-horizon returns.[7] By contrast the literature on economic exposure using longer maturity returns is far less developed.

Notable contributions in estimating long-horizon exchange rate exposure include Chow et al. (1997a, 1997b) and Chow and Chen (1998) who replace a stock market return with dividend yield, default premium, and term premium.[8] They run all these variables together with the trade-weighted exchange rate index on stock as well as bond returns. Their multi-factor model is claimed that the tendency of dividend yield, default premium, and term premium are able to exhibit the business-cycle of firms, and they have an ability to capture the market's ex-ante expectations of the stock's returns. They employ return horizons that vary from one to sixty month. Chow et al. (1997a) find that the transaction exposure of stocks is negatively exposed in a short run whereas the economic exposure becomes positively exposed for longer horizons. Additionally, the magnitude of exposure is increasing as the horizon lengthens. These results are also confirmed by Chow et al. (1997b) and Chow and Chen (1998). Chow et al. (1997b) moreover ascertain that the relation between the sign (including magnitude of exposure) and firm size are significantly negatively related. That is, the size of exposure is greater for smaller firms than larger firms. Rees and Unni (2005) follow Chow et al. (1997a ,1997b) but replace the real exchange rate index with the returns of ECU, yen, and US dollar. The European firms in France, Germany, and the UK are investigated before the introduction of Euro, with the results showing that firms in all three countries typically earn benefits when their local

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to explain this sensitivity. The latter model is called a 'residual model', proposed by Jorion (1990), and is becoming a well-known model in estimating exchange rate exposure.

[7] See, for example, Bodnar and Gentry (1993), He and Ng (1998), Allayannis and Ofek (2006), Chue and Cook (2008), among others

[8] All these variables are first proposed by Fama and French (1989).

currency depreciates against the US dollar. Nonetheless, most UK firms are hurt by a depreciation of Pound Sterling against the ECU.

Later, there are many papers apply the residual model with the long-horizon returns by using overlapping observation. With this model, the analysis of exchange rate exposure of firms can be made in terms of both transaction and economic exposure. For example, Dahlquist and Robertson (2001) investigate the exchange rate exposure of Swedish firms. Their finding shows that the percentage of firms with statistically significant exposure is positively related to return horizon; that is, the magnitude of exchange rate exposure increases over the return horizons of one week, one month, and three months. However, the exposure disappears when firms are aggregated at industry level and exchange rate index is applied. The degree of homogeneity of an industry might explain this vanishing. Di Iorio and Faff (2001) and Nguyen and Faff (2003) examine the exchange rate exposure of Australian firms. The former reveals that the economic exposure of Australian firms is captured and most of them are exposed to the fluctuations of the Australian dollar against Japanese yen. The latter also focuses on the use of foreign currency derivatives in alleviating the exchange rate exposure of Australian firms. However, the results still confirm that Australian firms tend to be more exposed to exchange rate movements when the return horizons increase. The findings also show that Australian firms appear to be very effective in hedging short-term exposure but they have limited success in long-term exposure. Muller and Verschoor (2007) report that Asian firms are a bit more exposed to US dollar than to Japanese yen. The extent to which firms are exposed to the exchange rate movements also increases with return horizons. Additionally, transaction exposure seems to relatively well hedged while considerable evidence of economic exposure is found. The results in terms of hedging by Nguyen and Faff (2003) and Muller and Verschoor (2007) are in line with the assumption that the economic exposure is the long-run effects and the analysis is more complex, less certain, and difficult to identify. Consequently, companies are having difficulties in eliminating this foreign exchange risk through their hedging instruments, so we anticipate that this exposure is found to be significant in the long-horizon. Chow et al. (1997a, 1997b) confirm this assumption and find that economic exposure significantly exists when the return-horizon is longer.

Recently, Aggawal and Harper (2010) applied the Fama and French theory to measure the exchange rate exposure. They claim that stock returns are more sensitive to many factors rather than one factor – the market index. The market risk premium, the return of small stocks minus big stocks (SMB) and the returns for value relative to growth stocks (HML) are substituted for a market index, then regressed them together with exchange rate returns on stock returns. They assume that US domestic firms do not expose or are less exposed to exchange rate movements than the multinational firms do. Their findings argue the hypothesis; that is, on average, exchange rate exposure of domestic firms is not significantly different from that of multinational firms. Due to the fact of market globalisation, most domestic firms have indirect exposure through their foreign suppliers, customers, or competitors. The results also confirm the increasing in magnitude of exchange rate exposure across the return horizons.

3.2.3 Econometric approach dealing with overlapping problems

Long-horizon regressions can have been used in a variety of fields ranging from stock price predictability, term structure of interest rates investigation, to exchange rate exposure puzzle examination. In the case of long-horizon predictability of stock returns evidence suggests that explanatory variables such as dividend yields or inflation rates are useful in determining the evolution of the stock price.[9] Campbell (2001), for example, compares the power of short- and long-horizon regression to reject the hypothesis of unpredictable stock returns. The results suggest that the analysis of overlapping observations in calculating long-horizon regressions has greater statistical power than the use of non-overlapping observations. Particularly, a number of studies in exchange rate exposure reveal that the use of overlapping long-horizon returns generate a substantial increase in the frequency of detecting statistically significant exchange rate exposure, for example, Chow et al. (1997a, 1997b), Chow and Chen (1998), Nguyen and Faff (2003), Muller and Verschoor (2007), Aggarwal and Harper (2010), among others.

However, two main econometric problems arise when long-horizon regressions are used. One is a downward bias in the coefficient estimates which emerges from the persistence and endogeniety of predetermined variables (Andrews and Monahan, 1992; Boudoukh and Richardson, 1994; Killian, 1999; Campbell, 2001; Hjalmarsson, 2011). However, this bias is not directly caused by the overlapping observations but arises when the predictor variable is persistent and its innovations are strongly correlated with returns. This difficulty not only arises in long-horizon regressions but also in short-horizon regressions. Another concern is that there is strong evidence for the presence of a strong serial correlation when the overlapping data are typically used in the long-horizon return regressions (Hansen and Hodrick (1980); Nelson and Kim (1993)). This problem induces a lower level of standard errors and leads to biased inference.

Even though researchers realize this serial correlation problem in a long-horizon estimation arising from overlapping data, they still believe in substantial benefits from using overlapping data apart from the problems of autocorrelation on the regressors. Therefore,

[9] See, for example, Fama and French (1988), Campbell and Shiller (1988), Mishkin (1992), Boudoukh and Richardson (1993), among others.

researchers often attempt to deal with this problem arising from the overlapping observations by using the White (1980), Hansen and Hodrick (1980), or Newey and West (1987) to adjust the variance-covariance matrix of these estimated coefficients for both heteroscedasticity and autocorrelation in the error terms (See, for example, Chow et al., 1997a, 1997b; Chow and Chen, 1998; Di Iorio and Faff, 2001; Nguyen and Faff, 2003; Muller and Verschoor, 2007; and Aggarwal and Harper, 2010). Newey and West (1987) or HAC procedure ensures that the variance-covariance matrix is positive semi-definite. However, Andrews and Monahan (1992) argue that these techniques tend to perform poorly in finite samples. Nelson and Kim (1993) also show that data overlapping is so severe that Hansen and Hodrick (1980) or HAC is not able to cope with the overlapping data problems in predicting stock returns.

3.3 Methodology

As the use of a residual model is acknowledged by many researchers as we mentioned in Section 3.2.2, our estimated specification (3.1) conforms to the residual model, which is able to assess both transaction and economic exposure as following

$$r_{i,t,t+k} = \alpha_i + \beta_i r_{m,t,t+k} + \gamma_i r_{x,t,t+k} + \varepsilon_{i,t,t+k} \tag{3.1}$$

where $r_{i,t,t+k}$ is the log returns of stock i for period t to t+k ; $r_{m,t,t+k}$ is the log returns on local market index for period t to t+k ; $r_{x,t,t+k}$ is the log returns of an index of trade weighted exchange rates defined as domestic currency against foreign currency for period t to t+k , and $\varepsilon_{i,t,t+k}$ is error terms. The coefficient γ_i measures the sensitivity of firm i' s returns to exchange rate movements or exchange rate exposure. In our analysis, the horizons k are 1, 4, 12, 52, 104, 156, 260 weeks. Specifically, a transaction exposure is referred to as a short-horizon period, which is less than 1 year, so k = 1, 4, 12, 52 weeks represents a transaction exposure. By contrast, k = 104, 156, 260 weeks (2 , 3, and 5 years) are deemed to be long-horizon and represent economic exposure, where long-horizon stock returns are affected by corresponding long-horizon exchange rate movements.[10]

Notably, to increase the number of observations for the return horizons longer than one week (k > 1), overlapping observations are used in the model. This causes the error term $\varepsilon_{i,t,t+k}$ in Equation (3.1) to be autocorrelated with order k > 1. The variance-covariance matrix of estimated coefficients will also be inconsistent. To tackle this econometric problem and make an attempt to improve inference in long-run regression with overlapping observations, we employ the methods of Britten-Jones et al. (2011) to transform the original regression in which the independent variables are overlapping into an equivalent representation of non-overlapping variables. Intuitively, the transformation matrix Q, the matrix of (t-k+1) × t with 1's on the main diagonal and the first k-1 right off-diagonals and 0's otherwise, is created and used to convert independent variables in Equation (3.1) with overlapping returns into non-overlapping returns as follows

$$Qr_{i,t} = \theta r_{x,t-k+1} + \varepsilon \quad (3.2)$$

where $r_{i,t}$ is the vector of t period log returns of stock i. $r_{x,t-k+1}$ is the matrix of explanatory variables with (t-k+1) periods return, which k is overlapping horizon. The columns in the explanatory matrix denotes 1 in the first column, log returns on local market index in the second column and log returns of an index of trade weighted exchange rate in the third column. ε is the error term vector. Therefore, the θ denotes the OLS parameter estimates of Equation (3.2) and is given by

$$\hat{\theta} = (r'_{x,t-k+1} r_{x,t-k+1})^{-1} r'_{x,t-k+1} Q r_{i,t} \quad (3.3)$$

[10] The definition of transaction exposure (short-horizon) and economic exposure (long-horizon) follows the extant literature which is mentioned in section 3.2.1.

which can be rewritten as

$$\hat{\theta} = (r'_{x,t-k+1} r_{x,t-k+1})^{-1} (Q' r_{x,t-k+1})' r_{i,t} \tag{3.4}$$

Equation (3.4) represents the original overlapping returns. Then, $\tilde{r}_{x,t}$ is denoted as a matrix of transformed explanatory variables given by

$$\tilde{r}_{x,t} \ = Q' r_{x,t-k+1} (r'_{x,t-k+1} Q Q' r_{x,t-k+1})^{-1} r'_{x,t-k+1} r_{x,t-k+1} \tag{3.5}$$

Next, the matrix $\tilde{r}_{x,t}$ which is now transformed to non-overlapping is used to estimate θ

$$r_{i,t} = \theta \tilde{r}_{x,t} + \tilde{\varepsilon} \tag{3.6}$$

According to the OLS estimation, the value of θ is obtained by

$$\theta = (\tilde{r}'_{x,t} \tilde{r}_{x,t})^{-1} \tilde{r}'_{x,t} r_{i,t} \tag{3.7}$$

$\tilde{r}_{x,t}$ Equation (3.5) is replaced in Equation (3.7) and finally $\hat{\theta}$ yields

$$\hat{\theta} \ = (r'_{x,t} r_{,x,t})^{-1} r'_{x,t} Q r_{i,t} \tag{3.8}$$

Consequently, this transformation in Equation (3.8) abstracts away from that part of the strong serial correlations which is induced by the overlapping scheme, while the beta coefficients of transformed regression are identical to those of the normal OLS method in Equation (3.3). Hence, these transformation techniques solve the problem of strong serial correlation which arises from the overlapping horizons and finally reduce an overestimation of *t*-statistics. This process is called the transformed regression (TRF) method.[11] Nonetheless, as we are not able to know the autocorrelation structure in the error terms that may or may not remain after applying

[11] For more details see Britten-Jones et al. (2011)

the TRF regression, the standard Newey-West HAC covariance matrix is resorted to ensure that the estimates are consistent and positive definite.

Therefore, the exposure coefficient from Equation (3.1) and the percentage of significant exposure are estimated by (a) the overlapping OLS regression relying on the Newey-West covariance estimates (b) the TRF regression relying on the standard OLS covariance estimates and (c) the TRF regression relying on the Newey-West covariance estimates. Then, the inferences on exposure coefficient are compared among these three methods.

3.4 Data and sample

Our purpose is to investigate both transaction and economic exposures of individual firms in 4 main industrialised countries including The United States of America, The United Kingdom, Canada, and Japan. We include all representative sample of firms listed on the major world stock indices of each country from January 1990 to December 2012. This selected period include the period of both Asian crisis and Subprime crisis. All data are downloaded from DataStream.

Stock returns: We include firms which have a weekly data available from 1 January 1990 to 31 December 2012. Firms with missing data are excluded. Across the four economies this yields 887 listed firms comprising 306 US firms, 265 British firms, 76 Canadian firms, and 240 Japanese firms. Prices and subsequent returns are transformed using the natural logarithm. For each firm selected we also collect the Industry Classification Benchmark (ICB) classifying forms as belonging to one of the following 10 industries types: Basic materials, Consumer goods, Consumer services, Financials, Health care, Industrials, Oil & Gas, Technology, Telecommunications, and Utilities.

Market returns: For local market returns, the natural logarithm of returns for the weekly stock market indices is used: the S&P500 for the US; the FTSE100 for the UK; TSX60 for Canada, and Nikkei225 for Japan.

Exchange rate returns: Weekly trade weighted exchange rate indices are used for each country from the period of 1 January 1990 to 31 December 2012. The quoted trade weighted exchange rates are transformed to represent the domestic currency price of a basket of foreign currencies, and thus an increase in the index indicates a deprecation of the domestic currency. As with the other series the natural logarithm of the change in the trade weight returns are used. All trade weighted exchange rate indices used in this chapter are compiled by the Bank of England.

Table 3.1 presents the basic descriptive statistics of stock market returns and exchange rate returns from all four countries from 1990 – 2012. Panel A shows the value-weighted stock market returns, which are S&P500, FTSE100, TSX60 and NIKKEI225. All average returns, apart from NIKKEI225, are positive but the median indicates positive returns for all indices. The standard deviation suggests that the return of Japanese stock market is more volatile than those of other countries. The equal-weighted stock market returns shown in Panel B are averaged from the stock returns which are only included in the sample. The results in Panel B show a slightly greater value than the results in Panel A. In Panel C, the average returns of Canadian dollar and Japanese yen are negative while those of US dollar and UK pounds are positive. The Japanese yen has the highest value of standard deviation, indicating the most volatile exchange rate, whereas the US dollar has the lowest volatility during this period. The residuals of US dollar, UK pounds, and Canadian dollars are positively skewed. Conversely, the Japanese yen shows the opposite.

[Table 3.1 around here]

3.5 Results

3.5.1 Foreign exchange exposure of 4 economies

Using the full dataset we estimate the exchange rate exposure regression of 887 firms in 4 economies using both the OLS and TRF approaches. Table 3.2 presents the characteristics of exchange rate exposure of individual firms in terms of both transaction and economic exposure across the 7 horizons. The calculations of cross-sectional mean values as well as standard deviations of firms' exchange rate exposure (γ_i) across 4 economies and number of firms with negative (positive) exposure are based on all coefficients. The percentage of firms with significant negative (positive) exposure is presented by three estimations which are mentioned in previous section. The exchange rate exposures of firms in the US are mostly positive in value, with the exception of the horizon of 4, 12 and 52 weeks. Due to this changing on sign of exposures, Bodnar and Wong (2003) mention that this shifting over different return horizons might occur because the average total exposure sensitivities depends on the return horizon. For the exposure of the UK and Canada, both transaction and economic exposures of firms experience the negative cross-sectional mean value, indicating that depreciation in Pound sterling and Canadian dollar hurts firms in the UK and Canada, respectively. Our results on UK exposure confirm the finding of Rees and Unni (2005) that most UK firms are hurt by a depreciation of Pound Sterling against the ECU. Since Japan is an export–oriented country, the cross-sectional mean values for exchange rate exposure of firms in Japan are positive as we expected. This indicates that Japanese firms would have positive impact from Yen depreciation. This is in line with the finding of He and Ng (1998). The total average exchange rate exposures (γ) we obtained from Table 3.2 are consistent with the fact that the US, the UK, and Canada have negative current account balances for the last five years whereas Japan has the positive current account balance during the same periods.[12] The trends of total average exposures, in terms of their absolute values, tend to increase as a result of return horizons. The longer horizons, the greater absolute values of average exposure are. This finding is consistent with previous research such as Chow et al. (1997a, 1997b), Chow and Chen (1998), and Rees and Unni (2005). Rees and Unni (2005) explain this situation as the 'hypothesis of gradual adjustment'. When the returns horizon is lengthened, investors have more opportunity to learn from additional corporate disclosure, followed by expected returns adjustment. The exposure coefficients might increase in absolute magnitude until the return horizon is long enough to allow for investors to obtain new information and have fully incorporated the impact of the currency movement into stock prices. This gradual incorporation of news into prices might also explain the situation of the reversal sign from transaction exposure coefficients to economic exposure coefficients for the US firms as well. In addition, we find that the percentage of firms with significant exposure, estimated by the overlapping OLS regression, increases across horizons for all economies. The interesting finding is that there are approximately 70-85 percent of firms being exposed to longer return horizons, implying that economic exposure manifests for all economies examined. Even though the Newey-West HAC standard errors are resorted on the basis of this regression for inference, we should remember that, in this case, the serial correlation problems have been reduced but not totally eliminated.

[Table 3.2 around here]

We consider next the TRF method is proposed in order to correct the inference. On inspection of the Table, the findings are striking and in stark contrast with the results just

[12] Data statistics recorded by World Bank

discussed. First, the total average γ estimated by the TRF regression are identical to the total average γ estimated by the overlapping OLS regression, regardless any horizons or any types of covariance estimators. Second, the inference on percentage of firms with significant exposure at 1-week return horizon of the TRF method as well as that of the OLS method are similar because the observations are non-overlapping.[13] It is clear that as maturity increases the TRF and TRF-HAC estimates yield a far lower percentage of significant results vis-à-vis the OLS-HAC method. More specifically, for horizons greater than 1 week, the results show that the percentage of firms with significant exposures estimated via the TRF method is less than that estimated via OLS for all return horizons. We are able to see that the percentage of significant firms via the TRF method reduces dramatically using horizons as small as 4 weeks, where at 12 weeks the proportion of significant coefficients using the TRF method is at least half that using OLS. At the 5-year return horizon, there are less than 15 percent of US, UK, and Canadian firms with significant exposures, and less than 1 percent of Japanese firms with significant exposure. Based on these striking results we adduce that there has been an overvaluation of economic exposure in the literature to date, and contrary to these studies we posit that the exchange rate exposure puzzle extends into the long horizon.

3.5.2 Foreign exchange exposure across 10 industries

Given the transaction and economics exposure documents in the previous section, we now examine this exposure at an industry level, aggregating across countries and segregating by 10

[13] The results are identical only when the same covariance estimators are used. For example, at 1-week return horizon, the percentage of firms with significant exposure estimated on the overlapping OLS regression with the standard OLS covariance estimators is equal to the percentage of firms with significant exposure estimated on the TRF regression relying on the same covariance estimators. However, we do not present the estimation based on the overlapping OLS regression with the standard OLS covariance estimators but it is available from the authors on request.

industries types.[14] The results in Table 3.3 show that the Consumer services, Financials, and Health care experience the negative exposure for both transaction exposure and economic exposure. The Consumer goods, Oil & gas and Utilities mostly experience positive exposure across horizons, with the exception of 1-year return horizon. Basic materials, Industrials, Technology, and Telecommunications are negatively exposed to the currency movements in the short-run (transaction exposure) and become positively exposed in the long-run (economic exposure). Therefore, we are able to suggest that the impacts of exchange rate exposure vary according to industry. Again comparing OLS and TRF methods, the table confirms that using the former yields a significant overestimation of economic exposure for all industries. For example, an economic exposure at 5-year return horizons in Telecommunications is over 80 percent when the OLS is estimated but this decrease to zero when the TRF regression, regardless covariance method applied. Even though the economic exposure of firms in Basic materials is captured approximately 13-15 percent when the TRF regression is applied, these percentages drop about 70 percent from the estimation by the overlapping OLS regression. Consider the industry such as Consumer goods, Consumer services, Financials, Health care, Industrials, Oil & Gas, Technology, and Utilities, the percentage of economic exposure at 5-year return horizons are approximately two to seven when the TRF regression is applied. The economic exposure at 5-year horizon reduces by about 70-80 percent when it is compared with the OLS estimation. This is consistent with the findings we previously obtained across economies in Table 3.2.

[Table 3.3 around here]

[14] According to Industry Classification Benchmark (ICB), all firms are assigned into 10 industries, which are basic materials, consumer goods, consumer services, financials, health care, industrials, oil & gas, technology, and telecommunication. The results of exchange rate exposure in each industry by country are not tabulated but available from the authors on request.

3.5.3 Time variation in foreign exchange exposure of 4 economies

We examine whether the subprime crisis in 2007 – 2008 influences the behaviour of firms' exchange rate exposure in the four main industrialised countries. The investigations are split into 2 equal size periods; the first ten years from 1990 to 2000 and the last ten years from 2002 – 2012. The former period is accompanied by a gradual appreciation in the US dollar while the second period encompasses the subprime crisis. The evidence in Table 3.4 suggests that the total average exchange rate exposures of firms in the US and Japan increase for all return-horizons from the period without crisis (1st) to the period that includes the crisis (2nd). The directions of exchange exposure of firms in these two countries become positive in the crisis period suggesting that a depreciation of US dollar and Yen tends to benefit firms in the US and Japan respectively. In contrast, the total average exchange rate exposures of British and Canadian firms turn out to be negative in the second period for all return-horizons. Contrary to the US and Japan results, this indicates that firms in the UK and Canada receive a negative impact from a depreciation of their currency against their major trading partners. In terms of statistical significance a similar pattern emerges. When the OLS method is used for examination, we find an increase in the number of firms with significant exposure in most of the return-horizons for UK and Canada, but not for US and Japan.[15] Even though the total average exposures of firms in the Canada decrease in crisis periods, the results show that the percentage of firms with significant exposure mostly increases. Therefore, we cannot reject the assumption that firms' exposure is impacted by subprime crisis.

[Table 3.4 around here]

[15] We however find that the percentage of firms with significant exposure, estimated by the OLS method, decreases at 5-year horizon for all countries.

The results in Table 3.4 exhibit a clear variation in the relationship between evolution of exchange rates and stock prices. We explore this issue further by implementing a rolling regression framework for all 887 firms. Specifically, we estimate Equation (3.1) examining both transaction and economic exposure using a 10-year rolling window. This yields 681 coefficients per firm per horizon, and a total of 4,228,329 regression results across all 4 economies. In order to highlight the transaction and economic exposure in each economy, they are separately displayed in Figure 3.1 and 3.2, respectively. Figure 3.1 demonstrates the overall movements of the transaction exposure of 4 economies across horizons of 1, 4, 12, 52 week while Figure 3.2 plots the economic exposure across horizons of 2, 3, 5 years.

From Figure 3.1 and 3.2, it is apparent that the exchange rate exposures of these four economies are not very constant over time; in other words, all economies present a time varying pattern of exposure due to the impact of the economic cycles and exchange rate movements in each period. The graphs in Figures 3.1 show clearly that the movements of transaction exposures at horizons of 1-, 4-, 12-week of firms in all economies are quite similar across the sample periods, with average coefficients varying with greater magnitude as horizon increases. In the US and Japan, their transaction exposures experience negative value in the early period before the subprime crisis is considered. The exposures in Japan, however, experience less negative when they are compared to US exposure. During the crisis periods, the exchange rate exposure of Japanese firms becomes more positive and continually increases. It then declines again to the normal level after 2008 while the exposure of US firms shows the contradiction. Given the increase in exchange rate exposure of Japanese firms during the crisis, it would be reasonable to conjecture that the more export firms were exposed to a sudden rising of yen after the unwinding of yen-carry trade during that time.[16] The movements of transaction exposure in the US and Japan are contrary to the transaction exposure in the UK, which presented the positive value in the early part and became negative when the crisis started onwards. As many firms in the UK are importers, they were much more exposed to a tumble of pounds during the crisis. Accordingly, a downward trend of average exposure is found during the recession. In addition, we also find that transaction exposures of firms in Canada are less affected by the crisis. The transitions of transaction exposures after crisis are not much different than that of pre-crisis periods. The possible explanations of less impact of the global financial turmoil on Canadian exchange rate exposures during the crisis and afterwards are (i) the Canada's banking system was the soundest in the world from the year 2008 – 2011[17] which enabled the Canadian financial sectors to weather the financial storm better than other industrialised economies such as the US and UK. (ii) the Canadian subprime-mortgage market is not only relatively small, simple, and conservative but also remains good quality, particularly when compared with its US counterparts.[18] (iii) the external debt of Canada is less than that of other industrialised countries such as the US, UK, and Japan, suggesting that the changes in exchange rates had less impact upon the Canadian exposure when compared with other economies.[19]

[Figure 3.1 around here]

[16] Melvin and Taylor (2009) provide an evidence of yen carry trade during 2007 -2009.

[17] reported by The Global Competitiveness Reports 2008 -2009 and 2010 – 2011, The World Economic Forum

[18] Financial System Review, Bank of Canada, June 2008

[19] The world Factbook, Central Intelligence Agency

For the economic exposure presented in Figure 3.2, the exposure plots are similar in overall trend to the transaction exposure presented previously but exhibit much more volatility, particularly the 5-year return horizon.[20]

[Figure 3.2 around here]

The percentage of firms with significant exposure at the horizons of 1-, 4-, 12-, 52-week, and 2-, 3-, and 5- year are plotted at each rolling window in Figure 3.3. Figure 3.3(a) presents the percentage of firms with significant exposure, estimated by the overlapping OLS method relying on the Newey-West covariance estimates. Estimating by the overlapping OLS regression, we find that the percentage of US, UK, and Canadian firms with significant transaction exposure increases minimally during the crisis periods and afterwards, while the percentage of Japanese firms with significant transaction exposure has a big jump during the crisis. For economic exposure, we find that there are approximately 80 – 90% of firms exposed to this long-run exposure across the sample periods but, interestingly, the noticeable drop in economic exposure of firms in Canada is found after the crisis periods.

The percentage of firms with significant exposure, estimated by the TRF method relying on the standard OLS covariance estimates, is shown in Figure 3.3(b). The results estimated by this TRF regression show that the fluctuations of firms exposed to the short- or long-run exchange rate returns have the same pattern as the fluctuations estimated by the OLS method. With the TRF regression, we however find a huge drop in percentage of firms with significant coefficients for both transaction and economic exposure. For example, the percentage of firms

[20] Note that the number of observations used to estimate the exposure reduces as a function of k in Equation (3.1). Whilst the largest horizon of 5 years results in a 50% reduction in sample size in our 10-year rolling regression setup, there are nevertheless 261 remaining observations, which we view as more than sufficient.

with statistically significant exposure in US, Canada, and Japan fall to 0% in some periods after crisis.

Finally turning to the more robust TRF-HAC results, Figure 3.3(c) shows that the percentage of firms with significant transaction exposure at 1-week horizon exhibits a fluctuation from 1990 to 2012. Since the movement on trade weighted exchange rates of US dollar and British Pounds are not much different during this period, which is strengthening from 1990 to mid-1995, continuously more strengthening from 1997-2002, becoming weakening during 2002-2007 and minimally fluctuating after 2008, the movement on percentage of US and UK firms with significant exposure has a similar pattern, particularly at 5-year horizon. Specifically, the movement of exposure at 5-year horizon displays large swing with four jumps across the sample periods. Additionally, the percentage of US and UK firms with significant exposure slightly drops in transaction exposure but seriously falls in economic exposure after crisis. This is intuitively saying that most American and British firms have greater ability in accessing hedging instruments to avoid the exchange rate risks, particularly a long-term economic exposure hedging. The movement on percentage of Canadian firms with significant exposure displays two big jumps – once at the early periods accompanied by the US dollar appreciation again during the periods of subprime crisis – but has much less volatility. The economic exposure at 5-year horizon has been found about 10 percent in the early period and has a downward trend afterwards until it disappear during 2003-2008. The economic exposure of Canadian firms can be captured again during the period of subprime crisis. The time-varying exchange rate exposure of Japanese firms has a different picture, compared to other three countries. For transaction exposure, the percentage of firms with significant transaction exposure is not much volatile but sharply increases during the period of subprime crisis, particularly, at 1-week horizon. For economic exposure, it is less than 10 percent in the earlier period and increase immediately when the period of Asian crisis is included. The economic exposure at 5-year horizon reaches about 30 percent during this period and gradually drops afterwards. The percentage of firm that significantly exposed to exchange rate movement during the subprime crisis is approximately half of the percent during the Asian crisis. This infers that subprime crisis had less impacted on Japanese firms than Asian crisis did. It is possible to assume that most Japanese firms use the lesson from Asian crisis to minimise the economic exposure during subprime crisis.

[Figure 3.3 around here]

3.6 Conclusion

This paper examines both transaction and economic exposure of individual firms in a sample of industrialised countries (US, UK, Canada, and Japan) by adopting the recent technique called 'TRF regression' introduced by Britten Jones et al. (2011) to correct for the autocorrelation in the error term induced by data-overlapping. Using standard inference the literature finds support for economic exposure, as indeed do we in this study, with 70-80 percent of firms are found to be exposed at longer horizons. Strikingly, adopting the TRF regression method and explicitly addressing the problem of data overlapping find evidence of huge reductions in the percentage of firms with statistically significant exposure. This novel result suggests that the exchange rate exposure puzzle, which is normally viewed as a puzzle only in terms of transaction exposure, is worse than previously believed.

In addition, we also investigate the evidence of transaction and economic exposure across industry types as well as the effect of the subprime crisis in 2007 – 2008 on the firms' exchange rate exposure. The time-varying exposures with rolling-window regressions are used to capture the variation of exposure in each period. The original model has to be properly modified in order to capture the firms significantly exposed to exchange rate movement. Our findings show that all economy exhibits a time variation in exchange rate exposure due to the impact of global financial turmoil. Interestingly, we find that the transaction exposure of firms in Canada is less affected by this crisis. Even though the absolute magnitude of average exchange rate exposure of British and Japanese firms increases during the crisis, the percentage of those firms that significantly exposed to long-horizon exchange rate changes decreases during these periods. From this it is possible to infer that these two countries have a greater ability in accessing hedging instruments to alleviate the economic exposure.

Table 3.1 The summary statistics of stock market returns and exchange rate returns in 4 economies

Panel A: Value-weighted stock market returns[a]				
	SP500	FTSE100	TSX60	NIKKEI225
Mean	0.12%	0.07%	0.11%	-0.11%
Median	0.21%	0.24%	0.27%	0.07%
Standard Deviation	2.51%	2.48%	2.61%	3.44%
Kurtosis	4.34	3.59	6.73	4.69
Skewness	-0.37	-0.35	-0.92	-0.43
Minimum	-14.91%	-14.14%	-18.86%	-23.54%
Maximum	12.95%	14.26%	13.42%	18.02%
Observations	1200	1200	1200	1200
Panel B: Equal-weighted stock market returns[b]				
	US	UK	Canada	Japan
Mean	0.16%	0.10%	0.18%	-0.07%
Median	0.30%	0.30%	0.39%	0.03%
Standard Deviation	2.58%	2.10%	2.23%	3.14%
Kurtosis	5.89	4.95	9.28	5.65
Skewness	-0.48	-0.78	-1.30	-0.46
Minimum	-17.05%	-13.35%	-18.15%	-23.19%
Maximum	14.44%	10.30%	11.10%	17.60%
Observations	1200	1200	1200	1200
Panel C: Exchange rate returns[c]				
	US dollar	GBP	Canadian dollar	Yen
Mean	0.02%	0.01%	-0.01%	-0.04%
Median	0.03%	-0.03%	0.00%	0.09%
Standard Deviation	0.97%	0.98%	1.07%	1.54%
Kurtosis	1.03	9.08	6.70	7.87
Skewness	0.01	1.09	0.15	-1.18
Minimum	-3.83%	-3.68%	-8.17%	-12.92%
Maximum	4.55%	9.07%	7.75%	7.33%
Observations	1200	1200	1200	1200

Notes: a) Value-weighted stock market returns are calculated as the log returns from the weekly stock market indices. b) Equal-weighted stock market indices of each country are averaged of weekly log returns of firms which are included in the sample – 306 US firms, 265 British firms, 76 Canadian firms, and 240 Japanese firms. c) Exchange rate returns are calculated as the log return of the weekly trade weighted exchange rate indices of each country. The sample period covers the period of 1 January 1990 to 31 December 2012.

Table 3.2 Transaction and economic exposure of firms classified by 4 economies

		Transaction Exposure				Economic Exposure		
	Return-horizon	1 wk	4 wks	12 wks	52 wks	2 yrs	3 yrs	5 yrs
	US (306 firms)							
	Average γ	0.05	0.00	-0.05	-0.01	0.03	0.26	0.52
	Std. dev γ	0.30	0.36	0.47	0.75	0.95	1.46	1.93
	Average - γ	-0.16	-0.26	-0.39	-0.58	-0.70	-0.94	-1.29
	Average +γ	0.26	0.29	0.34	0.57	0.75	1.20	1.63
	Number of firms with – γ	150	164	164	153	152	134	116
	Number of firms with + γ	156	142	142	153	154	172	190
A	Percentage of firms with –γ	12.75	16.01	22.88	27.45	32.68	31.05	31.37
	Percentage of firms with +γ	23.20	20.59	18.95	24.51	31.37	42.16	51.96
B	Percentage of firms with –γ	13.73	10.46	7.19	1.31	0.33	0.65	0.98
	Percentage of firms with +γ	25.16	14.05	8.82	1.31	1.31	4.90	5.88
C	Percentage of firms with –γ	12.75	13.07	11.44	4.25	2.94	2.29	1.96
	Percentage of firms with +γ	23.20	16.34	13.07	2.94	0.98	4.58	4.58
	UK (265 firms)							
	Average γ	-0.06	-0.10	-0.30	-0.25	-0.19	-0.07	-0.24
	Std. dev γ	0.26	0.38	0.63	0.99	1.44	1.79	2.29
	Average - γ	-0.23	-0.33	-0.62	-0.89	-1.16	-1.49	-1.82
	Average +γ	0.18	0.25	0.30	0.58	0.94	1.18	1.52
	Number of firms with – γ	155	161	175	149	142	124	140
	Number of firms with + γ	110	104	90	116	123	141	125
A	Percentage of firms with –γ	18.87	17.36	35.47	32.83	34.72	36.98	41.89
	Percentage of firms with +γ	16.60	16.23	14.72	26.79	32.08	39.25	40.38
B	Percentage of firms with –γ	27.17	20.75	24.15	9.43	7.92	4.91	4.91
	Percentage of firms with +γ	18.49	13.58	5.66	4.15	5.66	3.77	1.51
C	Percentage of firms with –γ	18.87	13.58	15.85	5.28	2.26	1.13	1.13
	Percentage of firms with +γ	16.60	13.96	7.17	3.77	4.53	1.13	0.38
	Canada (76 firms)							
	Average γ	-0.22	-0.29	-0.43	-0.65	-0.51	-0.44	-0.38
	Std. dev γ	0.38	0.46	0.79	1.48	2.33	2.47	2.85
	Average - γ	-0.36	-0.46	-0.78	-1.29	-1.94	-2.10	-2.33
	Average +γ	0.13	0.15	0.32	0.82	1.25	1.40	1.68
	Number of firms with – γ	55	55	52	53	42	40	39
	Number of firms with + γ	21	21	24	23	34	36	37
A	Percentage of firms with –γ	30.26	26.32	32.89	43.42	36.84	47.37	42.11
	Percentage of firms with +γ	3.95	2.63	6.58	18.42	31.58	34.21	42.11
B	Percentage of firms with –γ	32.89	23.68	14.47	10.53	10.53	6.58	3.95
	Percentage of firms with +γ	9.21	2.63	2.63	5.26	5.26	3.95	3.95
C	Percentage of firms with –γ	30.26	23.68	19.74	15.79	14.47	10.53	7.89
	Percentage of firms with +γ	3.95	2.63	5.26	3.95	5.26	5.26	6.58

Table 3.2 Transaction and economic exposure of firms classified by 4 economies (continued)

		Transaction Exposure				Economic Exposure		
Return-horizon		1 wk	4 wks	12 wks	52 wks	2 yrs	3 yrs	5 yrs
Japan (240 firms)								
Average γ		0.01	0.00	0.05	0.17	0.18	0.21	0.58
Std. dev γ		0.23	0.27	0.36	0.56	0.58	0.53	0.75
Average - γ		-0.16	-0.20	-0.24	-0.48	-0.43	-0.38	-0.40
Average +γ		0.20	0.22	0.32	0.47	0.52	0.50	0.83
Number of firms with – γ		126	125	117	76	86	81	49
Number of firms with + γ		114	115	123	164	154	159	191
A	Percentage of firms with –γ	25.83	24.17	17.92	19.58	21.25	20.00	9.58
	Percentage of firms with +γ	20.83	17.08	25.00	47.92	50.83	52.08	59.58
B	Percentage of firms with –γ	32.08	16.67	5.42	2.08	0.42	0.00	0.00
	Percentage of firms with +γ	27.92	13.33	10.42	2.92	2.50	0.83	0.42
C	Percentage of firms with –γ	25.83	20.00	5.83	2.92	0.83	0.00	0.00
	Percentage of firms with +γ	20.83	14.58	11.67	5.00	3.75	1.67	0.42

Notes: (A) The percentage of firms with significant –γ or +γ estimated by the overlapping OLS regression relying on the Newey-West covariance estimates. (B) The percentage of firms with significant –γ or +γ estimated by the TRF regression relying on the standard OLS covariance estimates. (C) The percentage of firms with significant –γ or +γ estimated by the TRF regression relying on the Newey-West covariance estimates. All results are reported by 1-tailed test at 5% significant level.

Table 3.3 Transaction and economic exposure of firms across 10 industries

		Transaction Exposure				Economic Exposure		
	Return-horizon	1 wk	4 wks	12 wks	52 wks	2 yrs	3 yrs	5 yrs
	Basic Materials (69 firms)							
	Average γ	-0.08	-0.14	-0.13	-0.09	-0.23	0.02	0.41
	Std. dev γ	0.48	0.54	0.79	1.46	2.16	2.46	3.06
	Average - γ	-0.40	-0.47	-0.70	-1.20	-1.94	-2.01	-2.82
	Average +γ	0.26	0.27	0.36	0.71	0.87	1.25	1.74
	Number of firms with – γ	36	38	32	29	27	26	20
	Number of firms with + γ	33	31	37	40	42	43	49
A	Percentage of firms with –γ	26.09	26.09	17.39	24.64	31.88	30.43	24.64
	Percentage of firms with +γ	17.39	17.39	23.19	39.13	46.38	53.62	59.42
B	Percentage of firms with –γ	27.54	21.74	8.70	4.35	8.70	4.35	2.90
	Percentage of firms with +γ	20.29	11.59	8.70	4.35	5.80	4.35	10.14
C	Percentage of firms with –γ	26.09	18.84	8.70	7.25	10.14	7.25	5.80
	Percentage of firms with +γ	17.39	13.04	10.14	8.70	4.35	5.80	8.70
	Consumer Goods (125 firms)							
	Average γ	0.02	0.00	-0.03	-0.03	0.02	0.18	0.41
	Std. dev γ	0.22	0.30	0.45	0.69	0.89	1.17	1.52
	Average - γ	-0.13	-0.21	-0.35	-0.59	-0.67	-0.76	-1.23
	Average +γ	0.21	0.23	0.30	0.42	0.53	0.73	1.00
	Number of firms with – γ	69	64	64	55	53	46	33
	Number of firms with + γ	56	61	61	70	72	79	92
A	Percentage of firms with –γ	16.00	15.20	20.00	21.60	25.60	23.20	17.60
	Percentage of firms with +γ	17.60	15.20	19.20	32.00	36.00	44.00	52.80
B	Percentage of firms with –γ	23.20	12.00	7.20	3.20	3.20	1.60	0.00
	Percentage of firms with +γ	20.00	14.40	11.20	3.20	3.20	1.60	0.00
C	Percentage of firms with –γ	16.00	12.00	6.40	3.20	0.80	0.00	0.00
	Percentage of firms with +γ	17.60	15.20	12.80	3.20	4.00	3.20	2.40
	Consumer Services (100 firms)							
	Average γ	-0.17	-0.24	-0.37	-0.32	-0.23	-0.26	-0.42
	Std. dev γ	0.21	0.37	0.65	0.94	1.16	1.55	2.23
	Average - γ	-0.24	-0.37	-0.59	-0.93	-1.03	-1.37	-1.95
	Average +γ	0.12	0.22	0.31	0.52	0.79	1.05	1.44
	Number of firms with – γ	81	78	75	58	56	54	55
	Number of firms with + γ	19	22	25	42	44	46	45
A	Percentage of firms with –γ	42.00	39.00	45.00	38.00	39.00	43.00	45.00
	Percentage of firms with +γ	4.00	6.00	10.00	21.00	32.00	41.00	39.00
B	Percentage of firms with –γ	46.00	32.00	24.00	8.00	2.00	2.00	4.00
	Percentage of firms with +γ	4.00	5.00	1.00	5.00	3.00	4.00	3.00
C	Percentage of firms with –γ	42.00	35.00	25.00	9.00	6.00	4.00	3.00
	Percentage of firms with +γ	4.00	3.00	5.00	5.00	4.00	4.00	4.00

Table 3.3 Transaction and economic exposure of firms across 10 industries (continued)

		Transaction Exposure				Economic Exposure		
	Return-horizon	1 wk	4 wks	12 wks	52 wks	2 yrs	3 yrs	5 yrs
Financials (186 firms)								
	Average γ	-0.01	-0.03	-0.18	-0.18	-0.15	-0.08	-0.11
	Std. dev γ	0.25	0.33	0.49	0.87	1.22	1.44	1.80
	Average - γ	-0.21	-0.26	-0.46	-0.72	-0.92	-1.16	-1.44
	Average +γ	0.19	0.25	0.29	0.62	0.81	0.85	1.10
	Number of firms with – γ	91	103	116	110	103	86	89
	Number of firms with + γ	95	83	70	76	83	100	97
A	Percentage of firms with –γ	16.67	17.74	36.02	36.02	34.41	35.48	39.78
	Percentage of firms with +γ	24.19	19.89	14.52	30.65	31.18	37.63	43.01
B	Percentage of firms with –γ	25.27	15.05	19.89	6.45	6.45	3.76	4.30
	Percentage of firms with +γ	29.57	15.59	6.45	4.84	4.30	3.23	0.54
C	Percentage of firms with –γ	16.67	13.98	18.28	6.99	3.76	2.69	2.15
	Percentage of firms with +γ	24.19	17.20	8.60	3.76	4.30	0.54	0.54
Health Care (39 firms)								
	Average γ	-0.01	-0.07	-0.05	-0.02	-0.10	-0.27	-0.10
	Std. dev γ	0.20	0.24	0.27	0.59	0.96	1.45	1.89
	Average - γ	-0.13	-0.17	-0.21	-0.47	-0.84	-1.15	-1.42
	Average +γ	0.15	0.20	0.19	0.46	0.68	0.99	1.43
	Number of firms with – γ	23	28	24	20	20	23	21
	Number of firms with + γ	16	11	15	19	19	16	18
A	Percentage of firms with –γ	12.82	20.51	12.82	25.64	38.46	46.15	46.15
	Percentage of firms with +γ	5.13	5.13	5.13	20.51	30.77	30.77	41.03
B	Percentage of firms with –γ	17.95	15.38	0.00	0.00	0.00	2.56	2.56
	Percentage of firms with +γ	7.69	2.56	2.56	0.00	2.56	7.69	7.69
C	Percentage of firms with –γ	12.82	15.38	0.00	2.56	2.56	5.13	5.13
	Percentage of firms with +γ	5.13	2.56	2.56	2.56	2.56	5.13	2.56
Industrials (215 firms)								
	Average γ	-0.01	-0.06	-0.14	-0.06	0.00	0.17	0.44
	Std. dev γ	0.20	0.30	0.53	0.88	1.13	1.38	1.68
	Average - γ	-0.16	-0.29	-0.49	-0.84	-0.93	-1.06	-1.21
	Average +γ	0.15	0.19	0.30	0.52	0.73	0.97	1.32
	Number of firms with – γ	111	114	121	92	94	85	75
	Number of firms with + γ	104	101	94	123	121	130	140
A	Percentage of firms with –γ	12.09	18.14	25.12	26.51	27.91	28.37	22.33
	Percentage of firms with +γ	15.35	13.95	19.07	35.35	40.93	46.51	51.63
B	Percentage of firms with –γ	16.28	14.88	13.49	6.98	3.26	2.33	1.86
	Percentage of firms with +γ	20.47	7.91	5.58	0.93	1.86	2.79	2.79
C	Percentage of firms with –γ	12.09	14.88	11.63	6.51	2.79	0.93	0.47
	Percentage of firms with +γ	15.35	11.16	6.98	2.33	1.86	1.86	1.40

Table 3.3 Transaction and economic exposure of firms across 10 industries (continued)

		Transaction Exposure				Economic Exposure		
Return-horizon		1 wk	4 wks	12 wks	52 wks	2 yrs	3 yrs	5 yrs
Oil & Gas (50 firms)								
Average γ		0.23	0.16	0.02	-0.01	0.10	0.60	0.87
Std. dev γ		0.54	0.54	0.77	1.01	1.39	1.76	2.26
Average - γ		-0.32	-0.39	-0.60	-0.85	-0.92	-1.15	-1.45
Average +γ		0.63	0.53	0.60	0.60	0.97	1.50	1.97
Number of firms with – γ		21	20	24	21	23	17	16
Number of firms with + γ		29	30	26	29	27	33	34
A	Percentage of firms with –γ	24.00	16.00	18.00	24.00	24.00	26.00	24.00
	Percentage of firms with +γ	54.00	42.00	40.00	26.00	34.00	52.00	58.00
B	Percentage of firms with –γ	26.00	16.00	4.00	0.00	0.00	0.00	0.00
	Percentage of firms with +γ	54.00	40.00	22.00	0.00	2.00	4.00	4.00
C	Percentage of firms with –γ	24.00	14.00	4.00	0.00	0.00	0.00	0.00
	Percentage of firms with +γ	54.00	42.00	32.00	2.00	0.00	8.00	4.00
Technology (49 firms)								
Average γ		-0.02	-0.09	-0.14	0.25	0.34	0.39	0.43
Std. dev γ		0.26	0.35	0.49	0.87	1.26	1.74	2.17
Average - γ		-0.18	-0.27	-0.46	-0.58	-0.73	-1.03	-1.58
Average +γ		0.22	0.33	0.36	0.78	1.15	1.55	1.93
Number of firms with – γ		30	34	30	19	21	22	21
Number of firms with + γ		19	15	19	30	28	27	28
A	Percentage of firms with –γ	12.24	6.12	18.37	18.37	28.57	28.57	36.73
	Percentage of firms with +γ	16.33	16.33	14.29	36.73	44.90	40.82	51.02
B	Percentage of firms with –γ	12.24	6.12	2.04	0.00	0.00	0.00	0.00
	Percentage of firms with +γ	18.37	12.24	12.24	6.12	6.12	2.04	2.04
C	Percentage of firms with –γ	12.24	6.12	8.16	0.00	0.00	0.00	2.04
	Percentage of firms with +γ	16.33	14.29	14.29	6.12	4.08	2.04	0.00
Telecommunications (10 firms)								
Average γ		-0.05	-0.07	-0.03	0.03	0.25	0.20	0.06
Std. dev γ		0.19	0.23	0.31	0.63	0.94	1.13	1.35
Average - γ		-0.20	-0.22	-0.28	-0.38	-0.31	-0.42	-0.89
Average +γ		0.10	0.08	0.21	0.65	1.10	1.13	1.01
Number of firms with – γ		5	5	5	6	6	6	5
Number of firms with + γ		5	5	5	4	4	4	5
A	Percentage of firms with –γ	30.00	20.00	20.00	30.00	40.00	50.00	50.00
	Percentage of firms with +γ	0.00	0.00	0.00	30.00	30.00	20.00	30.00
B	Percentage of firms with –γ	30.00	20.00	20.00	0.00	0.00	0.00	0.00
	Percentage of firms with +γ	10.00	0.00	0.00	0.00	10.00	0.00	0.00
C	Percentage of firms with –γ	30.00	20.00	20.00	0.00	0.00	0.00	0.00
	Percentage of firms with +γ	0.00	0.00	0.00	10.00	10.00	0.00	0.00

Table 3.3 Transaction and economic exposure of firms across 10 industries (continued)

		Transaction Exposure				Economic Exposure		
Return-horizon		1 wk	4 wks	12 wks	52 wks	2 yrs	3 yrs	5 yrs
Utilities (44 firms)								
Average γ		0.02	0.04	0.09	-0.03	0.15	0.35	0.77
Std. dev γ		0.21	0.24	0.28	0.46	0.57	0.71	0.88
Average - γ		-0.19	-0.17	-0.20	-0.42	-0.35	-0.28	-0.22
Average +γ		0.18	0.22	0.27	0.33	0.53	0.65	1.02
Number of firms with – γ		19	21	17	21	19	14	9
Number of firms with + γ		25	23	27	23	25	30	35
A	Percentage of firms with –γ	25.00	9.09	9.09	25.00	20.45	15.91	6.82
	Percentage of firms with +γ	34.09	31.82	34.09	27.27	40.91	47.73	70.45
B	Percentage of firms with –γ	25.00	9.09	0.00	0.00	0.00	0.00	0.00
	Percentage of firms with +γ	40.91	20.45	13.64	0.00	0.00	6.82	6.82
C	Percentage of firms with –γ	25.00	6.82	0.00	0.00	0.00	0.00	0.00
	Percentage of firms with +γ	34.09	18.18	18.18	2.27	0.00	2.27	2.27

Notes: (A) The percentage of firms with significant –γ or +γ estimated by the overlapping OLS regression relying on the Newey-West covariance estimates. (B) The percentage of firms with significant –γ or +γ estimated by the TRF regression relying on the standard OLS covariance estimates. (C) The percentage of firms with significant –γ or +γ estimated by the TRF regression relying on the Newey-West covariance estimates. All results are reported by 1-tailed test at 5% significant level.

Table 3.4 A comparison of the average exchange rate exposure and the percentage of firms with significant exposure between 1990-2000 and 2002-2012

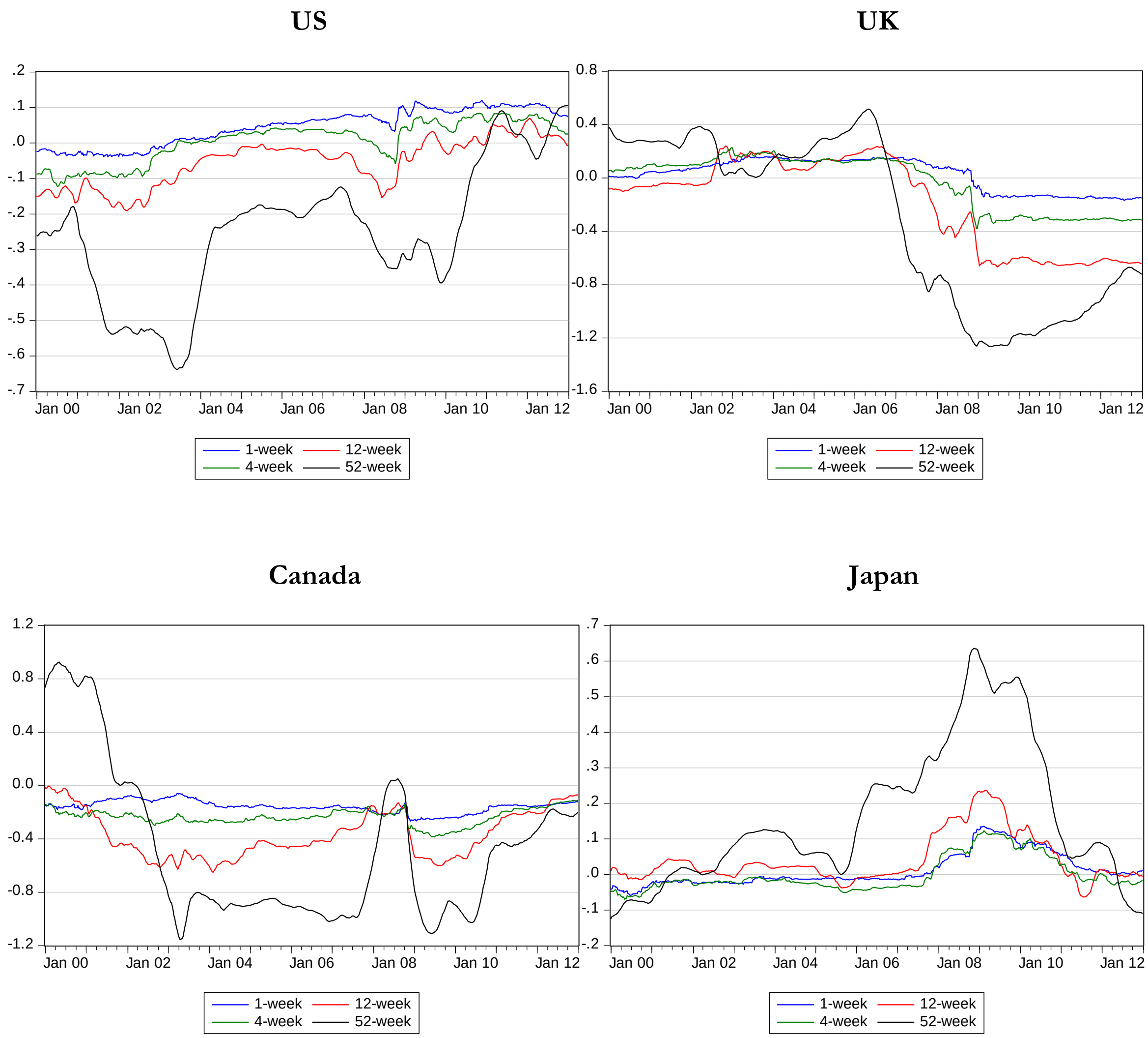
		Transaction Exposure								Economic Exposure					
	Return-horizon	1 wk		4 wks		12 wks		52 wks		2 yrs		3 yrs		5 yrs	
		1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
US															
	Average γ	-0.05	0.10	-0.14	0.08	-0.22	0.08	-0.22	0.15	-0.49	0.17	-0.25	0.46	0.41	0.25
A	Percentage of firms with $-\gamma$	9.15	12.75	20.26	9.80	27.45	11.11	36.93	23.53	44.12	24.84	35.95	25.49	16.99	12.09
	Percentage of firms with $+\gamma$	5.56	25.49	9.15	18.95	8.17	24.18	16.67	32.03	15.69	33.99	19.93	40.85	44.44	19.61
B	Percentage of firms with $-\gamma$	11.44	15.36	13.73	4.58	10.46	2.61	2.94	0.65	2.29	0.00	2.61	0.00	1.31	0.98
	Percentage of firms with $+\gamma$	5.56	28.10	4.90	11.44	1.96	3.59	1.63	2.29	0.33	0.65	0.33	0.65	3.27	1.63
C	Percentage of firms with $-\gamma$	9.15	12.75	15.03	5.88	14.38	2.94	5.23	0.65	6.86	0.00	7.19	0.00	1.31	1.31
	Percentage of firms with $+\gamma$	5.56	25.49	6.86	14.71	3.27	7.19	2.29	4.90	2.94	2.29	3.59	3.92	4.25	4.25
UK															
	Average γ	0.02	-0.15	0.07	-0.30	-0.06	-0.61	0.31	-0.76	0.70	-0.95	1.29	-0.98	0.98	-1.40
A	Percentage of firms with $-\gamma$	10.57	19.25	7.17	24.91	18.11	41.51	16.98	49.06	13.21	52.83	13.21	49.43	21.13	59.25
	Percentage of firms with $+\gamma$	17.36	14.72	18.87	10.19	16.60	10.94	48.68	16.98	59.25	19.62	68.30	20.38	63.02	22.64
B	Percentage of firms with $-\gamma$	12.45	32.08	6.42	27.17	7.55	26.04	1.89	8.30	1.51	4.91	1.13	6.79	1.89	7.55
	Percentage of firms with $+\gamma$	20.00	15.47	15.09	5.66	4.91	1.51	7.55	0.38	15.09	0.00	20.00	0.00	14.72	0.00
C	Percentage of firms with $-\gamma$	10.57	19.25	4.91	19.62	6.42	13.58	1.89	3.40	0.38	0.00	0.75	0.75	0.75	4.15
	Percentage of firms with $+\gamma$	17.36	14.72	14.72	7.17	8.30	1.89	10.57	0.00	14.34	0.00	18.49	0.00	15.09	0.00
Canada															
	Average γ	-0.13	-0.15	-0.17	-0.17	-0.07	-0.21	0.66	-0.34	1.67	-1.33	0.98	-1.55	3.85	-1.18
A	Percentage of firms with $-\gamma$	9.21	25.00	9.21	15.79	17.11	27.63	11.84	27.63	13.16	53.95	30.26	59.21	22.37	57.89
	Percentage of firms with $+\gamma$	3.95	15.79	6.58	5.26	13.16	10.53	34.21	10.53	46.05	10.53	36.84	13.16	53.95	11.84
B	Percentage of firms with $-\gamma$	13.16	27.63	6.58	13.16	2.63	9.21	1.32	5.26	0.00	10.53	1.32	11.84	3.95	5.26
	Percentage of firms with $+\gamma$	5.26	18.42	3.95	3.95	6.58	1.32	5.26	2.63	6.58	0.00	2.63	0.00	9.21	0.00
C	Percentage of firms with $-\gamma$	9.21	25.00	6.58	13.16	3.95	17.11	2.63	5.26	1.32	15.79	6.58	14.47	3.95	9.21
	Percentage of firms with $+\gamma$	3.95	15.79	3.95	3.95	6.58	0.00	3.95	0.00	10.53	0.00	6.58	1.32	13.16	1.32

Table 3.4 A comparison of the average exchange rate exposure and the percentage of firms with significant exposure between 1990-2000 and 2002-2012 (continued)

		Transaction Exposure								Economic Exposure					
	Return-horizon	1 wk		4 wks		12 wks		52 wks		2 yrs		3 yrs		5 yrs	
		1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
	Japan														
	Average γ	-0.04	0.02	-0.04	0.01	0.01	0.00	-0.07	0.05	-0.15	-0.01	-0.16	0.15	-0.21	0.52
A	Percentage of firms with $-\gamma$	24.58	15.42	19.58	18.75	17.50	23.75	32.50	27.08	45.83	35.83	52.08	36.67	53.75	19.58
	Percentage of firms with $+\gamma$	12.08	14.58	10.83	17.50	16.67	21.67	27.50	34.58	28.33	36.67	29.58	44.58	27.50	49.58
B	Percentage of firms with $-\gamma$	29.17	21.25	9.17	8.75	1.67	5.42	0.42	0.42	0.42	0.00	0.42	0.00	0.42	0.00
	Percentage of firms with $+\gamma$	13.75	23.33	6.67	12.92	5.00	7.50	0.83	0.42	0.83	0.42	0.83	0.83	0.42	2.50
C	Percentage of firms with $-\gamma$	24.58	15.42	12.08	10.42	3.33	5.00	2.08	0.42	2.50	0.42	0.83	0.42	0.83	0.00
	Percentage of firms with $+\gamma$	12.08	14.58	9.17	15.00	6.25	7.08	1.67	1.25	2.92	0.42	2.92	1.67	1.25	2.92

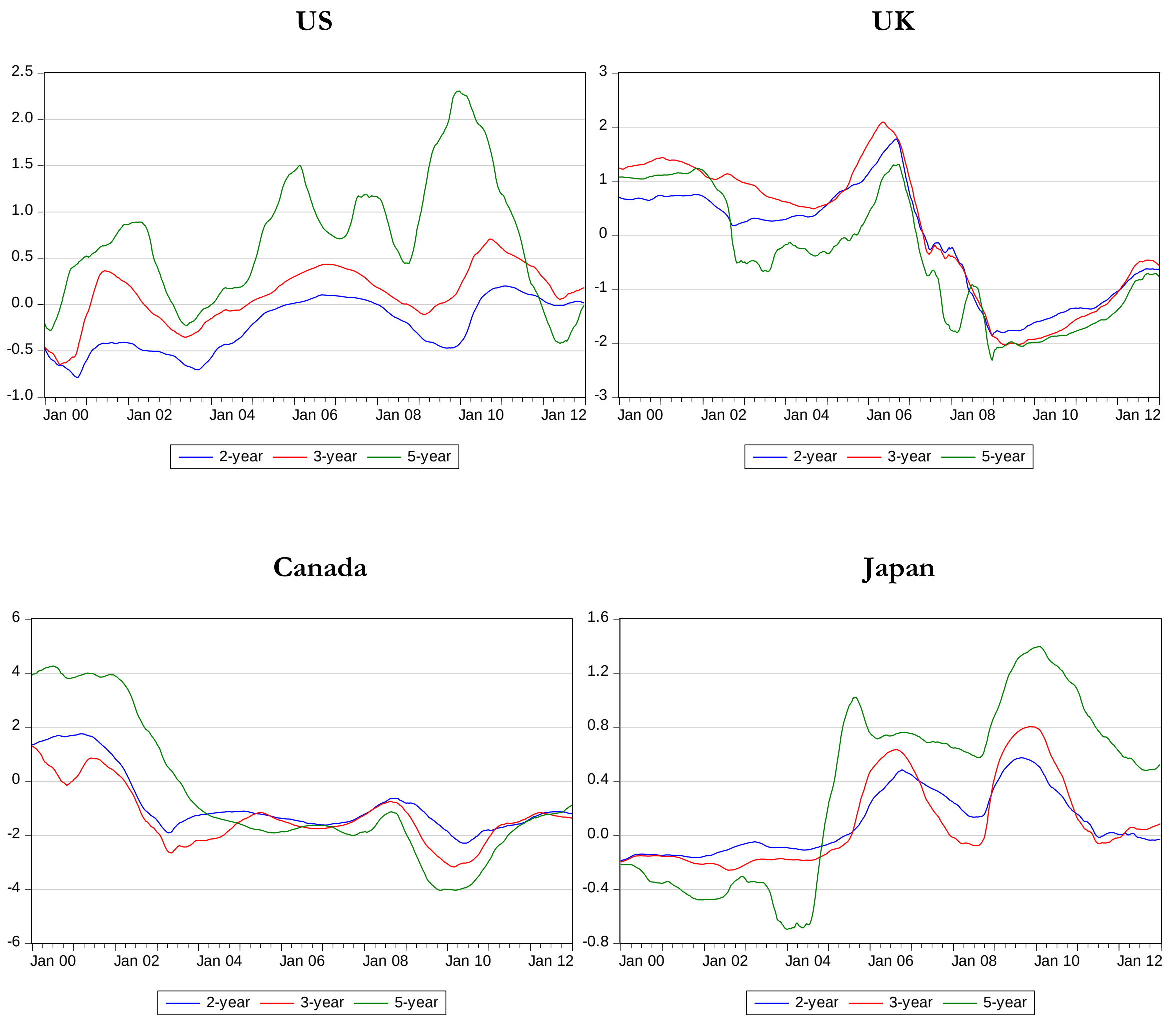
Notes: The 1st shows the periods 1990 – 2000 and the 2nd shows the periods 2002 – 2012. (A) The percentage of firms with significant $-\gamma$ or $+\gamma$ estimated by the overlapping OLS regression relying on the Newey-West covariance estimates. (B) The percentage of firms with significant $-\gamma$ or $+\gamma$ estimated by the TRF regression relying on the standard OLS covariance estimates. (C) The percentage of firms with significant $-\gamma$ or $+\gamma$ estimated by the TRF regression relying on the Newey-West covariance estimates. All results are reported by 2-tailed test at 5% significant level.

Figure 3.1 Transaction exposure estimated by 10-year rolling window estimation



Notes: The average weekly transaction exposure estimated by 10-year rolling window estimation. The estimation starts from 1/1/1990-27/12/1999 and ends 1/1/2003-27/12/2012, which yields 681 coefficients per firms per horizons.

Figure 3.2 Economic exposure estimated by 10-year rolling window estimation

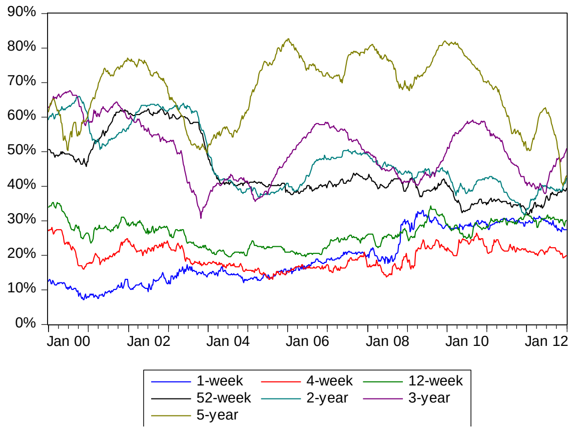


Notes: The average weekly economic exposure estimated by 10-year rolling window estimation. The estimation starts from 1/1/1990-27/12/1999 and ends 1/1/2003-27/12/2012, which yields 681 coefficients per firms per horizons.

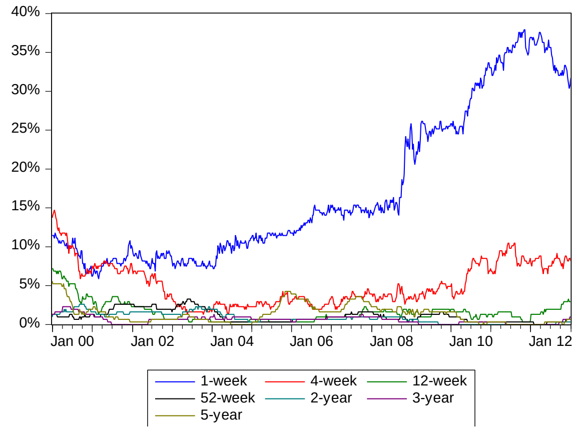
Figure 3.3 Percentage of firms with significant exposure with 10-year rolling window estimation

US

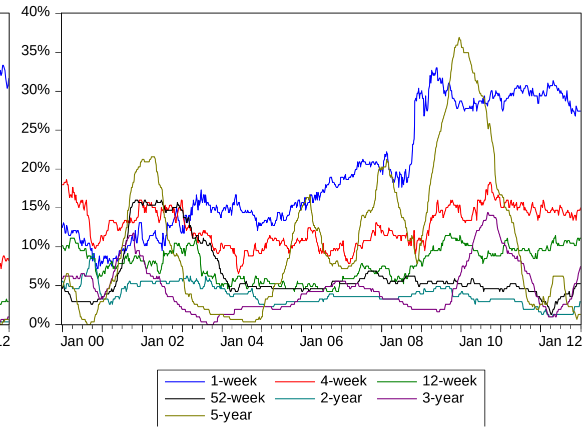
(a)



(b)

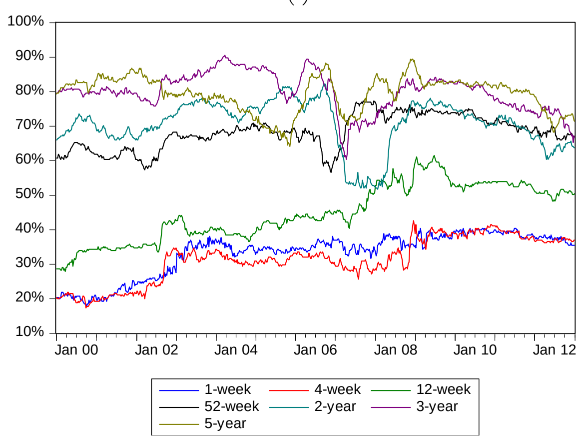


(c)

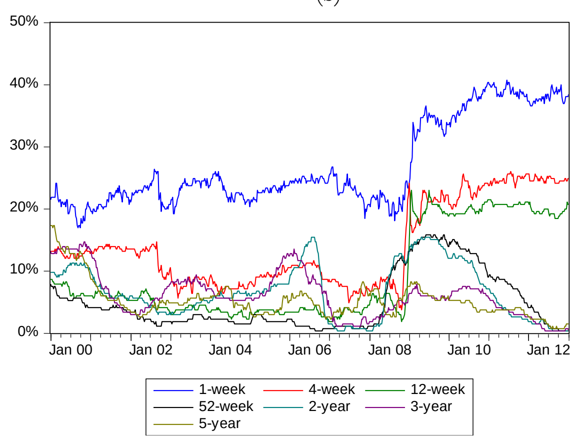


UK

(a)



(b)



(c)

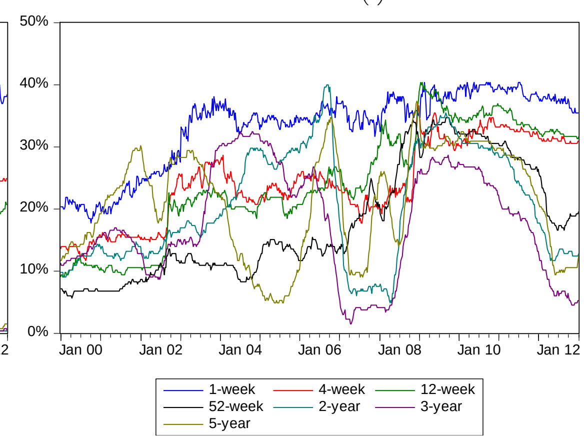
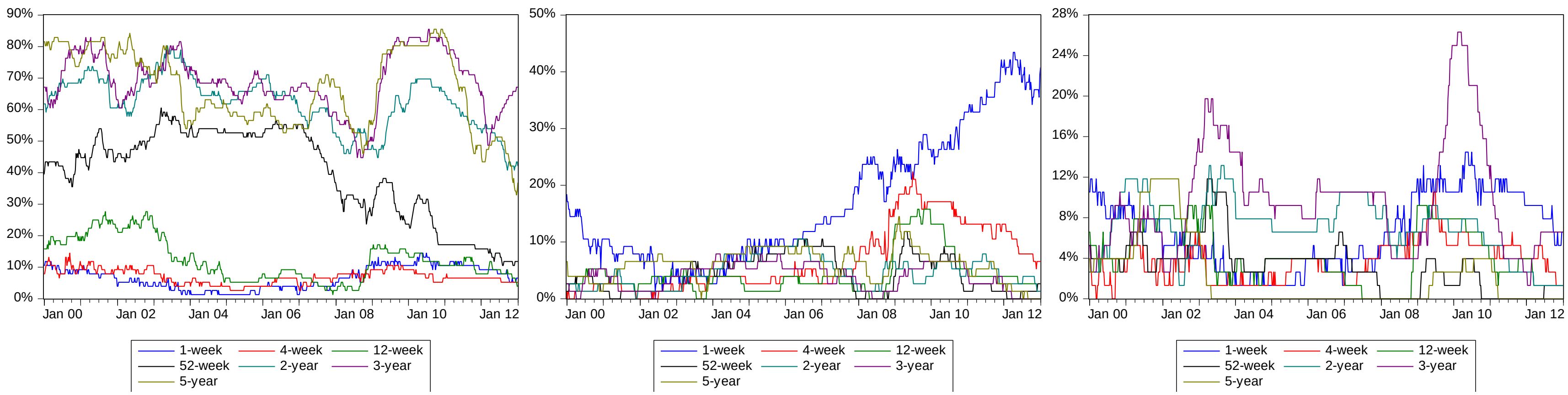


Figure 3.3 Percentage of firms with significant exposure with 10-year rolling window estimation (continued)

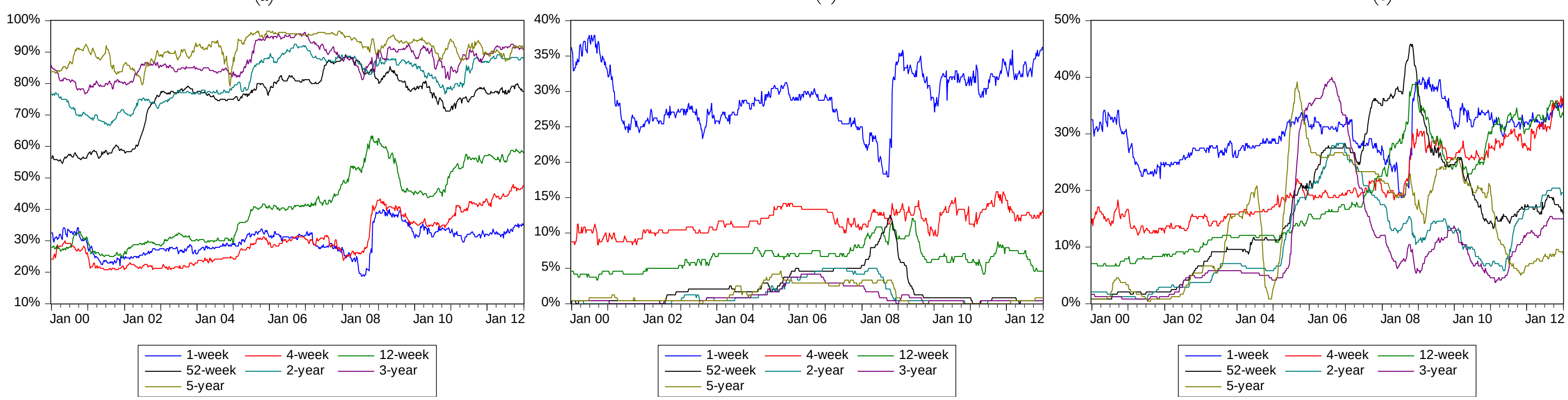
Canada

(a) (b) (c)



Japan

(a) (b) (c)



Notes: The percentage of firms with significant exposure estimated by 10-year rolling window estimation. The estimation starts from 1/1/1990-27/12/1999 and ends 1/1/2003-27/12/2012, which yields 681 regressions per firms per horizons. (a) the overlapping OLS regression relying on the Newey-West covariance estimates (b) the TRF regression relying on the standard OLS covariance estimates and (c) the TRF regression relying on the Newey-West covariance estimates.

Chapter 4 How does inflation targeting influence exchange rate pass through?

4.1 Introduction

Understanding the effects of exchange rate fluctuations on domestic prices has been a crucial issue to central banks of open economies. This effect is called exchange rate pass-through (ERPT) and the extent of pass-through is an important factor for policymakers when conducting proper monetary policy. More formally, the ERPT relationship is the percentage change in domestic price resulting from a one percent change in the exchange rate between imported and exported countries. The degree of ERPT to prices ranges between 0 (no pass-through) to 1 (complete pass-through), where values in this interval are referred to as incomplete or partial ERPT. It is important to make a distinction between the pass-through of exchange rate changes into the import price and into the domestic consumer price. The ERPT into import price is a narrower notion with the price being observed “at the dock” while the ERPT into the domestic consumer price is a broader notion widely examined in the literature. As the relationship between ERPT and domestic inflation is of interest in this chapter the broader definition is employed throughout this chapter.

The degree of ERPT plays an important role to central bank and policymakers because understanding the link between nominal exchange rate changes and price stability will help effectively conduct the appropriate monetary policy under circumstances of exchange rate variations. For instance, in cases of high pass-through a depreciation of the importing country’s currency could result in an import input prices increase which could raise the consumer price level and inflation for the importing countries; this situation makes it difficult for net importers to control or target inflation.[1] The degree of pass-through is also important for forecasting inflation and for deciding how much to tighten monetary policy in response to an increase in inflation. In the presence of a deprecation, the lower the degree of ERPT the smaller the interest rate adjustment required to maintain the inflation target; thus monetary policy becomes more effective. Since the 1980s, one of the important issues in the field of ERPT has been the weakening relationship between exchange rate changes and import and domestic prices. Taylor (2000) suggests that the decline in ERPT has important implications for monetary policy because it affects both forecasts of inflation and the effects of changes in monetary policy on inflation. Following Taylor's rule, this decline in pass-through can be interpreted as the decline in pricing power of firms. Although much of the previous literature confirmed the decline in the degree of pass-through as a result of a lower inflation in recent years (for example Campa and Goldberg, 2002; Gagnon and Ihrig, 2004; Marazzi et al., 2005; Ihrig et al., 2006; Junttila and Korhonen, 2012), little attention has been paid to the explicit impact of the adoption of inflation targeting (IT) which mainly causes inflation to decrease.[2] The study of relationship between ERPT and the adoption of IT can also shed light on how successful a central bank is in stabilising the domestic price in the presence of exchange rate fluctuations. Thus, examining the level of ERPT of economies in which inflation targeting is a primary goal of their monetary policy is of interest for this chapter.

In investigating ERPT and the effect of IT, this chapter also addresses recent findings in the literature regarding evidence of asymmetry and nonlinearity in the ERPT relationship. The presence of pass-through asymmetry can be explained by price rigidities, capital constraints

[1] This issue of high pass-through influencing central bank in attaining the target of inflation is pointed out by many papers such as Eichengreen (2002), Mishkin (2004) and Fraga et al. (2004).

[2] See, for example, Eichengreen (2002), Schmidt_Hebbel et al. (2002), and Flamini (2007). A decline in ERPT pertaining to an inflation targeting regime is discussed in more details in section 4.2.2.

theory, market share theory, or switching cost theory whereas nonlinearities are measured by partial sum decompositions of the positive and negative exchange rates.[3] The model used in this chapter differs from previous studies by extending a symmetric ERPT specification based on new open-economy macroeconomic models proposed by Choudhri and Hakura (2006) with a nonlinear autoregressive distributed lag (NARDL) framework introduced by Shin et al. (2013). The approach adopted in this chapter is suitable for examining the asymmetries of depreciation and appreciation impacts on domestic consumer prices. The NARDL model is deployed across a sample of six carefully chosen developed countries (Australia, Canada, New Zealand, Norway, Sweden, and United Kingdom) and six emerging countries (Brazil, Hungary, Indonesia, Mexico, South Korea, and Turkey), where inflation targeting is the main monetary policy for theses twelve countries. To examine the effects of inflation targeting on ERPT, the asymmetric pass-through model is estimated in the period prior to and proceeding the implementation of inflation targeting.

Our main results indicate that asymmetric pass-through is mainly found in the long-run whereas symmetric pass-through is presented in the short-run. For the full sample, our results reveal strong evidence of long-run complete pass-through for depreciation in developed economies and long-run zero pass-through in emerging economies. An asymmetric response of consumer price to exchange rate changes exists in developed economies but this asymmetry cannot be found in emerging economies. When asymmetric pass-through is captured in

[3] The issues of non-linearities in ERPT which have been examined previously are focused on non-linear functional models; for example, Herzberg et al. (2003), Frankel et al. (2005), Bussiere (2007), and Al-Abri and Goodwin (2009). None of these link nonlinearlities in pass-through to the role of the inflation environment or monetary policy. However, the nonlinearity in this chapter refers to non-linearity in variables but linear in model. See section 4.3.1 for more details.

developed economies, depreciations pass through more strongly than do appreciations in both the long-run and short-run.

Turing to the analysis of pass-through and inflation targeting, our results show that the ERPT before the inflation targeting period is greater than ERPT after adoption of inflation targeting. In addition, there is strong evidence of zero pass-through in both developed and emerging economies after adoption of inflation targeting. Two possible explanations for the zero pass-through after adoption of inflation targeting are (i) exchange rate variations do not impact the price level of the country according to a success of central bank in stabilising the domestic price and targeting inflation or (ii) domestic consumers substitute import products with cheaper local products when the import prices increase according to a depreciation of domestic exchange rate. Finally, after the adoption of IT pass-through coefficients in emerging economies are, on average, larger than pass-through coefficients in developed economies. This indicates that emerging countries is likely to implement weaker commitment to their target of inflation.

Section 4.2 reviews the association between exchange rate pass-through and the inflationary environment, including the assumption of asymmetric pass-through. The model extension and data are presented in section 4.3. Key descriptive statistics and model selection are summarised in section 4.4. The empirical findings and conclusion are discussed in section 4.5 and 4.6, respectively.

4.2 Literature review

4.2.1 A degree of exchange rate pass-through and inflationary environment

Generally, an investigation of the ERPT with respect to the inflationary environment is analysed by using either import prices or domestic consumer prices. The import prices are prices calculated from only import goods observed at the dock, which is the narrowest notion of pass-through to the price of goods. However, the ERPT to import prices well represent the price behaviour of foreign firms but may not have a strong association with the domestic inflationary environment.[4] By contrast, consumer prices represent domestic consumer baskets which are broader definition and widely employed in the literature.[5] Taylor (2000) and Mihaljek and Klau (2001) suggest that the domestic consumer prices (e.g., consumer price index or producer price index) would provide a more appropriate measurement for ERPT.

The relationship between a degree of ERPT and inflationary environment is discussed by a number of key articles.[6] Taylor explains the link between inflation and pass-through in terms of a model of firm behaviour based on staggered price setting and monopolistic competition. Here the notion is that periods with lower inflation are likely to have less persistent changes in costs and would thus tend to decrease the exchange rate pass-through. Following the Taylor view, the ERPT to CPI is therefore the more meaningful approach in examining a connection between an ERPT and inflationary environment. Taylor hypothesises a low inflationary environment leading to a low ERPT to domestic consumer prices. Further, there is an observed decline in pass-through to aggregate prices as a result of a low inflation environment. For example, Gagnon and Ihrig (2004) document a decline in ERPT to consumer price across countries since 1980s. They examine the relationship between ERPT to CPI and inflation stabilisation by observing twenty industrial countries during 1971-2003 and creating two sub-samples. The results show the evidence of a robust and statistically significant

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[4] Ihrig et al. (2006) note that the import price pass-through can explain consumer price pass-through, but only in the countries which their import volumes are relatively high. Sekine (2006) finds a weak association between import price pass-through and inflationary environment.

[5] The literature examining ERPT to consumer prices includes: McCarthy (2000), Goldfajn and Werlang (2000), Choudhri and Hakura (2006), Gagnon and Ihrig (2004), and Delatte and Lopez-Villavicencio (2012).

[6] See, for example, Ball (1999) and Taylor (2000).

relationship between pass-through and inflation variability. The pass-through has generally declined since the 1980s. The countries in which inflation declined substantially from the first to second period tend to have a large decline in estimated pass-through. They therefore conclude that observed monetary policy behaviour is an important factor affecting the decline of pass-through. In line with the ERPT findings using CPI data, Campa and Goldberg (2002) estimate import price pass-through instead in OECD countries and show evidence that pass-through has also been declining over time in some countries. This pattern of pass-through decline however has not been a common feature of all OECD countries. Meanwhile, Marazzi et al. (2005) and Ihrig et al. (2006) analyse both import price pass-through and consumer price pass-through. The former documents a sustained decline in ERPT to US import prices during 1980 to 2004. This decline in the pass-through coefficient is also robust to the measure of consumer price index and producer price index. The latter also discovers a decline in both pass-through to import price and pass-through to consumer price for almost all of the G-7 countries. However, the decline in pass-through to import price and pass-through to consumer price is similar in magnitude only in the UK and France whereas the decline in pass-through to import price and pass-through to consumer price is not closely related in other G-7 countries. This disassociation can be explained by a weak relation between import price inflation and consumer price inflation. Sekine (2006) estimates an ERPT of six major industrial countries, using a time varying parameter with stochastic volatility model. The ERPT is analysed by impacts of exchange rate variations to import price for first-stage pass-through and those of import price movements to domestic consumer prices for second-stage pass-through. The results confirm that an ERPT has declined over time for all sample countries. The decline in second-stage pass-through is associated with the emergence of the low and stable inflation environment in addition to a rise in import penetration.

Further, Campa and Goldberg (2005) document that pass-through to import prices tends to be higher for countries with high inflation and high exchange rate variability. Choudhri and Hakura (2006) empirically explore how inflation affects the pass-through by gauging the ERPT to CPI in 71 countries, based on new open-economy macroeconomic models. Countries are grouped into low inflation countries, moderate inflation countries, and high inflation countries. They find strong evidence of a positively significant relationship between the pass-through and the average inflation rate across countries. The pass-through also varies across periods in countries having two inflation regimes. Recently, Devereux and Yetman (2010) strongly support Choudhri and Hakura's (2006) findings, namely those countries with looser monetary policy (or higher inflation) tend to experience more frequent price changes and higher pass-through. The ERPT is also increasing in average inflation with a decreasing rate. Extending the model with the importing country inflation regime as an explanatory variable for the pass-through coefficient, a recent study by Junttila and Korhonen (2012) investigate ERPT into import prices for nine OECD countries considering nonlinear functional form such as a simple threshold (TAR), nonlinear exponential (ESTAR), and logistic smooth transition (LSTAR). The results strongly support Taylor's suggestion and Gagnon and Ihrig (2004) which the degree of pass-through depends on the importing country inflation regime.

In addition, the ERPT elasticity is low in low inflation countries and is higher in high inflation countries. This result is quite similar for both the emerging countries which normally experience high inflation and developed countries with low inflation. Unlike developed economies, the use of tight monetary policy is less prevalent emerging countries. There is a strong evidence of a higher observed average annual inflation in emerging countries, during the past decade.[7] The difference in inflation also manifests in different levels of ERPT when comparing developed and emerging economies. For example, Goldfajn and Werlang (2000) survey the pass-through from depreciation to inflation of 71 countries during the period 1980-1998. The pass-through is substantially lower in OECD (or developed countries) relative to emerging countries. Campa and Goldberg (2002) find that pass-through to import prices is lower for developed countries with low average inflation and low exchange rate variability. These findings are confirmed by Calvo and Reinhart (2000), Eichengreen (2002), Schmidt-Hebbel et al. (2002), and Frankel et al. (2005) revealing evidence of lower pass-through in developed economies relative to pass-through in emerging economies. Nonetheless, Nogueira Junior (2007) and Ca'Zorzi et al. (2007) partly support the hypothesis that a degree of ERPT is always greater in emerging than in developed countries. Their paper finds that some emerging countries having low inflations, particularly in Asian economies, have a low ERPT. In other words, we would say that their ERPT is not dissimilar from the ERPT in developed economies.

4.2.2 An exchange rate pass-through and inflation targeting

Even though much previous literature documents a relationship between a decline in ERPT and a lower inflation period, and thus link it to the monetary policy regime, an average inflation measure or the variability of inflation are normally used as a proxy of the monetary policy. Only a few studies discuss the introduction of inflation targeting as a reason for a decline of inflation. Eichengreen (2002) and Schmidt-Hebbel et al. (2002) theoretically propose that a lower ERPT is a consequence of a credible central bank after the adoption of IT. Flamini (2007) develops a model which analyses the relation between exchange rate pass-through and inflation targeting for a small open-economy and finds that the ability in identifying the degree of pass-through is crucial for the central bank to stabilise short run CPI inflation. Mishkin (2008) also confirms the

[7] See, for example, Fraga et al. (2004) and Rasche and Williams (2005)

strong presence of a nominal anchor toward price stability leads to less depreciation pass-through to consumer price in a country with low and stable inflation. Empirically, Edwards (2006) studies the effectiveness of nominal exchange rates as shock absorbers in seven countries implementing inflation targeting by adding dummy variables which represent the time IT was adopted and estimating by using a seemingly unrelated regressions (SURE) procedure. The results show that all seven countries experience a decline in ERPT as a result of an adoption of IT. Nogueira Junior (2007) analyses ERPT before and after adoption of inflation targeting, using the autoregressive distributed lag (ARDL) method. The empirical results in five emerging countries and three developed countries confirms Edwards (2006) that there is strong evidence of decline in ERPT after IT adoption for all countries regardless of using any consumer or producer price indices in estimation. Prasertnukul et al. (2010) also use the ARDL approach in estimating a relationship among exchange rates, price levels, and inflation targeting in Asian economies. A dummy variable for a period of inflation targeting is added into their model. Their paper mainly focuses on an ERPT with respect to an adoption of IT in Indonesia, South Korea, the Philippines, and Thailand. There is strong evidence of a statistically significant relationship between a decline in ERPT and the adoption of inflation targeting in South Korea and Thailand whereas the results are less clear for Indonesia and the Philippines. However, there is additional evidence of decline in exchange rate volatility in four countries after IT period. Estimating by the GMM method, Taguchi and Sohn (2010) examine the difference in ERPT of four East Asian countries between the period before and the period after adopting inflation targeting. According to their results of a decline in pass-through after the adoption of inflation targeting, the reaction of domestic agents is also investigated and revealed that domestic agents are likely to change prices in response to an exchange rate shock under a strong nominal anchor toward price stability. Meanwhile, Coulibaly and Kempf (2010) study the impact of inflation targeting on exchange rate pass-through. A panel VAR is used to examine 27 emerging countries, which are 15 inflation targeters and 12 inflation nontargeters. There is strong evidence of a decline in pass-through to all price indexes (import prices, producer prices, and consumer prices) for inflation targeters. However, exchange rate pass-through to all price indexes for inflation nontargeters is not statistically significant before 1999 but becomes significant after 1999. All above empirical results confirm a decline in ERPT after the adoption of IT which contributes to an inflation stability and central bank credibility. This conclusion supports Eichengreen (2002) and Schmidt-Hebbel et al. (2002).

In a related study Reyes (2007) examines ERPT to inflation targeting in six emerging economies which implement this regime due to a 'fear of floating'.[8] The results suggest that a declining pass-through effect in emerging markets can be explained by a switch in monetary policy regimes from crawling peg to inflation targeting. His emerging economies findings confirm that the adoption of IT causes the lower degree of pass-through. According to exogenous shocks which cause exchange rate more fluctuations than central bank's expectation, the decoupling of exchange rates from national prices is seen to be a result of direct or indirect interventions of the central bank in the foreign exchange market in order to achieve their inflation target. This is consistent with Pavasuthipaisit (2010) who studies the responsiveness of inflation-targeting central banks to exchange rate movements. His results reveal that central banks should pay more attention to nominal exchange rate movements when countries experience complete pass-through. By contrast, central banks can have less concern with exchange rate fluctuations and rather focus on inflation and monetary growth when exchange rate pass-through is very small. However, Nogueira Jumior (2006) examines exchange rate pass-

[8] Calvo and Reinhart (2002) define 'fear of floating' as an extent to which central bank uses interest rates as a tool to stabilise nominal exchange rate when countries experience credibility problems or a high pass-through.

through and fear of floating in three developed countries and five emerging countries by using the VAR method. The findings conclude that pass-through has declined after the adoption of inflation targeting and central banks may choose intervene the foreign exchange market by smoothing short-run exchange rate movements in order to attain their target of inflation. This finding can be inferred as fear of inflation rather than fear of floating.

4.2.3 Asymmetric exchange rate pass-through

The ERPT literature discussed in the preceding subsections test a symmetric long-run relationship between the exchange rate and price level. This implies that appreciations and depreciations of currencies have an effect of the same direction (sign effect) as well as proportionally, magnitude (size effect). This assumption is not ideal, as it is likely that consumer prices may react differently to exchange rate depreciations and appreciations. One explanation for this difference is price rigidities: Prices tend to be stickier downwards than they are upwards and thus the higher degree of price rigidity the smaller the pass-through. These rigidities make the hypothesis of a symmetric pass-through unrealistic and too restrictive. Other justifications for asymmetry include capacity constraints theory, market share theory, and technology switching theory. According to the capacity constraints theory, input prices of importing countries will decrease when the exporting countries' currency depreciates. Knetter (1994) concludes that exporters cannot accommodate an excess demand from the depreciation of exporting countries' currency due to the limitation of full capacity. Then, exporters are likely to increase their prices. Conversely, input prices of importing countries will increase when the exporting countries' currency appreciates. The exporting countries then keep their price unchanged. Consequently, the ERPT is higher when exporting countries' currency depreciates.

Asymmetry of pass-through can also be explained by a market share theory.[9] Under this theory, exporters tend to decrease their mark-ups when competition is high and their own currency appreciates in order to maintain their market share while they tend to keep their mark-ups unchanged when their own currency depreciates. Finally, technology switching theory suggests that exporters are likely to change to a source of cheaper production or use local inputs when domestic currency depreciates, which causes their importing input costs more expensive.[10] Hence, there are many explanations regarding an asymmetric response of consumer price. When asymmetric effects of exchange rates on prices are neglected, these may seriously distort the proper conduct of monetary policy. Recent empirical studies in a relationship between asymmetric ERPT and monetary policy however are still relatively scarce.

In the first stage of investigating an asymmetric ERPT, adding dummy variables for asymmetry as explanatory variables into the model is a simple way to measure the asymmetric ERPT. For example, Pollard and Coughlin (2004) analyse asymmetric import price pass-through by adding dummy variables which are created for currency appreciations and depreciations into the model. They investigate ERPT to import prices at industry-level in 30 US industries. The results show an existence of asymmetric pass-through at industry-level. They also suggest that these asymmetries may not be captured in the aggregate level due to an offset of currency depreciation and appreciation among industries. Bussiere (2007) examines not only the asymmetric ERPT to trade prices (export prices and import prices) for G-7 countries but also an

[9] Krugman (1986), Froot and Klemperer (1989), Marston (1990) discuss an asymmetric impact of market share on exchange rate pass-through. Feenstra et al. (1996) also find a nonlinear relationship between exchange rate pass-through and market share.

[10] See, for example, Ware and Winter (1988) and Webber (2000)

existence of the non-linearity in ERPT.[11] Dummy variables are created for an asymmetry in exchange rate. The results reveal that asymmetry is found in most countries, particularly on the pass-through to export prices. However, Webber (2000) argues that dummy variables are restricted an analysis to a particular time frame that contains continuous appreciation or depreciation series. He examines the difference between the degree of deprecation pass-through and that of appreciation pass-through to import price in eight Asian countries by decomposing exchange rates into the series of accumulated sum of the appreciation and depreciation and using the VAR framework for analysis. The asymmetric pass-through is significantly confirmed in six out of seven countries.

The latest research in this area uses the nonlinear autoregressive distributed lags (NARDL) model proposed by Shin et al. (2013) which permits estimation of asymmetric long run as well as short run pass-through at the same time. For example, Delatte and Lopez-Villavicencio (2012) investigate the response of consumer price to exchange rate shocks in a framework that accommodates asymmetry both in the long-run equilibrium relationship and in the short-run dynamics in four advanced economies. Their model is based on a mark-up model. The results show that prices react differently to appreciations and depreciations over the long-run. They also show that depreciations pass-through to prices more than appreciations, suggesting weak competition structures in international trade and downward price rigidities. Brun-Aguerre et al. (2013) explore possible asymmetries in the reaction of import price to changes in the exchange rate in 33 economies, of which 19 are developed and 14 emerging. Analysing by time series as well as panel estimation, they find that depreciations result in more

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[11] Bussiere (2007) confirms non-linearity in ERPT by using various functional forms such as Quadratic function, Cubic function, logistic function, and a smooth transition (Thresholds).

pass-through than appreciations in the long-run.[12] This indicates downward rigidity of import prices and can be inferred that pass-through strongly affects realised and expected inflation of importing countries. This confirms the results of Delatte and Lopez-Villavicencio (2012) albeit using the different price indexes. Finally, El bejaoui (2013) also implement the NARDL model, examining both import and export price pass-through for four developed economies. The results however suggest that the appreciations yield stronger pass-through to export and import-prices than depreciations. Even though all above ERPT findings mainly contribute to asymmetric ERPT, they only concern about imperfect competition structures or market power which better explains price behaviour of foreign firms. They incompletely mention the ERPT regarding to monetary policy decision.

4.3 Methodology and data

4.3.1 The extension of asymmetric exchange rate pass-through model using NARDL framework

Choudhri and Hakura (2006) propose an exchange rate pass-through model based on a new open-economy macroeconomics theory, which complements the staggered pricing model by Taylor (2000). Aron et al. (2014) views this work as a catalyst for much of the recent empirical macroeconomic research on the ERPT. The Choudhri and Hakura model can be deployed to examine the symmetric response of consumer price to exchange rates under different inflationary environments:[13]

$$cpi_{i,t} = \alpha_i + \beta_{1,i}(L)cpi_{i,t-1} + \beta_{2,i}(L)e_{i,t} + \beta_{3,i}(L)cpi^{*}_{i,t-1} + \varepsilon_t \qquad (4.1)$$

[12] The evidence of asymmetric pass-through in the short-run shows in approximately 30 percent of countries in the sample, compared to more than half of countries experiencing long-run asymmetric pass-through.

[13] In order to conserve space, the more details on the derivation of the model can be seen in Choudhri and Hakura (2006).

where $cpi_{i,t}$ is the domestic consumer price for country *i* at time *t*, $e_{i,t}$ is the nominal effective exchange rate index, $cpi^*_{i,t-1}$ is the foreign consumer price index, $\beta_{1,i}(L)$, $\beta_{2,i}(L)$, and $\beta_{3,i}(L)$ are lag polynomials and ε_t is the error term representing the residual effect of shocks. All variables in Equation (4.1) are expressed in terms of logarithms and estimated in the first-difference form. Under the standard autoregressive distributed lag (ARDL) framework, Equation (4.1) is extended to combine a multiple cointegrating long-run equilibrium ERPT and exchange rate as follows:

$$cpi_{i,t} = \beta_i e_{i,t} + \lambda_i cpi^*_{i,t} + u_{i,t} \tag{4.2}$$

$u_{i,t}$ in Equation (4.2) can be rewritten as $cpi_{i,t}$ - $cpi^e_{i,t}$ where $cpi^e_{i,t}$ equals to $\beta_i e_{i,t} + \lambda_i cpi^*_{i,t}$. We then substitute an error correction term, $\rho_i(cpi_{i,t}$ - $cpi^e_{i,t})$ into a standard linear ARDL model:

$$\Delta cpi_{i,t} = \alpha_i + \rho_i cpi_{i,t-1} + \pi_i e_{i,t-1} + \gamma_i cpi^*_{i,t-1} + \sum_{j=1}^{p-1} \omega_{i,j} \Delta cpi_{i,t-j}$$

$$\sum_{j=0}^{q-1} \theta_{i,j} \Delta e_{i,t-j} + \sum_{j=0}^{r-1} \delta_{i,j} \Delta cpi^*_{i,t-j} + \varepsilon_{i,t} \tag{4.3}$$

However, the symmetric ERPT under the ARDL framework in Equation (4.3) is too restrictive and in this chapter we focus on an asymmetry of the nominal effective exchange rate index, which can be decomposed into:

$$e_{i,t} \equiv e_{i,0} + e^+_{i,t} + e^-_{i,t} \tag{4.4}$$

where $e_{i,0}$ is an arbitrary initial value[14] and

$$e^+_{i,t} = \sum_{j=1}^{t} \Delta e^+_{i,t} = \sum_{j=1}^{t} \max(\Delta e_{i,j}, 0) \text{ and } e^-_{i,t} = \sum_{j=1}^{t} \Delta e^-_{i,t} = \sum_{j=1}^{t} \min(\Delta e_{i,j}, 0) \tag{4.5}$$

[14] The initial value $e_{i,0}$ can be set to zero without loss of generality.

which are partial sum process of positive and negative exchange rate changes, thereby $e_{i,t}^{+}$ and $e_{i,t}^{-}$ captures periods of depreciation and periods of appreciation of the domestic currency, respectively. Under the nonlinear autoregressive distributed lag (NARDL) model proposed by Shin et al. (2013), Equation (4.1) is again extended by combining a multiple cointegrating long-run equilibrium ERPT with a decomposition of exchange rate index as follows:

$$cpi_{i,t} = \beta_i^{+} e_{i,t}^{+} + \beta_i^{-} e_{i,t}^{-} + \lambda_i cpi_{i,t}^{*} + u_{i,t} \tag{4.6}$$

where β_i^{+}, β_i^{-}, and λ_i is a vector of unknown long-run coefficients and $u_{i,t}$ follows i.i.d process with zero means and finite variances. Again, the error correction term $\rho_i(cpi_{i,t}$ - $cpi_{i,t}^{e})$ where $cpi_{i,t}^{e}$ equals to $\beta_i^{+} e_{i,t}^{+} + \beta_i^{-} e_{i,t}^{-} + \lambda_i cpi_{i,t}^{*}$ is substitute into the NARDL framework. Therefore, the NARDL(*p,q,r*) for investigating the asymmetric ERPT to consumer price are yielded as follows

$$\Delta cpi_{i,t} = \alpha_i + \rho_i cpi_{i,t-1} + \pi_i^{+} e_{i,t-1}^{+} + \pi_i^{-} e_{i,t-1}^{-} + \gamma_i cpi_{i,t-1}^{*} + \sum_{j=1}^{p-1} \omega_{i,j} \Delta cpi_{i,t-j}$$

$$+ \sum_{j=0}^{q-1} \left(\theta_{i,j}^{+} \Delta e_{i,t-j}^{+} + \theta_{i,j}^{-} \Delta e_{i,t-j}^{-}\right) + \sum_{j=0}^{r-1} \delta_{i,j} \Delta cpi_{i,t-j}^{*} + \varepsilon_{i,t} \tag{4.7}$$

where the Δ denotes the (log) price differences. The $\frac{-\pi_i^{+}}{\rho_i}$ (or β_i^{+}) and $\frac{-\pi_i^{-}}{\rho_i}$ (or β_i^{-}) denote coefficients of positive and negative long-run pass-through to consumer price for country *i*, respectively. The $\frac{-\gamma_i}{\rho_i}$ (or λ_i) represents the long-run relationship between domestic consumer price and foreign consumer price. Since Marrazi et al. (2005) and Seikine (2006) discover that pass-through tends to occur rapidly, we denote that the lag structure *p, q*, and *r*, is equal to 2 for all economies. Then, coefficients of short-run pass-through are explained by the contemporaneous ($\theta_{i,0}^{+}$ and $\theta_{i,0}^{-}$) and one-quarter lag ($\theta_{i,1}^{+}$ and $\theta_{i,1}^{-}$). Therefore, the summation of the contemporaneous pass-through in the same period of exchange rate shock and one quarter lag after the exchange rate shock is considered for the short-run pass-through. Equation (4.7) therefore accommodates asymmetry in both the short- and long-run asymmetric pass-through to consumer price under the NARDL framework.

To assess the significance of the long-run relationship the BDM test (*tBDM*) of Banerjee et al. (1998) or the PSS test (*fPSS*) of Persaran et al. (1996) and Pesaran et al. (2001) can be deployed. The bounds test (*tBDM* and *fPSS)* recommends itself since it can give reliable inference in the presence of a mixture of *I*(0) and *I*(1) variables – the case that is likely to be observed when estimating Equation (4.7). In the case of the BDM test the null hypothesis that ρ_i equals zero in (4.7) is tested. The *fPSS* is on the joint null hypothesis that the coefficients are jointly equal to zero, $\rho_i = \beta_i^+ = \beta_i^- = \lambda_i = 0$. In both tests, the null hypothesis indicates the absence of a long-run relationship.

From Equation (4.7) standard Wald test statistics are used to test the null hypothesis of symmetric pass-through in the long-run and short-run. Specifically, the null hypothesis of long-run symmetry is $\beta_i^+ = \beta_i^-$ against the alternative of long-run asymmetry which is $\beta_i^+ \neq \beta_i^-$. In the short-run ERPT, the summation of ERPT in the same quarter and one quarter after the exchange rate shocks is considered. The null hypothesis of short-run symmetry is $\sum_{j=0}^{q-1} \theta_i^+ = \sum_{j=0}^{q-1} \theta_i^-$ against the alternative which is $\sum_{j=0}^{q-1} \theta_i^+ \neq \sum_{j=0}^{q-1} \theta_i^-$. Based on the unrestricted NARDL model and the above restrictions three restricted NARDL models are formed:

SA model (Symmetric long-run but Asymmetric short-run): If the symmetry in the long-run is not rejected but the symmetry in the short run is rejected, Equation (4.7) simplifies to the SA model as follows:

$$\Delta cpi_{i,t} = \alpha_i + \rho_i cpi_{i,t-1} + \pi_i e_{i,t-1} + \gamma_i cpi_{i,t-1}^* + \sum_{j=1}^{p-1} \omega_{i,j} \Delta cpi_{i,t-j}$$

$$+\sum_{j=0}^{q-1}\left(\theta_{i,j}^{+}\Delta e_{i,t-j}^{+}+\theta_{i,j}^{-}\Delta e_{i,t-j}^{-}\right)+\sum_{j=0}^{r-1}\delta_{i,j}\Delta cpi_{i,t-j}^{*}+\varepsilon_{i,t} \qquad (4.8)$$

AS model (Asymmetric long-run but Symmetric short-run): If the symmetry in the long-run is rejected while the symmetry in the short run is not, Equation (4.7) simplifies to:

$$\Delta cpi_{i,t}=\alpha_i+\rho_i cpi_{i,t-1}+\pi_i^{+}e_{i,t-1}^{+}+\pi_i^{-}e_{i,t-1}^{-}+\gamma_i cpi_{i,t-1}^{*}+\sum_{j=1}^{p-1}\omega_{i,j}\Delta cpi_{i,t-j}$$

$$+\sum_{j=0}^{q-1}\left(\theta_i\Delta e_{i,t-j}\right)+\sum_{j=0}^{r-1}\delta_{i,j}\Delta cpi_{i,t-j}^{*}+\varepsilon_{i,t} \qquad (4.9)$$

SS model (Symmetric short-run and Symmetric long-run): If symmetry in both the long-run and short-run is not rejected, Equation (4.7) simplifies to the SS model as follows

$$\Delta cpi_{i,t}=\alpha_i+\rho_i cpi_{i,t-1}+\pi_i e_{i,t-1}+\gamma_i cpi_{i,t-1}^{*}+\sum_{j=1}^{p-1}\omega_{i,j}\Delta cpi_{i,t-j}$$

$$+\sum_{j=0}^{q-1}\left(\theta_i\Delta e_{i,t-j}\right)+\sum_{j=0}^{r-1}\delta_{i,j}\Delta cpi_{i,t-j}^{*}+\varepsilon_{i,t} \qquad (4.10)$$

In case of the SS model, both null hypothesis of long-run and short-run symmetry are not rejected. As such, we would say that a reaction of domestic consumer prices has the same magnitude when exchange rate depreciates or appreciates in both long-run and short-run.

Note that the estimation in the chapter starts with the unrestricted NARDL model in Equation (4.7). Then, the long-run relationship – BDM test and PSS test – is tested. The standard Wald test statistics are tested for symmetry in the long-run and short-run. We re-estimate our sample with the appropriate model based on the results of the Wald tests. Where the number of observations for re-estimation are less than 100, bootstrap methods are used to increase an accuracy of the estimation.[15] All pass-through estimates obtained from the

[15] We resample the residuals ($\varepsilon_{i,t}$) with replacement and create the vector of resampled residuals. Then, generate the bootstrap consumer price for each country by recursion using resampled residuals. Finally, the unrestricted or

appropriate model – long-run and short-run pass-through – are finally tested in order to define the degree to which changes in the ERPT to prices (zero or complete pass-through) by these following hypotheses:

Hypothesis 1: H_0: β_i^+ (or β_i^-) = 0 against H_1: β_i^+(or β_i^-) >0 for zero long-run depreciation (appreciation) pass-through

Hypothesis 2: H_0: β_i^+ (or β_i^-) = 1 against H_1: β_i^+ (or β_i^-) <1 for complete long-run depreciation (appreciation) pass-through

Hypothesis 3: H_0: $\sum_{j=0}^{q-1} \theta_{i,j}^+$ (or $\sum_{j=0}^{q-1} \theta_{i,j}^-$) = 0 against H_1: $\sum_{j=0}^{q-1} \theta_{i,j}^+$ (or $\sum_{j=0}^{q-1} \theta_{i,j}^-$) >0 for zero short-run depreciation (appreciation) pass-through

Hypothesis 4: H_0: $\sum_{j=0}^{q-1} \theta_{i,j}^+$ (or $\sum_{j=0}^{q-1} \theta_{i,j}^-$) against H_1: $\sum_{j=0}^{q-1} \theta_{i,j}^+$ (or $\sum_{j=0}^{q-1} \theta_{i,j}^-$) <1 for complete short-run depreciation (appreciation) pass-through

4.3.2 Cumulative asymmetric dynamic multiplier

As Shin et al. (2013) discuss, asymmetric cumulative dynamic multipliers can be calculated using the coefficients from the NARDL model in Equation (4.7):

$$M_h^+ = \sum_{j=0}^{h} \frac{\partial cpi_{i,t+j}}{\partial e_{i,t}^+} \text{ and } M_h^- = \sum_{j=0}^{h} \frac{\partial cpi_{i,t+j}}{\partial e_{i,t}^-}, h = 0, 1, 2, \ldots \tag{4.12}$$

measuring unit changes in periods of depreciation of the domestic currency (M_h^+) and in periods of appreciation of the domestic currency (M_h^-). Note that, $M_h^+ \rightarrow \beta_i^+$ and $M_h^- \rightarrow \beta_i^-$ when $h \rightarrow \infty$ by construction.[16] The cumulative asymmetric dynamic multiplier allows us to detect

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restricted NARDL equations are re-estimated using the bootstrap consumer price to obtain bootstrap parameters and standard errors. Shin et al. (2013) recommend this bootstrap method when observations are less than 100.

[16] See Shin et al. (2013) for derivation.

positive and negative adjustment paths as well as identify the length of time from the initial equilibrium to new equilibrium for both a depreciation and appreciation. These multipliers also recommend themselves as robustness results of the asymmetry over time horizon.

4.3.3 Data

This chapter examines ERPT across 12 countries that have used inflation targeting – six developed countries and six emerging countries. Developed countries comprise: Australia, Canada, New Zealand, Norway, Sweden, and UK. Emerging countries comprise: Brazil, Hungary, Indonesia, Mexico, South Korea, and Turkey. Appendix A details the samples, sub-samples, and dates on which IT was adopted, as well as the data sources for the series in Equation (4.7). The longest dataset is from 1980Q1 to 2013Q4 but the total sample span varies according to data availability. From each country's sample two subsamples are formed based on the date IT was adopted: a pre-inflation targeting period and inflation targeting period.[17] Therefore, asymmetric pass-through in each country is separately analysed both before and during inflation targeting.

Data downloaded to facilitate estimation of the NARDL model are at the quarterly frequency and domestic consumer prices ($cpi_{i,t}$) are used to estimate country specific pass-through to consumer prices. The nominal effective exchange rate index of the foreign currency against the domestic currency ($e_{i,t}$) are transformed to the domestic (importer's) currency against a basket of foreign (exporter's) currency, implying that an increase of index indicates a depreciation of the domestic currency. The foreign consumer price index ($cpi^*_{i,t}$) represents the trade weighted average of the consumer price index of partner countries. The series for the

[17] The break date of inflation targeting adopted in each country is provided by Centre for Central Banking Studies handbook, Bank of England.

foreign consumer price index is obtained from a subtraction of the log of the domestic consumer price index and the log of the relative price index.

4.4 Summary of key statistics and model selection

As a precursor to estimating the NARDL model, Table 4.1 summarises statistics of inflation, exchange rate changes, and foreign CPI. All countries experience a wide range of inflation during the full sample period. The average annual inflation in developed market ranges from 1.373% to 2.028%. The inflation in emerging market is relatively high, which varies from 1.938% to 34.112%. The standard deviation of inflation in developed countries ranges from 1.386% to 2.340% whereas standard deviation of inflation in emerging countries ranges from 1.971% to 51.600%. We find that Canada (South Korea) has the lowest average annual inflation and the lowest volatility and New Zealand (Brazil) has the highest average annual inflation and the highest volatility among developed (emerging) countries. Before the adoption of IT, the average annual inflation in emerging countries varies from 2.714% to 60.159% while the average annual inflation in developed countries is not varying by anywhere near as much. Figure 4.1 confirms a sudden fall of average annual inflation in developed countries as well as emerging countries when an inflation target is adopted. The inflation is approximately 0.552%-1.157% in developed countries and 1.034%-3.427% in emerging countries. The standard deviation dramatically falls around 0.861%-1.354% in developed countries and 0.753%-3.111% in emerging countries. This reduction in an average inflation and its volatility after implementation of IT is the most likely to be a consequence of the target of inflation pursuing by central banks in each country. In addition, our findings reveal that an average annual inflation and standard deviation of emerging countries are, on average, higher than those of developing countries regardless any periods of time. Our results are similar to Fraga et al. (2004) and Rasche and

Williams (2005), who point out that most emerging countries experience more inflation volatility regarding to their weaker commitment to the targeting of inflation.

[Table 4.1 around here]

[Figure 4.1 around here]

Table 4.2 provides unit root tests applied to all variables in both log level and log first-difference form. The series of log differences in consumer price index, foreign CPI, and nominal effective exchange rates and are tested using the 10% significant level for all countries, and indicate that all series are stationary. Even though some series such as CPI before IT in Canada and foreign CPI before IT in South Korea do not rejected the ADF unit root null, they are deemed stationary when tested by either the KPSS or NG-Perron test.[18]

[Table 4.2 around here]

Due to the fact that the NARDL equations can comprise a mixture of I(0) and I(1) series, the bound testing procedure of Benerjee et al. (1998) and Persaran et al. (1996) is used to test for an asymmetric long-run relationship. The BDM test and PSS test are used to capture the long-run relationship in Equation (4.7). The results are reported in Table 4.3. Using the BDM test for the full sample period, we can confirm only three out of twelve countries (one country in developed economies and two countries in emerging economies) exhibit a long-run relationship or cointegration. However, the PSS test strongly rejects the null hypothesis of an absence in long-run relationship in all six developed countries and three out of six emerging countries. Referring to the PSS test we conclude that approximately 75 percent of our sample is confirmed an existence of long-run relationship among variables by performing the PSS test.

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[18] The results on KPSS and Ng-Perron tests are presented in Appendix B.

[Table 4.3 around here]

Table 4.4 suggests an appropriate ERPT equation for each country in each period. Again, an unrestricted pass-through model in Equation (4.7) is tested for asymmetry in the long-run and short-run.[19] The decision is based on a standard Wald test statistics. In cases of two joint restrictions – long-run and shot-run symmetry – the Chi-square statistic (χ^2) is used for the first-step in identifying the asymmetry in either long-run or short-run or both. Then t-statistics are used to confirm asymmetry for either the long-run or short-run. For full sample period, the χ^2shows that five out or six developed countries and two out of six emerging countries reject the null hypothesis of either symmetric long-run or symmetric short-run pass-through. More specifically, t-statistics help us identify the appropriate model. For the full sample, four out of six developed countries are rejected the null hypothesis of long-run symmetry but cannot reject the null hypothesis of short-run symmetry. The restricted AS model (Equation 4.9) is therefore suitable for estimating pass-through in Australia, Canada, New Zealand, and Sweden. In Norway, the null hypotheses of long-run symmetry and short-run symmetry are rejected so the unrestricted AA model (Equation 4.7) is able to capture both asymmetric long-run and short-run pass-through. Since the symmetric long-run and short-run pass-through in UK cannot be rejected, the restricted SS model is going for estimating an ERPT in UK. In emerging economies, the χ^2 shows that two out of six countries experience asymmetry in either short-run or long-run pass-through. T-statistics confirms that only Brazil and Hungary experience short-run asymmetry while other emerging countries have no asymmetry. The restricted SA model (Equation 4.8) then is using for estimating an ERPT in Brazil and Hungary while the restricted

[19] All estimates from unrestricted model in Equation 4.7 before the Wald-test is applied for model selection is shown in Appendix C.

SS model (Equation 4.10) is going for pass-through in the rest of the countries.[20] However, almost 60 percent of our full sample shows the asymmetric response of consumer price to exchange rate changes in short-run or/and long-run, underscoring the importance of accounting for asymmetry in the ERPT relationship. Now, we turn our attention to a selected model for subsample periods. The results show that three out of six developed countries and two out of six emerging countries experience asymmetry in short-run or/and long-run before IT period. We find that approximately 60 percent of countries from our sample have symmetric short-run as well as long-run pass-through before an inflation targeting is begun. When IT is adopted, two out of six developed countries have long-run asymmetry and short-run symmetry while four out of six has symmetry in the long-run as well as the short-run. These contradict with the results in emerging economies in which two out of six economies have both long-run and short-run symmetry but four out of six experiences long-run asymmetry. The results after the adoption of inflation targeting are very interesting. Most developed countries experience more symmetry in both long-run and short-run whereas most emerging countries experience more asymmetry in long-run but not in short-run. This might be explained by the effectiveness of developed countries in controlling their domestic prices or domestic firms absorb a marginal increase in import costs regarding to local currency depreciations.

[Table 4.4 around here]

[20] Interestingly, Brun-Aguerre et al. (2013) found that 50 percent of emerging markets and about 60 percent of developed markets experiences long-run asymmetric pass-through to import prices, inferring that long-run symmetric pass-through to import price still exists for countries in both emerging markets and developed markets.

4.5 Empirical results

Based on the model selection in Table 4.4, the individual pass-through estimates for all countries are measured by Equation (4.7) – (4.10) with lag structure $p = q = r = 2$ and reported in Table 4.5.

4.5.1 An ERPT in full sample periods

For full sample period, adjusted R-squared of the estimated regression varies from 42.0%-63.6% in developed economies and 48.7%-96.1% in emerging economies. Note that bootstrap regressions are applied when observations are less than 100. When ERPT coefficients in developed economies are compared to emerging, we find that long-run ERPT coefficients range from -1.732 to 1.675 in developed economies while they range from -1.566 to 0.659 in emerging economies. Four out of six developed countries and half of emerging countries experience positive pass-through relationship, indicating that currency depreciations (appreciation) cause consumer price to rise (fall). Only UK, Sweden and half of emerging countries (Brazil, Hungary, and Indonesia) exhibit a negative relationship. All coefficients are also tested whether they are complete pass-through (equal to unity) or incomplete (partial) pass-through (greater than zero but less than one) or zero pass-through (equal to zero). Testing hypothesis 1 and 2 for the long-run pass-through from section 4.3.1, we find that there exists complete pass-through for depreciation in most countries, particularly in developed countries, which have a positive relationship. This suggests that changes in exchange rate are passed through to domestic consumer price in Australia, Canada, New Zealand, and Norway completely. In emerging economies, only Mexico shows partial pass-through, suggesting that exchange rate changes partially affect consumer prices. Meanwhile, all countries which have negative relationship are found to be insignificantly different from zero thus confirming zero pass-through, indicating that consumer price is not sensitive to exchange rate for all these countries. When the short-run is analysed, hypothesis 3 and 4 from section 4.3.1 are tested. The results reveal that five developed and four emerging countries have symmetric short-run pass-through but cannot reject the null of zero-pass through. This suggests that changes in exchange rate do not affect consumer price in the short-run for all these countries. Although three countries – Norway, Brazil, and Hungary – exhibit asymmetric pass-through in the short run, only Hungary is confirmed a partial pass-through whereas the others also experience zero pass-through.

Additionally, when the asymmetric pass-through is captured, our findings indicate that a depreciation of currencies in both developed and emerging economies is pass-through more powerfully than an appreciation over the long-run. Our results are consistent with the previous findings such as Delatte and Lopez-Villavicencio (2012) or Brun-Aguerre et al. (2013), which supports the theory indicating prices are likely to be stickier downwards than upwards.

4.5.2 An ERPT before inflation targeting periods

When an ERPT before IT period is investigated, long-run coefficients of ERPT range from -5.265 to 2.902 in developed economies while they range from -2.456 to 3.143 in emerging economies. The relationship between consumer price and exchange rate variation is unclear in seven out of twelve countries (four developed and three emerging countries) during the high inflation since we cannot reject the null hypothesis of both zero pass-through and complete pass-through. However, the null hypothesis of zero asymmetric pass-through in Canada and zero symmetric pass-through in Indonesia cannot be rejected but the null of complete pass-through in both countries is rejected, indicating the zero pass-through in these two countries. For the symmetric pass-through in Norway and Mexico, the null hypothesis of zero pass-through is rejected while the null hypothesis of complete pass-through is not rejected, inferring that these two countries experience complete pass-through during the period before IT.

Therefore, during the pre IT period there are a variety of models that fit the data for the long-run pass-through.

Turning to our short-run analysis, our results show that all short-run ERPT in developed economies are zero symmetric pass-through since the null of zero pass-through cannot be rejected but the null of completed pass-through is strongly rejected for all developed countries. Only Norway has zero asymmetric short-run ERPT which again is not significantly different from zero but is significantly different from one indicating zero pass-through. In emerging economies, almost all countries experience zero symmetric pass-through in short-run. Only Hungary has asymmetric short-run and exhibits partial pass-through.

4.5.3 An ERPT after adoption of inflation targeting

Turing to the post-IT sample, far more conformity is observed. Long-run coefficients of ERPT range from -1.311 to -0.262 in developed economies while they range from -1.748 to 2.478 in emerging economies. Although different models and methods are applied in investigating ERPT, our results not only support Edwards (2006)'s empirical evidence in terms of a decline in ERPT after an adoption of IT but also support Calvo and Rehinhart (2000), Eichengreen (2002), Schmidt-Hebbel et al. (2002) in terms of higher pass-through in emerging countries possibly linked to their higher inflation and untightened monetary policy. In terms of long-run pass-through inference, four of the six developed countries (Australia, Canada, Sweden, and UK) experience zero symmetric pass-through and two out of six (New Zealand and Norway,) experience zero asymmetric pass-through. In emerging countries, Brazil, Indonesia, and Mexico experience asymmetric zero pass-through whereas Turkey have symmetric zero pass-through. Hungary and South Korea exhibit unclear pass-through since the both null hypothesis of zero and complete pass-through cannot be rejected. Therefore, ten out of the twelve countries (six developed and four emerging countries) yield support for zero pass-through in the long-run after adoption of IT. This indicates that exchange rate movements have no impact on consumer price in developed economies after IT adopted. According to Pavasuthipaisit (2010) arguments, our results suggest that central banks do not much concern on exchange rate fluctuation since ERPT is relatively small. This is confirmed by Figure 4.1, demonstrating that all developed countries have less frequency in adjusting their interest rates in recent years. Calculating standard deviation of domestic interest rates help us confirm interest rate variability in developed countries.[21] Standard deviation of domestic interest rate in developed countries is 2.297%-3.783% before inflation targeting and drops to 1.253% - 2.666% during inflation targeting period.[22]

In the short-run, all developed countries exhibit symmetric zero pass-through. By contrast, the results in emerging countries are mixed up; half of emerging countries has symmetric zero pass-through, two countries (Hungary and Mexico) have symmetric partial pass-through and one country (Indonesia) has zero depreciation pass-through but partial appreciation pass-through.

[Table 4.5 around here]

To sum up, our results reveal that asymmetric pass-through is mostly captured only in the long-run whereas symmetric pass-through is common in the short-run. Depreciations are passed-through more strongly than appreciations when asymmetric pass-through is found. After adoption of inflation targeting, ERPT in developed countries exhibits more symmetry while

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[21] The calculation for average domestic interest rate and its standard deviation are available from the authors on request.

[22] The decline in standard deviation of interest rates also happens in emerging countries, from 6.849%-31.082% before inflation targeting to 1.001%-5.080% during inflation targeting period.

ERPT in emerging countries tends to exhibit more asymmetry. This might be explained by the effectiveness of developed countries in controlling their domestic prices or they absorb an excess importing costs regarding to local currency depreciations. Although asymmetric pass-through is captured in most countries in the long-run, both currency depreciation and appreciation have no noticeable impact on domestic consumer price, according to their zero pass-through. Our results reveal zero pass-through in ten out of twelve countries (all six developed countries and four emerging countries). Additionally, results after adoption of IT support prevailing findings such as Eichengreen (2002) and Schmidt-Hebbel et al. (2002), indicating that a lower degree of pass-through is a consequence of a credibility of central bank after pursuing inflation targeting

Remarkably, our results in full sample and before IT period challenge previous findings. The degree of ERPT in emerging economies is not clearly higher than that in developed economies. Ca'Zorzi et al. (2007) notice this ambiguity which might occur in case that some emerging economies with low-inflation and low ERPT are included in the sample. In our cases, an average annual inflation in South Korea is smaller than an average annual inflation in some developed economies such as New Zealand. However, after adoption of IT, ERPT in emerging countries is explicitly higher according to their higher inflation and untightened monetary policy, which can be measured by the interest rates variability.

4.5.4 A cumulative dynamic multipliers

The cumulative asymmetric dynamic multipliers associated with a unit change in domestic exchange rate depreciation (positive shocks) and appreciation (negative shocks) for developed economies and emerging economies are plotted in Figure 4.2 and 4.3, respectively. The graphs show an evolution of inflation in response to a depreciation and appreciation adjustments from an initial short-run equilibrium towards a new long-run equilibrium up to 24 quarters (h = 0…24 quarters). We do not impose restrictions on the NARDL model, and instead plot the multipliers based on the unrestricted model (4.7) to provide an additional confirmation of short- and long-run asymmetries (or symmetries) tested in the previous tables. The difference between the dynamic multipliers associated with positive and negative shocks is plotted with a 95% bootstrap confidence interval. This difference helps us clearly trace evidence of the asymmetry or symmetry in ERPT relationship. If the difference trends zero on horizontal axis, it indicates the symmetry of pass-through since the magnitude of depreciation and appreciation nearly equals.

In full sample, it can be seen that most developed countries experience asymmetric pass-through over the long-run. The cumulative dynamic multipliers also confirm evidence of short-run symmetric ERPT for all developed countries, except for Norway. Only in Norway, the cumulative dynamic multipliers explicitly present an asymmetry in the short-run for full sample and before IT. This reaffirms the results we obtain in Table 4.5, indicating that the pass-through of appreciation is more powerful in the short-run but the pass-through of depreciations strengthens when the horizon increases. In Canada, there is a switch in the sign of cumulative dynamic multipliers in full sample period. This might be explained by the strong and rapid response in consumer price to Canadian dollar fluctuation in the short-run. In emerging economies, the graphs are rather mixed among symmetry and asymmetry in either short-run or long-run. The cumulative dynamic multipliers in Brazil and Hungary explicitly present an asymmetric short-run ERPT in full sample period. Meanwhile, the others show the symmetry. These support the results in Table 4.5 that Brazil and Hungary have asymmetric responses of consumer price to exchange rate changes in the short-run.

Mostly, a depreciation of exchange rates is passed through more than an appreciation over the long-run when the asymmetric pass-through is captured. This is supported by a price rigidity theory explaining an asymmetric response to prices when exchange rate changes. Producers are likely to absorb the benefit of domestic currency appreciation because of the decrease in import prices while they always pass excess costs from depreciation to domestic consumers by increasing their product price. This situation can occur only if the countries have the market power in setting the prices. However, this is not happening in Brazil before IT in which their cumulative asymmetric dynamic multipliers shows a unit change domestic appreciation is more transmitted to consumer price than a unit change in domestic depreciation over the long-run. Although this anomaly is detected, the difference line ascertains the existence of symmetric pass-through in the long-run for all these countries, which is consistent to our results estimated in Table 4.4.

[Figure 4.2 around here]

[Figure 4.3 around here]

4.6 Conclusion

The exchange rate pass-through (ERPT) into domestic consumer prices is of interest for central banks and policy makers alike because exchange rate variations are one important element that may affect the level of domestic inflation. In this chapter, we develop an ERPT model which combines the concept of a new open-economy macroeconomic model and the concept of nonlinear and asymmetric pass-through. The contribution of this chapter is to achieve the new and suitable model by deploying the nonlinear and asymmetric autoregressive distributed lag (NARDL) framework with the view to examine how inflation target impacts on pass-through. Using quarterly data with all available data over the period from 1980 to 2013, we investigate the possibility of asymmetric non-linear ERPT in six developed and six emerging countries which adopted inflation targeting policy using pre- and post-targeting sub-samples. Although some of the recent literature examines the issue of asymmetry in the ERPT relationship the findings of this chapter find the picture is more nuanced with some countries evidencing asymmetry, and others symmetry. To accommodate this heterogeneity we introduce simplifying variants of the unrestricted NARDL model permitting symmetry in the long-run, short-run or both. Therefore, the ERPT coefficients we obtained are from the appropriate pass-through regression for each country and each period.

For the full sample, our result suggests that there is strong evidence of long-run complete pass-through for depreciation in developed economies and long-run zero pass-through in emerging economies. In addition, an asymmetric long-run pass-through relationship exists in developed economies but cannot be found in emerging economies. When asymmetric pass-through is captured in developed economies, depreciations are passed-through more strongly than appreciations regardless of long-run or short-run pass-through. This is consistent with Delatte and Lopez-Villavicencio (2012) and Brun-Aguerre et al. (2013). Our findings clearly indicate that the size of pass-through coefficients in emerging economies is larger than the magnitude of pass-through in developed economies only when IT is adopted. This suggests that central banks in developed market have tightened their monetary policy to attain their target of inflation, indicated by less variability in interest rates.

When the pre- and post-IT subsamples are considered, our results show that, in the long-run, ERPT relationship before IT has no particular pattern. Most countries exhibit unclear ERPT relationship. Remarkably, there is strong evidence of a zero pass-through in both developed and emerging economies when IT is adopted. In the short-run, most countries experience zero pass-through regardless any sample periods. A zero pass-through indicates no noticeable impact on consumer prices regarding to domestic exchange rate change. Lastly, there is little evidence of symmetric pass-through in the long-run but strong evidence of symmetric pass-through in the short-run.

Appendix A Data sources and periods

Country	Full sample period	Date IT adopted	Before IT period	After IT period	CPI	RPI	NEER
Developed economies							
Australia	1980Q1-2013Q4	June 1993	1980Q1-1993Q1	1993Q2-2013Q4	IMF	OECD	IMF
Canada	1980Q1-2013Q4	February 1991	1980Q1-1990Q4	1991Q1-2013Q4	IMF	OECD	IMF
New Zealand	1980Q1-2013Q4	December 1989	1980Q1-1989Q3	1989Q4-2013Q4	IMF	OECD	OECD
Norway	1980Q1-2013Q4	March 2001	1980Q1-2000Q4	2001Q1-2013Q4	IMF	OECD	IMF
Sweden	1980Q1-2013Q4	January 1993	1980Q1-1992Q4	1993Q1-2013Q4	IMF	OECD	IMF
UK	1980Q1-2013Q4	October 1992	1980Q1-1992Q3	1992Q4-2013Q4	IMF	OECD	IMF
Emerging economies							
Brazil	1981Q2-2013Q4	June 1999	1981Q2-1999Q1	1999Q2-2013Q4	IMF	OECD	IMF
Hungary	1993Q2-2013Q4	June 2001	1993Q2-2001Q1	2001Q2-2013Q4	OECD	OECD	IMF
Indonesia	1994Q2-2013Q4	July 2005	1994Q2-2005Q2	2005Q3-2013Q4	IMF	OECD	BIS
Mexico	1980Q1-2013Q4	January 2001	1980Q1-2000Q4	2001Q1-2013Q4	IMF	OECD	IMF
South Korea	1980Q1-2013Q4	April 1998	1980Q1-1998Q1	1998Q2-2013Q4	IMF	OECD	IMF
Turkey	1994Q2-2013Q4	January 2006	1994Q2-2005Q4	2006Q1-2013Q4	Oxford Economics	OECD	BIS

Notes: The date of inflation targeting (IT) adopted in each country is provided by Centre for Central Banking Studies, Bank of England.

Appendix B KPSS unit root test

	Level					1st difference				
	CPI	S	S_P	S_N	CPIF	CPI	S	S_P	S_N	CPIF
Developed Market										
Australia										
All	0.299***	0.199**	0.256***	0.103	0.333***	0.233***	0.035	0.053	0.058	0.049
Before IT	0.184**	0.147**	0.138*	0.152*	0.149**	0.097	0.100	0.139*	0.081	0.085
After IT	0.134*	0.186**	0.078	0.214**	0.160**	0.059	0.050	0.036	0.069	0.048
Canada										
All	0.307***	0.271***	0.105	0.294***	0.334	0.222***	0.049	0.047	0.098	0.062
Before IT	0.175**	0.105	0.107	0.126*	0.175**	0.182**	0.116	0.125*	0.106	0.074
After IT	0.189**	0.249***	0.175**	0.294***	0.256***	0.141*	0.074	0.047	0.149**	0.111
New Zealand										
All	0.295***	0.241***	0.133*	0.318***	0.300***	0.270***	0.058	0.079	0.048	0.084
Before IT	0.069	0.162**	0.109	0.184**	0.190**	0.077	0.051	0.126*	0.105	0.041
After IT	0.272***	0.057	0.192**	0.271***	0.071	0.081	0.048	0.061	0.065	0.051
Norway										
All	0.320***	0.326***	0.148**	0.359***	0.354***	0.300***	0.087	0.047	0.095	0.171**
Before IT	0.326***	0.233***	0.190**	0.190**	0.323***	0.212**	0.084	0.066	0.055	0.074
After IT	0.118	0.046	0.086	0.141*	0.067	0.123*	0.040	0.047	0.060	0.043
Sweden										
All	0.347***	0.286***	0.109	0.299***	0.319***	0.194**	0.023	0.043	0.069	0.048
Before IT	0.137*	0.200**	0.198**	0.096	0.199**	0.116	0.091	0.091	0.128*	0.108
After IT	0.151**	0.122*	0.143*	0.121*	0.064	0.057	0.032	0.033	0.069	0.035
UK										
All	0.344***	0.149**	0.226***	0.253***	0.206**	0.198**	0.058	0.106	0.044	0.094
Before IT	0.123*	0.199**	0.215**	0.131*	0.208**	0.256***	0.112	0.106	0.106	0.098
After IT	0.184**	0.247***	0.237***	0.210**	0.248***	0.238***	0.063	0.066	0.063	0.074
Emerging Market										
Brazil										
All	0.337***	0.340***	0.337***	0.350***	0.340***	0.141*	0.139*	0.136*	0.132*	0.141*
Before IT	0.140*	0.138*	0.138*	0.247***	0.137*	0.217***	0.222***	0.222***	0.059	0.228***
After IT	0.200**	0.146*	0.156**	0.177**	0.137*	0.102	0.134*	0.115	0.127*	0.131*
Hungary										
All	0.297***	0.226***	0.158**	0.308***	0.237***	0.243***	0.212***	0.187**	0.124*	0.268***
Before IT	0.194**	0.184**	0.182**	0.190**	0.191**	0.107	0.073	0.068	0.201**	0.112
After IT	0.195**	0.224***	0.210**	0.141*	0.214**	0.065	0.243***	0.15**	0.120*	0.264***
Indonesia										
All	0.253***	0.207**	0.254***	0.255***	0.204**	0.040	0.048	0.063	0.079	0.043
Before IT	0.144*	0.155**	0.152**	0.104	0.156**	0.074	0.059	0.096	0.138*	0.061
After IT	0.183**	0.089	0.106	0.118	0.079	0.143*	0.093	0.107	0.074	0.078
Mexico										
All	0.338***	0.312***	0.306***	0.339***	0.323***	0.092	0.080	0.085	0.040	0.075
Before IT	0.271***	0.257***	0.256***	0.276***	0.263***	0.106	0.069	0.069	0.043	0.065
After IT	0.094	0.085	0.083	0.232***	0.105	0.149**	0.042	0.043	0.086	0.043
South Korea										
All	0.348***	0.203**	0.123*	0.229***	0.242***	0.078	0.035	0.071	0.044	0.037
Before IT	0.083	0.146*	0.152**	0.125*	0.099	0.146**	0.100	0.081	0.116	0.130*
After IT	0.067	0.120*	0.138*	0.043	0.158**	0.140*	0.080	0.076	0.083	0.082
Turkey										
All	0.306***	0.298***	0.307***	0.214**	0.300***	0.267***	0.163**	0.100	0.259***	0.160**
Before IT	0.228***	0.213**	0.203**	0.219***	0.212**	0.169**	0.123*	0.120*	0.094	0.149**
After IT	0.218***	0.090	0.068	0.197**	0.075	0.186**	0.051	0.058	0.051	0.050

Notes: The Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test equation includes both a constant and a linear time trend. Lags are chosen based on Schwarz Information Criterion (SIC). The values in the table present the LM-Statistic.

Appendix B Ng-Perron unit root test

	Level					1st difference				
	CPI	S	S_P	S_N	CPIF	CPI	S	S_P	S_N	CPIF
Developed Market										
Australia										
All	-1.274	-6.975	-4.540	-15.701	-1.182	-24.549***	-64.638***	-66.603***	-62.494***	-65.608***
Before IT	-2.436	-4.162	-4.120	-10.049	-5.242	-23.114**	-25.041***	-25.446***	-23.030**	-25.451***
After IT	-5.696	-15.357*	-14.353*	-7.864	-17.214*	-39.456***	-38.575***	-40.327***	-37.896***	-37.626***
Canada										
All	-1.631	-7.385	-14.129	-2.076	-1.736	-6.296	-60.939***	-63.579***	-60.486***	-57.407***
Before IT	-5.245	-5.703	-6.208	-2.684	-1.863	-10.351	-18.362**	-18.1414**	-19.810**	-19.719**
After IT	-3.952	-6.903	-10.209	-2.256	-3.772	-100.104***	-37.317***	-43.078***	-34.091***	-38.273***
New Zealand										
All	-1.608	-3.439	-4.506	-0.539	-1.273	-19.365**	-65.077***	-65.305***	-65.626***	-63.456***
Before IT	-45.423***	-6.918	-7.718	-1.856	-5.355	-15.452*	-13.483	-18.409**	-18.489**	-12.008
After IT	-6.838	-14.589*	-9.174	-1.999	-11.661	-41.571***	-43.226***	-38.879***	-46.336***	-43.313***
Norway										
All	-1.031	-7.828	-21.936**	-0.433	-0.593	-3.491	-63.506***	-62.404***	-66.105***	-65.348***
Before IT	-1.516	-7.910	-11.656	-9.389	-1.067	-1.576	-39.722***	-36.928***	-40.897***	-175.99***
After IT	-13.827	-10.761	-9.470	-6.115	-9.872	-24.116***	-24.229***	-24.101***	-24.809***	-24.677***
Sweden										
All	-1.980	-6.181	-14.842*	-0.170	-1.815	-10.559	-62.869***	-61.870***	-66.404***	-63.785***
Before IT	-5.434	-3.844	-3.611	-10.060	-2.034	-22.730**	-24.372***	-24.247***	-24.024***	-24.686***
After IT	-89.799***	-19.138**	-18.790**	-7.199	-21.151**	-154.415***	-38.396***	-53.105***	-40.609***	-39.088***
UK										
All	-1.016	-12.187	-3.933	-5.915	-4.970	-1.336	-61.283***	-62.411***	-63.198***	-61.126***
Before IT	-4.090	-10.305	-3.726	-9.957	-6.328	-1.604	-23.854***	-23.729**	-24.410***	-23.843***
After IT	-5.451	-4.836	-9.787	-9.073	-4.645	-12.852	-34.233***	-13.967	-33.696***	-31.752***
Emerging Market										
Brazil										
All	-7.153	-4.493	-2.209	-0.003	-1.389	-10.847	-22.478**	-21.230**	-64.292***	-22.274**
Before IT	-7.423	-7.809	-7.871	-3.370	-5.929	-12.787	-13.328	-13.164	-34.897***	-15.171*
After IT	-4.076	-4.421	-5.085	-8.356	-6.353	-23.297**	-52.102***	-25.765***	-28.401***	-48.330***
Hungary										
All	-3.266	-1.524	-3.599	-1.446	-0.980	-19.730**	-63.888***	-36.216***	-38.770***	-60.742***
Before IT	-10.411	-3.624	-3.615	-5.418	-2.805	-10.497	-13.907	-13.870	-14.855*	-39.568***
After IT	-5.742	-8.363	-7.668	-6.964	-9.193	-20.797**	-61.103***	-23.102**	-23.755**	-65.677***
Indonesia										
All	-8.278	-10.565	-6.351	-1.634	-6.893	-91.645***	-34.026***	-25.640***	-21.072**	-124.95***
Before IT	-17.616**	-12.011	-12.540	-3.308	-9.284	-84.206***	-18.750**	-13.616	-21.260**	-20.353**
After IT	-5.553	-6.982	-7.945	-3.577	-12.016	-1.933	-15.678**	-15.957**	-15.429**	-14.888**
Mexico										
All	-3.053	-3.489	-3.687	0.887	0.096	-7.264	-18.048**	-18.034**	-66.581***	-22.240**
Before IT	-5.727	-8.439	-8.649	-1.578	-0.826	-8.576	-27.467***	-27.803***	-40.953***	-40.377***
After IT	-5633.5***	-11.054	-17.776**	-3.798	-10.056	-142.313***	-23.848***	-23.844***	-1.663	-23.971***
South Korea										
All	-0.642	-14.741*	-16.775*	-9.359	-6.680	-1.604	-63.191***	-59.902***	-26.605***	-58.309***
Before IT	-3.974	-99.549***	-182.68***	-4.022	-67.06***	-0.160	-17.181*	-15.357*	-33.665**	-14.250*
After IT	-7.894	-7.250	-3.873	-6.670	-6.079	-9.862	-27.560***	-29.282***	-6.338	-26.110***
Turkey										
All	573.192***	-0.545	-0.420	-1.425	-0.743	-3.640	-37.717***	-37.339***	-38.180***	-32.704***
Before IT	-57.461***	-1.310	-2.302	-0.286	-2.205	-19.424**	-22.032**	-21.632**	-22.485**	-19.949**
After IT	-11.974	-521.85***	-10.343	-2.894	-9.541	-90.321***	-12.109	-11.034	-19.157**	-13.380

Notes: The Ng-Perron test equation includes both a constant and a linear time trend. Lags are chosen based on Schwarz Information Criterion (SIC). The values in the table present the NG-Perron test statistics.

Appendix C Asymmetric pass-through estimation

	c	ϱ	π+	π-	γ	ω	θ_t^+	θ_{t-1}^+	θ_t^-	θ_{t-1}^-	δ	δt-1
Developed Market												
Australia												
All	0.038	-0.028	0.043	0.018	-0.019	0.191	-0.112	0.108	-0.109	0.067	0.138	-0.089
	(0.027)	(0.016)	(0.014)	(0.011)	(0.010)	(0.088)	(0.102)	(0.097)	(0.111)	(0.100)	(0.105)	(0.095)
Before IT	-0.033	-0.003	0.107	0.046	-0.080	0.181	-0.026	0.115	-0.072	0.044	0.106	-0.070
	(0.079)	(0.039)	(0.069)	(0.036)	(0.064)	(0.170)	(0.272)	(0.222)	(0.255)	(0.240)	(0.270)	(0.220)
After IT	0.057	-0.032	-0.006	-0.017	0.026	0.173	-0.185	0.004	-0.135	-0.022	0.157	0.005
	(0.059)	(0.034)	(0.049)	(0.038)	(0.046)	(0.126)	(0.127)	(0.124)	(0.138)	(0.131)	(0.131)	(0.122)
Canada												
All	0.061	-0.034	0.021	0.001	0.000	0.292	-0.319	0.092	-0.255	0.102	0.289	-0.080
	(0.018)	(0.009)	(0.014)	(0.009)	(0.008)	(0.086)	(0.056)	(0.065)	(0.058)	(0.062)	(0.058)	(0.062)
Before IT	0.195	-0.106	0.006	-0.073	0.051	0.411	-0.163	0.024	-0.215	0.125	0.239	-0.108
	(0.086)	(0.044)	(0.025)	(0.044)	(0.041)	(0.141)	(0.077)	(0.079)	(0.070)	(0.081)	(0.067)	(0.079)
After IT	-0.009	0.007	-0.018	-0.009	0.023	0.093	-0.467	0.022	-0.356	0.041	0.411	-0.007
	(0.055)	(0.029)	(0.024)	(0.020)	(0.016)	(0.118)	(0.081)	(0.096)	(0.087)	(0.093)	(0.089)	(0.096)
New Zealand												
All	0.042	-0.029	0.038	0.017	-0.010	0.385	-0.585	0.387	-0.557	0.310	0.602	-0.328
	(0.023)	(0.011)	(0.021)	(0.015)	(0.017)	(0.082)	(0.201)	(0.182)	(0.212)	(0.193)	(0.202)	(0.181)
Before IT	0.268	-0.164	0.117	-0.007	0.061	0.225	-0.434	0.181	-0.291	0.239	0.464	-0.206
	(0.272)	(0.124)	(0.206)	(0.284)	(0.189)	(0.219)	(0.619)	(0.590)	(0.666)	(0.652)	(0.638)	(0.604)
After IT	0.325	-0.175	-0.048	-0.091	0.061	0.234	-0.583	-0.072	-0.641	-0.044	0.613	0.079
	(0.092)	(0.050)	(0.020)	(0.024)	(0.019)	(0.105)	(0.150)	(0.152)	(0.145)	(0.153)	(0.144)	(0.150)
Norway												
All	0.088	-0.051	0.052	0.020	-0.006	-0.123	-0.090	0.091	-0.271	0.053	0.200	-0.128
	(0.036)	(0.018)	(0.030)	(0.022)	(0.021)	(0.087)	(0.120)	(0.110)	(0.143)	(0.138)	(0.128)	(0.116)
Before IT	0.100	-0.061	0.104	0.065	-0.013	-0.139	-0.142	0.115	-0.423	0.012	0.291	-0.092
	(0.040)	(0.020)	(0.032)	(0.032)	(0.025)	(0.118)	(0.168)	(0.163)	(0.188)	(0.193)	(0.165)	(0.164)
After IT	0.778	-0.411	-0.090	-0.228	0.082	-0.103	0.081	0.240	-0.151	0.251	0.016	-0.286
	(0.288)	(0.151)	(0.092)	(0.082)	(0.094)	(0.154)	(0.202)	(0.158)	(0.229)	(0.215)	(0.219)	(0.176)
Sweden												
All	0.175	-0.068	-0.117	-0.076	0.115	0.091	-0.710	-0.041	-0.694	-0.020	0.735	0.046
	(0.064)	(0.025)	(0.048)	(0.033)	(0.046)	(0.086)	(0.131)	(0.143)	(0.140)	(0.153)	(0.131)	(0.143)
Before IT	0.164	-0.066	-0.103	-0.131	0.106	0.151	-1.182	0.285	-0.966	0.594	1.173	-0.229
	(0.243)	(0.089)	(0.236)	(0.268)	(0.189)	(0.168)	(0.387)	(0.472)	(0.572)	(0.660)	(0.386)	(0.461)
After IT	0.314	-0.140	-0.106	-0.078	0.142	-0.245	-0.458	-0.337	-0.433	-0.228	0.478	0.246
	(0.129)	(0.060)	(0.052)	(0.042)	(0.052)	(0.112)	(0.103)	(0.124)	(0.127)	(0.142)	(0.112)	(0.133)
UK												
All	0.058	-0.033	0.070	0.020	-0.036	-0.234	-0.308	-0.542	-0.427	-0.475	0.339	0.532
	(0.042)	(0.021)	(0.033)	(0.024)	(0.030)	(0.077)	(0.105)	(0.115)	(0.112)	(0.127)	(0.105)	(0.118)
Before IT	0.171	-0.092	-0.005	-0.076	0.039	-0.204	-0.263	-1.220	-0.377	-1.258	0.263	1.261
	(0.156)	(0.079)	(0.105)	(0.116)	(0.092)	(0.133)	(0.300)	(0.279)	(0.336)	(0.313)	(0.322)	(0.280)
After IT	0.095	-0.048	0.014	-0.008	0.018	-0.398	-0.344	-0.284	-0.408	-0.273	0.398	0.293
	(0.088)	(0.044)	(0.039)	(0.034)	(0.037)	(0.112)	(0.098)	(0.114)	(0.109)	(0.129)	(0.098)	(0.120)

Notes: All parameters are obtained from Equation 7 estimated by the OLS method.

Appendix C: Asymmetric pass-through estimation (continued)

	c	ϱ	π+	π-	γ	ω	θ_t^+	θ_{t-1}^+	θ_t^-	θ_{t-1}^-	δ	δt-1
Emerging Market												
Brazil												
All	0.382	-0.062	-0.085	-0.089	0.143	0.332	-0.369	0.145	-0.986	0.111	1.140	-0.264
	(0.235)	(0.030)	(0.073)	(0.061)	(0.077)	(0.086)	(0.099)	(0.086)	(0.206)	(0.220)	(0.082)	(0.119)
Before IT	0.181	-0.103	0.009	0.552	0.096	0.386	-0.301	0.085	-0.708	-0.125	1.120	-0.313
	(0.302)	(0.058)	(0.102)	(0.859)	(0.099)	(0.139)	(0.126)	(0.116)	(1.480)	(1.345)	(0.104)	(0.179)
After IT	1.058	-0.146	-0.008	-0.082	0.057	0.253	-0.017	0.015	-0.019	0.035	0.035	0.017
	(0.408)	(0.050)	(0.036)	(0.044)	(0.047)	(0.122)	(0.052)	(0.048)	(0.045)	(0.045)	(0.051)	(0.050)
Hungary												
All	0.172	-0.070	-0.094	-0.094	0.133	0.444	0.006	0.213	-0.282	0.205	0.119	-0.221
	(0.066)	(0.021)	(0.075)	(0.065)	(0.079)	(0.097)	(0.089)	(0.077)	(0.097)	(0.088)	(0.083)	(0.069)
Before IT	0.362	-0.209	0.083	-0.551	0.132	0.188	0.268	0.076	-0.738	-0.433	0.063	-0.107
	(0.125)	(0.064)	(0.167)	(0.443)	(0.137)	(0.173)	(0.134)	(0.117)	(0.473)	(0.693)	(0.117)	(0.093)
After IT	0.013	-0.012	0.043	0.056	0.010	0.288	-0.035	0.246	-0.177	0.234	0.102	-0.259
	(0.236)	(0.090)	(0.185)	(0.208)	(0.162)	(0.201)	(0.140)	(0.160)	(0.139)	(0.172)	(0.133)	(0.154)
Indonesia												
All	0.351	-0.118	-0.170	-0.191	0.232	0.356	-0.164	0.079	-0.101	-0.006	0.286	0.011
	(0.140)	(0.051)	(0.080)	(0.101)	(0.094)	(0.105)	(0.053)	(0.065)	(0.073)	(0.080)	(0.050)	(0.056)
Before IT	0.481	-0.160	-0.260	-0.304	0.322	0.448	-0.191	0.147	-0.117	0.008	0.308	-0.035
	(0.211)	(0.072)	(0.153)	(0.160)	(0.169)	(0.127)	(0.067)	(0.073)	(0.076)	(0.093)	(0.066)	(0.065)
After IT	0.774	-0.479	0.073	-0.157	0.247	0.187	0.186	-0.245	0.529	0.331	-0.169	0.080
	(0.379)	(0.202)	(0.205)	(0.208)	(0.189)	(0.125)	(0.091)	(0.177)	(0.216)	(0.182)	(0.164)	(0.179)
Mexico												
All	0.042	-0.148	0.099	0.087	0.060	-0.139	-0.355	0.351	-0.382	-0.030	0.558	-0.045
	(0.128)	(0.026)	(0.045)	(0.032)	(0.046)	(0.073)	(0.080)	(0.086)	(0.303)	(0.310)	(0.050)	(0.064)
Before IT	0.010	-0.202	0.143	-0.087	0.068	-0.177	-0.360	0.322	-0.620	0.056	0.550	-0.018
	(0.173)	(0.046)	(0.065)	(0.134)	(0.062)	(0.093)	(0.104)	(0.119)	(0.628)	(0.638)	(0.063)	(0.082)
After IT	1.140	-0.285	-0.234	-0.290	0.291	0.033	0.176	0.308	0.103	0.559	-0.143	-0.381
	(0.442)	(0.120)	(0.091)	(0.120)	(0.111)	(0.157)	(0.157)	(0.144)	(0.192)	(0.163)	(0.175)	(0.156)
South Korea												
All	0.028	-0.017	0.005	-0.002	-0.002	0.484	0.028	0.025	-0.018	0.091	0.023	-0.030
	(0.020)	(0.011)	(0.010)	(0.011)	(0.011)	(0.073)	(0.031)	(0.031)	(0.052)	(0.050)	(0.035)	(0.035)
Before IT	0.191	-0.138	0.054	-0.114	-0.022	0.212	0.032	0.000	-0.180	0.089	0.029	0.009
	(0.049)	(0.033)	(0.018)	(0.033)	(0.016)	(0.114)	(0.040)	(0.039)	(0.102)	(0.113)	(0.045)	(0.054)
After IT	0.092	-0.066	0.035	-0.006	-0.028	0.254	0.023	0.077	-0.040	0.097	0.020	-0.048
	(0.054)	(0.036)	(0.031)	(0.022)	(0.025)	(0.122)	(0.062)	(0.062)	(0.059)	(0.062)	(0.060)	(0.061)
Turkey												
All	0.599	-0.124	-0.191	-0.117	0.296	0.153	-0.227	-0.202	-0.354	0.313	0.591	0.006
	(0.346)	(0.044)	(0.193)	(0.140)	(0.185)	(0.117)	(0.112)	(0.134)	(0.199)	(0.176)	(0.146)	(0.103)
Before IT	0.814	-0.163	-0.269	-0.122	0.415	0.173	-0.246	-0.213	-0.486	0.460	0.690	-0.088
	(0.799)	(0.077)	(0.416)	(0.339)	(0.430)	(0.161)	(0.170)	(0.222)	(0.293)	(0.329)	(0.240)	(0.174)
After IT	1.236	-0.292	-0.370	-0.408	0.475	-0.176	-0.205	-0.020	-0.077	0.345	0.313	-0.036
	(0.730)	(0.186)	(0.274)	(0.301)	(0.296)	(0.228)	(0.170)	(0.165)	(0.241)	(0.195)	(0.184)	(0.141)

Notes: All parameters are obtained from Equation 7 estimated by the OLS method.

Table 4.1 Descriptive Statistics

	Mean					Standard Deviation				
	ΔCPI	Δe	Δe^{+}	Δe^{-}	ΔCPI*	ΔCPI	Δe	Δe^{+}	Δe^{-}	ΔCPI*
Developed Market										
Australia										
Full sample	1.824%	-0.227%	2.533%	-2.760%	1.676%	1.546%	7.477%	5.323%	3.672%	7.545%
Before IT	2.905%	0.426%	3.237%	-2.811%	3.666%	1.678%	8.154%	5.936%	3.562%	7.930%
After IT	1.154%	-0.660%	2.102%	-2.762%	0.376%	0.978%	7.081%	4.916%	3.772%	7.086%
Canada										
Full sample	1.373%	-0.282%	1.503%	-1.785%	1.265%	1.386%	4.382%	2.544%	2.708%	3.977%
Before IT	2.566%	0.062%	1.432%	-1.370%	2.172%	1.342%	3.487%	2.200%	1.817%	2.868%
After IT	0.770%	-0.410%	1.552%	-1.962%	0.850%	0.908%	4.768%	2.710%	3.038%	4.373%
New Zealand										
Full sample	2.028%	0.157%	2.386%	-2.229%	1.719%	2.340%	6.574%	4.668%	3.272%	6.767%
Before IT	4.716%	2.007%	3.434%	-1.427%	4.443%	2.750%	7.986%	6.587%	3.211%	8.049%
After IT	0.962%	-0.572%	1.996%	-2.568%	0.629%	0.861%	5.849%	3.630%	3.267%	5.930%
Norway										
Full sample	1.625%	0.244%	1.410%	-1.166%	1.561%	1.703%	3.618%	2.585%	1.759%	3.535%
Before IT	2.146%	0.594%	1.336%	-0.742%	2.199%	1.695%	2.803%	2.045%	1.292%	2.794%
After IT	0.760%	-0.271%	1.560%	-1.830%	0.591%	1.354%	4.645%	3.314%	2.183%	4.338%
Sweden										
Full sample	1.521%	0.592%	1.845%	-1.252%	1.876%	1.803%	4.982%	3.986%	2.069%	5.040%
Before IT	3.028%	1.160%	1.626%	-0.466%	3.100%	1.744%	4.632%	4.407%	0.696%	4.830%
After IT	0.552%	-0.040%	1.710%	-1.751%	0.839%	0.971%	4.486%	2.832%	2.459%	4.296%
UK										
Full sample	1.726%	0.449%	2.127%	-1.678%	1.956%	1.524%	5.345%	3.796%	2.640%	5.367%
Before IT	2.694%	0.633%	2.672%	-2.039%	2.788%	1.794%	6.138%	3.965%	3.293%	6.156%
After IT	1.157%	0.075%	1.558%	-1.484%	1.198%	0.978%	4.212%	2.893%	2.167%	4.152%
Emerging Market										
Brazil										
Full sample	34.112%	32.344%	34.311%	-1.967%	33.964%	51.600%	49.969%	48.313%	5.168%	52.373%
Before IT	60.159%	58.734%	58.925%	-0.192%	61.178%	58.210%	53.890%	53.664%	1.180%	57.294%
After IT	2.758%	0.718%	4.772%	-4.054%	1.346%	1.586%	13.111%	9.088%	7.068%	11.946%
Hungary										
Full sample	3.685%	1.877%	3.301%	-1.424%	2.998%	3.072%	6.044%	4.597%	2.425%	6.524%
Before IT	6.211%	6.044%	4.597%	2.425%	6.524%	2.746%	4.392%	4.199%	0.503%	5.720%
After IT	1.770%	0.195%	2.373%	-2.178%	1.000%	1.079%	6.309%	4.627%	2.801%	6.196%
Indonesia										
Full sample	4.294%	3.878%	7.716%	-3.838%	4.516%	5.986%	20.752%	16.980%	9.073%	20.829%
Before IT	5.281%	5.488%	10.658%	-5.170%	6.340%	7.394%	26.591%	21.516%	11.463%	27.313%
After IT	3.012%	1.530%	3.709%	-2.179%	1.996%	3.111%	8.688%	6.558%	3.974%	5.488%
Mexico										
Full sample	9.050%	7.567%	8.744%	-1.177%	9.126%	15.704%	16.135%	15.322%	2.204%	22.850%
Before IT	13.563%	11.482%	12.160%	-0.677%	13.382%	18.673%	18.679%	18.153%	1.642%	27.836%
After IT	1.825%	1.272%	3.285%	-2.013%	2.290%	1.131%	7.703%	6.197%	2.728%	7.099%
South Korea										
Full sample	1.938%	1.349%	3.411%	-2.062%	2.229%	1.971%	9.454%	7.863%	3.660%	8.655%
Before IT	2.714%	3.115%	4.400%	-1.285%	4.170%	2.349%	10.266%	9.405%	2.341%	8.902%
After IT	1.034%	-0.257%	2.318%	-2.575%	0.384%	0.753%	7.410%	5.503%	3.534%	7.340%
Turkey										
Full sample	11.797%	9.176%	11.196%	-2.020%	10.448%	10.931%	14.711%	12.424%	4.028%	14.160%
Before IT	17.629%	13.554%	15.378%	-1.823%	15.016%	10.760%	15.703%	13.031%	4.411%	15.673%
After IT	3.427%	2.941%	5.317%	-2.376%	3.997%	2.429%	10.667%	8.691%	3.483%	8.229%

Notes: All variables are calculated in log changes and returns are annualised. ΔCPI is the log difference in domestic consumer price index. Δe is the changes in nominal effective exchange rate index defined as a domestic currency against a basket of foreign currency. Δe+ is the cumulative of positive changes in exchange rates or the period of exchange rate depreciation. Δe- is the cumulative of negative changes in exchange rates or the period of exchange rate appreciation. ΔCPI* is the log difference in foreign consumer price index.

Table 4.2 ADF unit root tests

	Level					1st difference				
	CPI	e	e^+	e^-	CPI*	CPI	e	e^+	e^-	CPI*
Developed Markets										
Australia										
Full sample	0.033	0.543	0.681	0.205	0.778	0.001	0.000	0.000	0.000	0.000
Before IT	0.998	0.818	0.783	0.478	0.765	0.001	0.000	0.000	0.001	0.000
After IT	0.603	0.215	0.173	0.625	0.142	0.000	0.000	0.000	0.000	0.000
Canada										
Full sample	0.000	0.556	0.265	0.911	0.780	0.000	0.000	0.000	0.000	0.000
Before IT	0.000	0.750	0.601	0.929	0.674	0.333	0.008	0.010	0.001	0.001
After IT	0.550	0.260	0.504	0.562	0.163	0.000	0.000	0.000	0.000	0.000
New Zealand										
Full sample	0.072	0.295	0.572	0.711	0.286	0.004	0.000	0.000	0.000	0.000
Before IT	0.145	0.644	0.461	0.742	0.637	0.027	0.000	0.000	0.000	0.000
After IT	0.668	0.223	0.375	0.590	0.191	0.000	0.000	0.000	0.000	0.000
Norway										
Full sample	0.000	0.348	0.089	0.938	0.414	0.000	0.000	0.000	0.000	0.000
Before IT	0.000	0.562	0.376	0.474	0.804	0.000	0.000	0.000	0.000	0.000
After IT	0.089	0.023	0.329	0.723	0.150	0.000	0.000	0.000	0.000	0.000
Sweden										
Full sample	0.569	0.338	0.215	0.8044	0.351	0.049	0.000	0.000	0.000	0.000
Before IT	0.397	0.584	0.706	0.991	0.573	0.001	0.000	0.000	0.000	0.000
After IT	0.152	0.1066	0.023	0.621	0.070	0.005	0.000	0.000	0.000	0.000
UK										
Full sample	0.733	0.269	0.414	0.204	0.299	0.013	0.000	0.000	0.000	0.000
Before IT	0.030	0.333	0.941	0.295	0.640	0.208	0.000	0.000	0.000	0.000
After IT	0.947	0.642	0.549	0.387	0.709	0.100	0.000	0.079	0.000	0.000
Emerging Markets										
Brazil										
Full sample	0.888	0.967	0.965	0.906	0.972	0.009	0.005	0.008	0.000	0.001
Before IT	0.873	0.674	0.665	0.853	0.823	0.139	0.145	0.151	0.000	0.055
After IT	0.702	0.654	0.586	0.731	0.225	0.002	0.000	0.000	0.000	0.000
Hungary										
Full sample	0.040	0.073	0.197	0.543	0.021	0.037	0.000	0.000	0.000	0.000
Before IT	1.000	0.992	0.989	0.939	0.989	0.007	0.001	0.002	0.001	0.003
After IT	0.412	0.016	0.228	0.383	0.016	0.002	0.000	0.000	0.000	0.000
Indonesia										
Full sample	0.580	0.248	0.613	0.978	0.152	0.000	0.000	0.001	0.000	0.000
Before IT	0.318	0.439	0.564	0.845	0.818	0.016	0.006	0.035	0.000	0.001
After IT	0.687	0.711	0.614	0.820	0.389	0.051	0.001	0.001	0.001	0.013
Mexico										
Full sample	0.341	0.596	0.552	0.989	0.863	0.007	0.008	0.000	0.000	0.000
Before IT	0.877	0.915	0.614	0.919	0.982	0.036	0.000	0.000	0.000	0.000
After IT	0.011	0.309	0.154	0.892	0.415	0.093	0.000	0.000	0.000	0.000
South Korea										
Full sample	0.966	0.277	0.195	0.243	0.186	0.000	0.000	0.000	0.001	0.000
Before IT	0.022	0.854	0.772	0.887	0.718	0.035	0.313	0.586	0.000	0.490
After IT	0.321	0.467	0.768	0.018	0.488	0.024	0.000	0.000	0.000	0.000
Turkey										
Full sample	0.081	0.670	0.881	0.488	0.718	0.871	0.000	0.000	0.000	0.000
Before IT	1.000	1.000	1.000	0.985	1.000	0.000	0.000	0.000	0.000	0.000
After IT	0.323	0.011	0.022	0.567	0.005	0.009	0.000	0.000	0.002	0.000

Notes: The Augmented Dickey-Fuller (ADF) test equation includes both a constant and a linear time trend. Lags are chosen based on Schwarz Information Criterion (SIC). The values in the table present the p-value.

Table 4.3 Cointegration test

	AA		*SA*		*AS*		*SS*	
	tBDM	*fPSS*	*tBDM*	*tBDM*	*tBDM*	*tBDM*	*tBDM*	*tBDM*
Developed Market								
Australia								
Full sample	-1.761	7.261***	0.909	5.962**	-1.755	8.286***	1.198	6.886***
Before IT	-0.078	2.565	0.024	2.945	0.080	3.202	0.223	3.405
After IT	-0.928	0.551	-0.743	0.635	-1.178	0.646	-0.744	0.561
Canada								
Full sample	-3.614**	7.283***	-2.616	6.033**	-3.868**	8.407***	-2.838	7.181***
Before IT	-2.404	3.732	-0.326	2.044	-2.280	3.684	-0.292	2.223
After IT	0.246	2.235	-0.257	2.770	-0.486	2.199	-0.831	2.914
New Zealand								
Full sample	-2.541	4.712*	-1.925	3.645	-2.683	5.516**	-2.026	3.694
Before IT	-1.322	2.716	-0.766	3.186	-1.606	3.089	-0.754	3.334
After IT	-3.473*	4.384*	-2.326	3.117	-3.286*	4.137*	-2.383	3.251
Norway								
Full sample	-2.838	16.764***	-2.033	17.388***	-2.812	16.173***	-1.982	16.544***
Before IT	-3.044	11.197***	-3.656**	13.925***	-2.881	10.190***	-3.464*	12.809***
After IT	-2.711	3.610	-1.416	2.742	-2.801	3.263	-1.621	2.436
Sweden								
Full sample	-2.746	5.799**	-0.858	5.204**	-2.781	6.317**	-0.850	5.783**
Before IT	-0.736	0.234	-0.754	0.316	-0.586	0.287	-0.559	0.371
After IT	-2.341	4.011	-2.271	4.347*	-2.518	3.550	-2.385	4.126
UK								
Full sample	-1.613	5.113**	-1.682	2.864	-1.944	5.573**	-1.986	4.261*
Before IT	-1.168	1.864	-0.133	0.869	-1.226	1.663	-0.187	0.618
After IT	-1.100	4.603*	-0.691	5.830**	-1.277	5.528**	-0.971	7.151***
Emerging Market								
Brazil								
Full sample	-2.089	1.521	-2.152	2.033	-2.896	2.325	-2.867	3.021
Before IT	-1.763	1.203	-1.944	1.480	-1.811	1.320	-2.048	1.543
After IT	-2.906	2.940	-0.771	1.155	-3.046	3.403	-0.693	1.364
Hungary								
Full sample	-3.297*	7.200***.	-4.030**	9.739***	-2.637	6.683***	-3.322*	8.999***
Before IT	-3.279*	3.286	-3.055	3.567	-3.256*	3.244	-2.830	3.275
After IT	-0.134	2.316	-0.803	3.112	0.264	1.868	-0.347	2.433
Indonesia								
Full sample	-2.326	2.033	-2.771	2.593	-2.814	3.747	-3.416*	4.638*
Before IT	-2.217	1.461	-2.161	1.587	-3.250*	3.178	-2.844	2.988
After IT	-2.373	2.433	-1.626	1.943	-1.267	0.824	-1.410	0.978
Mexico								
Full sample	-5.675***	12.330***	-5.704***	16.503***	-5.760***	12.193***	-5.722***	16.127***
Before IT	-4.361***	6.636***	-4.345***	8.091***	-4.410***	6.751***	-4.320***	8.090***
After IT	-2.385	1.990	-2.330	1.876	-1.499	1.453	-2.104	1.857
South Korea								
Full sample	-1.534	2.234	-0.761	2.229	-1.362	2.310	-0.523	2.376
Before IT	-4.205***	5.126**	-0.587	0.370	-3.968**	4.186*	-1.023	0.488
After IT	-1.870	1.248	-0.058	0.379	-1.302	0.762	-0.024	0.383
Turkey								
Full sample	-2.818	10.902***	-3.048	13.833***	-2.438	10.211***	-2.672	12.509***
Before IT	-2.128	4.740*	-1.794	5.378**	-1.790	5.437**	-1.429	6.079**
After IT	-1.569	1.456	-2.070	2.015	-1.698	0.998	-1.899	1.269

Notes: *tBDM* and *fPSS* are used for testing long-run relationship (or cointegrating testing) for the unrestricted NARDL model. The null hypothesis of both *tBDM* and *fPSS* is no long-run relationship against the alternative the alternative of cointegrating. The critical values tabulated for the *tBDM* and the *fPSS* are different from the conventional t and f statistics. The critical values for the *tBDM* are -3.21(10%), -3.53(5%), and -4.10%(1%). The critical values for the *fPSS* are 4.14(10%), 4.85(5%), and 6.36(1%).

Table 4.4 Short- and long-run symmetry tests

	Wald test			Pass-through Model
	Chi-square	t-statistics		
		Long-run	Short-run	
Developed Market				
Australia				
All	8.313**	2.580**	0.636	AS
Before IT	1.038	0.079	0.989	SS
After IT	0.637	0.736	-0.352	SS
Canada				
All	8.935**	2.907***	-1.072	AS
Before IT	16.568***	3.961***	-0.393	AS
After IT	3.675	0.284	-1.652	SS
New Zealand				
All	5.056*	2.110**	0.576	AS
Before IT	7.509**	2.691**	-0.737	AS
After IT	41.989***	6.470***	0.514	AS
Norway				
All	9.724***	2.458**	1.711*	AA
Before IT	5.695*	1.209	2.022**	SA
After IT	13.349***	3.400***	1.075	AS
Sweden				
All	40.375***	-6.344***	-0.409	AS
Before IT	1.109	0.099	-1.035	SS
After IT	2.513	-1.361	-1.333	SS
UK				
All	2.152	1.430	0.696	SS
Before IT	2.535	1.335	0.913	SS
After IT	1.340	1.057	0.673	SS
Emerging Market				
Brazil				
All	5.059*	0.195	2.155**	SA
Before IT	0.510	-0.570	0.294	SS
After IT	72.796***	8.514***	-0.353	AS
Hungary				
All	8.980**	0.016	2.942***	SA
Before IT	8.418**	1.748*	1.735*	AA
After IT	2.699	-0.102	1.639	SS
Indonesia				
All	0.850	0.798	0.173	SS
Before IT	2.416	1.433	0.523	SS
After IT	20.082***	3.967***	-2.667**	AA
Mexico				
All	1.200	0.395	0.860	SS
Before IT	3.370	1.638	0.563	SS
After IT	10.910***	2.771***	-1.623	AS
South Korea				
All	4.403	1.773*	-0.368	SS
Before IT	91.943***	9.305***	0.877	AS
After IT	36.986***	6.050***	0.783	AS
Turkey				
All	3.804	-1.112	-1.461	SS
Before IT	3.689	-1.388	-1.066	SS
After IT	2.713	0.303	-1.443	SS

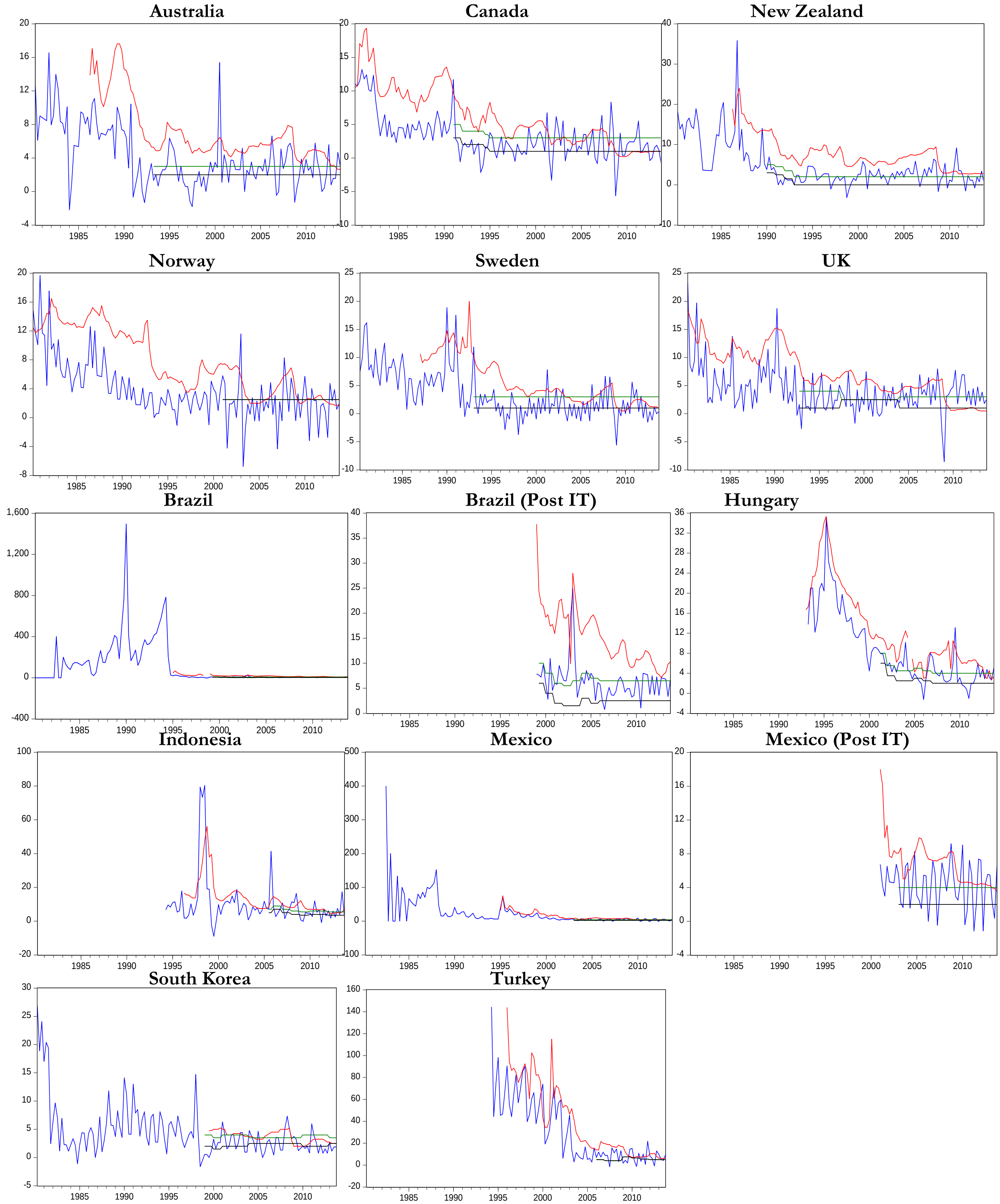
Notes: The Chi-square statistic is a first-step to identify whether there exists either asymmetric long-run or short-run pass-through. t-statistics are used to confirm for the long-run and short-run symmetry. The appropriate pass-through model is chosen based on the results of Wald test. *, **, and *** denote the rejection of the null at 10%, 5%, and 1% level, respectively. AA indicates asymmetric both long-run and short-run. SA indicates symmetric long-run but asymmetric short-run. AS indicates asymmetric long-run but symmetric short-run. SS indicates symmetric both long-run and short-run.

Table 4.5 Pass-through estimation

		Long-run relationship				Short-run relationship			Adj. R2
			sym.	*asymmetry*		*sym.*	*asymmetry*		
	obs.	λ	β	$\beta+$	$\beta-$	θ	$\Sigma\theta+$	$\Sigma\theta-$	
Developed Market									
Australia									
Full sample	136	-0.765	-	**1.675***	**0.723**	-0.007	-	-	0.466
Before IT	53	3.243	**-5.265**	-	-	-0.192	-	-	0.352
After IT	83	1.975	-1.311	-	-	-0.165	-	-	-0.029
Canada									
Full sample	136	0.027	-	**0.597***	0.039	-0.206	-	-	0.636
Before IT	44	0.472**	-	0.078	-0.668	-0.125	-	-	0.823
After IT	92	1.461	-0.801	-	-	-0.403	-	-	0.252
New Zealand									
Full sample	136	-0.426	-	**1.442***	**0.692**	-0.169	-	-	0.626
Before IT	39	0.510	-	**0.425**	**-0.341**	-0.292	-	-	0.395
After IT	97	0.380***	-	-0.311	-0.545	-0.675	-	-	0.288
Norway									
Full sample	136	-0.123	-	**1.018***	**0.401**	-	0.001	-0.218	0.533
Before IT	84	0.197	**1.201*****	-	-	-	0.018	-0.369	0.650
After IT	52	0.260	-	-0.262	-0.564	0.261	-	-	0.196
Sweden									
Full sample	136	1.695***	-	-1.732	-1.124	-0.735	-	-	0.579
Before IT	52	1.531***	**-1.269**	-	-	-0.810	-	-	0.273
After IT	84	0.625***	-0.375	-	-	-0.825	-	-	0.349
UK									
Full sample	136	0.870***	-0.019	-	-	-0.852	-	-	0.420
Before IT	51	0.568	**2.902**	-	-	-1.477	-	-	0.356
After IT	85	1.028	-0.304	-	-	-0.624	-	-	0.444
Emerging Market									
Brazil									
Full sample	131	2.489***	-1.566	-	-	-	-0.226	-1.226	0.961
Before IT	72	0.940	**0.068**	-	-	-0.185	-	-	0.957
After IT	59	0.415	-	-0.077	-0.579	0.003	-	-	0.491
Hungary									
Full sample	83	1.907***	-1.349	-	-	-	0.219***	-0.078	0.888
Before IT	32	0.633	-	**0.398**	-2.646	-	0.343***	-1.171	0.866
After IT	51	-0.383	**2.478**	-	-	0.213*	-	-	0.312
Indonesia									
Full sample	79	2.211***	-1.537	-	-	-0.067	-	-	0.767
Before IT	45	3.022***	-2.456	-	-	-0.017	-	-	0.876
After IT	34	0.517***	-	0.152	-0.327	-	-0.059	0.857***	0.205
Mexico									
Full sample	136	0.505**	0.559**	-	-	-0.020	-	-	0.805
Before IT	84	0.494*	**0.570****	-	-	-0.003	-	-	0.786
After IT	52	1.188***	-	-1.039	-1.156	0.463***	-	-	0.172
South Korea									
Full sample	136	-0.196	0.659	-	-	0.039	-	-	0.487
Before IT	73	-0.100	-	0.371**	0.783**	0.049	-	-	0.501
After IT	63	-0.957	-	**0.515**	-0.094	0.080	-	-	0.219
Turkey									
Full sample	79	0.790	0.144	-	-	-0.216	-	-	0.815
Before IT	47	-2.000	**3.143**	-	-	-0.314	-	-	0.719
After IT	32	2.097***	-1.748	-	-	-0.066	-	-	-0.055

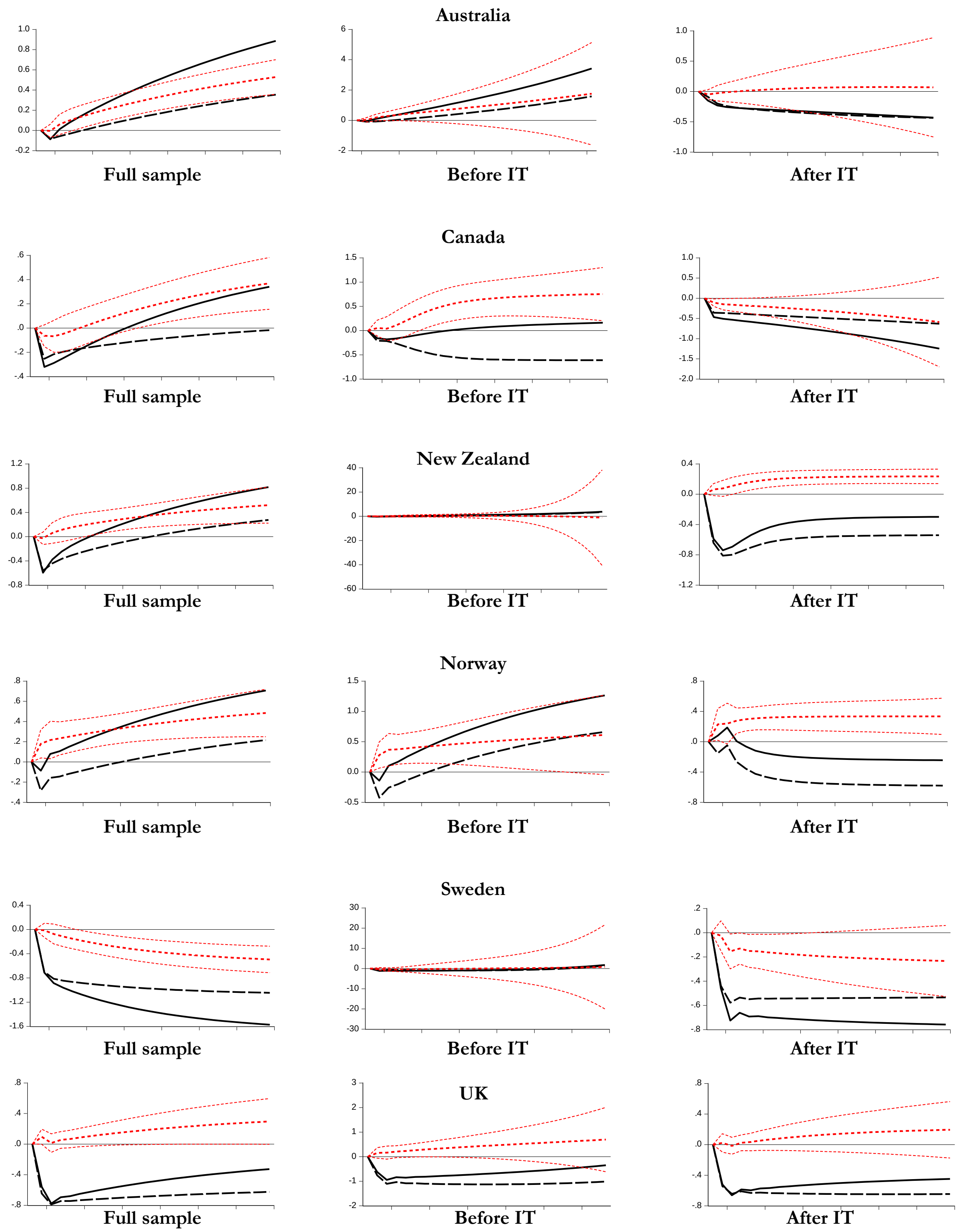
Notes: Each parameter obtained from the unrestricted and restricted NARDL model from Equation (7)-(10) has to be tested for the null hypothesis of zero pass-through and/or complete pass-through. Bootstrap methods are applied when the observations are less than 100. The four possible outcomes are presented in the table. The normal font without * indicates zero pass-through as the null of zero pass-through cannot be rejected whilst the null of complete pass-through is rejected. The normal font with * indicates partial pass-through as the null of zero pass-through and the null of complete pass-through are rejected. The bold font with * indicates complete pass-through as the null of zero pass-through is rejected but the null of complete pass-through cannot be rejected. The bold font without * indicate an unclear pass-through as both null hypothesis of zero and complete pass-through cannot be rejected. *, **, and *** also denote the rejection of the null at 10%, 5%, and 1% level, respectively.

Figure 4.1 Inflation and domestic interest rates



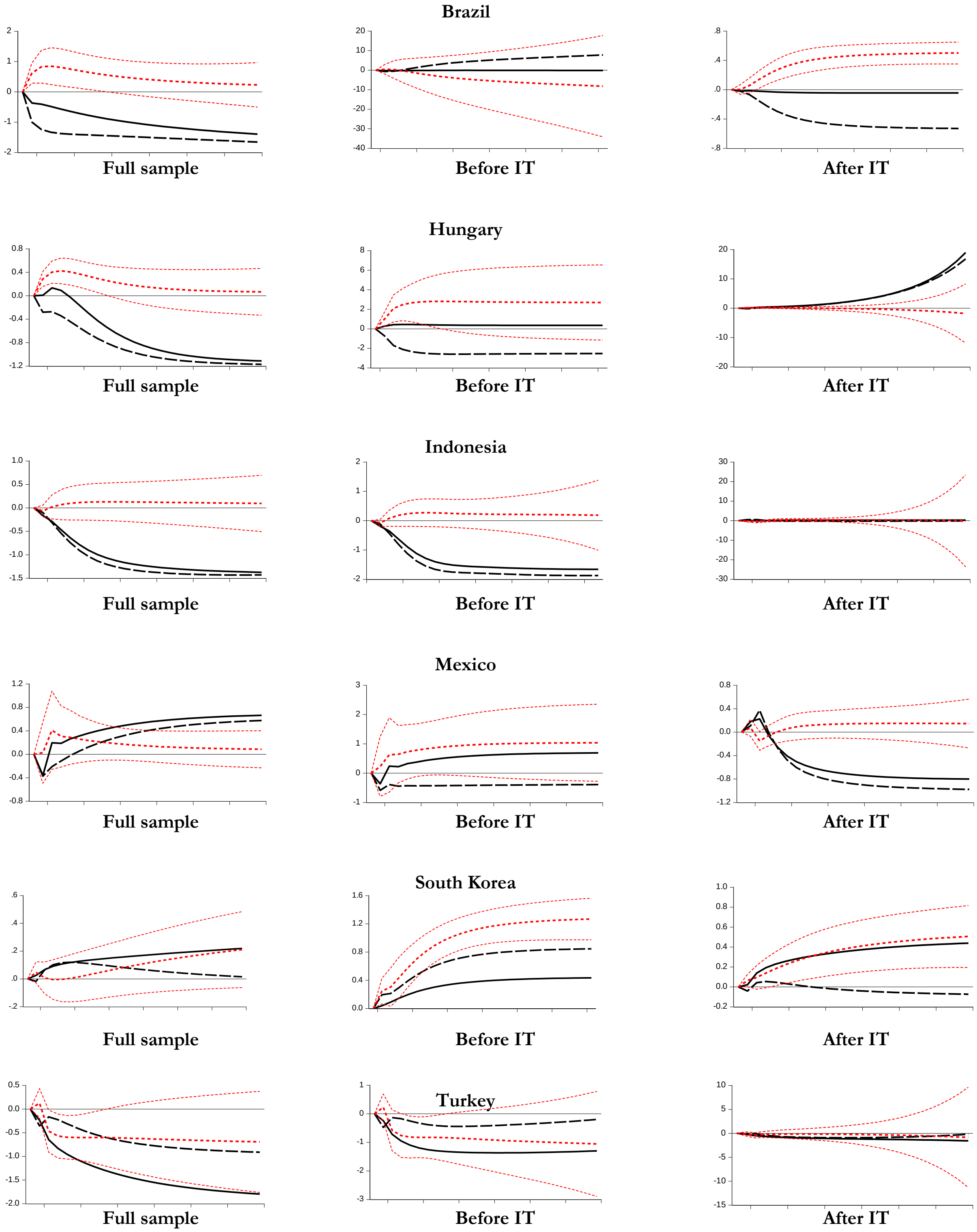
Notes: Inflation, domestic interest rates, the upper bound of inflation targeting, and the lower bound of inflation targeting are depicted by blue, red, green and black line, respectively. As the figures of Brazil and Mexico do not clearly illustrate the fluctuation of inflation and domestic interest rates during the period after IT, the figure of Brazil (Post IT) and Mexico (Post IT) is shown again in detail during this period.

Figure 4.2 Cumulative Asymmetric Dynamic Multiplier in Developed market



Notes: The solid (long-dashed) black line depicts the cumulative dynamic multiplier response of one percent change in depreciation (appreciation) of an exchange rate on the inflation. The heavy short-dashed red line depicts the difference between the cumulative multiplier of depreciation and appreciation. The short-dashed redlines depicted the 95% bootstrap confidence interval of the difference. The period in which the unit shock occurs are specified in X-axis over a 24 quarter horizon.

Figure 4.3 Cumulative Asymmetric Dynamic Multiplier in Emerging market



Notes: The solid (long-dashed) black line depicts the cumulative dynamic multiplier response of one percent change in depreciation (appreciation) of an exchange rate on the inflation. The heavy short-dashed red line depicts the difference between the cumulative multiplier of depreciation and appreciation. The short-dashed redlines depicted the 95% bootstrap confidence interval of the difference. The period in which the unit shock occurs are specified in X-axis over a 24 quarter horizon.

Chapter 5 Concluding Remarks

The thesis examines two closely related topics on the impact of exchange rate fluctuations. One is 'exchange rate exposure' which models the impact of exchange rate fluctuations on firms' returns. The other 'exchange rate pass-through' which models the impact of exchange rate variability on domestic prices. This thesis contributes in a number of ways to the exchange rate exposure and exchange rate pass-through literature, both in terms of the methodologies employed and the empirical findings.

Chapter Two investigates the exchange rate exposure at firm-level in five major ASEAN economies. In the first-step regression, the exposure coefficients are estimated by the framework of Chue and Cook (2008) in order to abstract the exclude the macroeconomic shocks in the model, as well as using an OLS benchmark method. The lagged effect of exchange rate changes is also considered in the model. The results of this chapter present a comprehensive study of exchange rate exposure in ASEAN economies. That is, (i) using the benchmark method there is strong evidence of negative exposure of ASEAN firms which is consistent with previous papers that document the idea of 'liability dollarization' (ii) applying the GMM approach to abstract from the macroeconomic shocks the average exposure coefficients in Indonesia, Philippines, and Thailand become positive (iii) applying the GMM approach results in a notable reduction in the percentage of firms with significant exposure (iv) the average exposure of banks is greater than the average exposure of nonbanks (v) the lagged exchange rate has more ability in capturing exchange rate exposure only in some countries such as Philippines, Singapore, and Thailand. In the second-step regression, the determinants of exchange rate exposure are explored by testing the cross-sectional hypothesis. The key firm-specific variables and countries-level variables are used to determine the level of exchange rate exposure. The findings reveal that (i) the firm size is a robust firm-specific estimator for nonbank companies. Nonetheless, the relationship between firm size and firm exposure is dependent on which types of firm (exporting or importing firms). (ii) Both ratio of international debt to GDP and ratio of country's openness are robust country-specific estimators in determining the degree of exchange rate exposure.

Chapter Three examines transaction and economic exposure in four main industrialised countries. This chapter is mainly dealing with the overlapping data problem which affects the empirical testing of such exposure. The overlapping data induce the serial correlation problem in economic exposure (long-horizon) estimation. A transformed regression method (TRF) proposed by Britten Jones et al. (2011) is used to alleviate this problem. The findings uncover an overvaluation of economic exchange rate exposure of firms in industrialised countries when a transformed regression method is applied. Compared to the OLS-HAC regression, approximately seventy percent of firms with significant economic exposure at a 5-year horizon disappear after the TRF-HAC method has been implemented. This reduction of economic exposure in each economy is confirmed by the industry level results. Further, the finding reveals the variation in exchange rate exposure when ten industries are investigated. When the TRF method is extended by the rolling regression with 10-year rolling windows, not only average exchange rate exposure but also percentage of firms with significant exposure in all economy shows a fluctuation due to the impact of global financial turmoil. Specifically, the percentage of firms with significant economic exposure using a 10-year rolling window reveals that (i) the movement of exposure in US and UK displays large swing with four big jumps across sample periods, which is consistent to the movement on the trade weighted exchange rates of US dollar and British Pounds. (ii) The movement on percentage of Canadian firms with significant exposure displays two big jumps according to the US dollar appreciation in the early periods and the periods of subprime crisis, respectively. (iii) The subprime crisis had less impacted on

Japanese firms than the Asian crisis since this percentage of firms with significant economic exposure during subprime crisis is less than that of firms with significant economic exposure during Asian crisis.

Chapter Four examines the effect of inflation targeting on the degree of exchange rate pass-through not only in emerging and developed countries but also pre- and post-inflation targeting. The nonlinear and asymmetric distributed lags approach (NARDL) is used to investigate the asymmetric ERPT relationship. Under this framework, asymmetric long-run as well as short-run pass through is permitted. The findings in Chapter Four show that there is strong evidence of long-run complete pass-through for depreciation in developed economies and long-run zero pass-through in emerging economies for the full sample. The results are slightly different when sub-samples are investigated. The long-run ERPT is not statistically significant in most countries during the period before inflation targeting. By contrast, there is strong evidence of a zero pass-through in both developed and emerging economies when IT is adopted. This might be explained by (i) an effectiveness of central banks in stabilising the domestic price and targeting their inflation so exchange rate variations do not impact the price level of the country (ii) import products are substituted with cheaper local products when the import prices increase regarding to a depreciation of domestic exchange rate. Further, when asymmetric pass-through is captured, depreciations are passed-through more strongly than appreciations regardless of long-run or short-run pass-through. This is consistent with the price rigidity theory. Finally, the size of pass-through coefficients in emerging economies is clearly larger than the magnitude of pass-through in developed economies only when IT is adopted. This suggests that emerging countries likely exhibit a weaker commitment to their target of inflation.

Building on this body of work, future research may include an investigation of volatility spillovers between stock returns and exchange rate changes as such spillovers may be more pertinent for firm risk management purposes. For the further study on exchange rate pass-through, the different price indices such as producer price index or export price index can be used to explain the relationship between exchange rate pass-through and monetary policy.

Bibliography

Aggarwal, R., Harper, J.T., 2010. Foreign exchange exposure of "domestic" corporations. Journal of International Money and Finance 29, 1619-1636.

Al-Abri, A.S., Goodwin, B.K., 2009. Re-examining the exchange rate pass-through into import prices using non-linear estimation techniques: Threshold cointegration. International Review of Economics & Finance 18(1), 142-161.

Alder, M., Dumas, B., 1984. Exposure to currency risk: definition and measurement. Financial Management 13(2), 41-50.

Allayannis, G., Brown, G.W., Klapper, L.F., 2003. Capital structure and financial risk: Evidence from foreign debt use in East Asia. The Journal of Finance 58(6), 2667-2710.

Allayannis, G., Ihrig, J., 2001. Exposure and markups. Review of financial studies 14(3), 805-835.

Allayannis, G., Ofek, E., 2001. Exchange rate exposure, hedging, and the use of foreign currency derivatives. Journal of International Money and Finance 20, 273-296.

Andrews, D.W.K., Monahan, J.C., 1992. An improved heteroscedasticity and autocorrelation consistent covariance matrix estimator. Econometrica 60, 953-966.

Aron, J., Macdonald, R., Muellbauer, J., 2014. Exchange rate pass-through in developing and emerging markets: A survey of conceptual, methodological and policy issues, and selected empirical findings. The Journal of Development Studies 50(1), 101-143.

Ball, L., 1999. Policy rules for open economies. In: Taylor John B. (Ed.), Monetary Policy Rules. University of Chicago Press, Chicago, Illinois, 127-144.

Banerjee, A., Dolado, J.J., Mestre, R., 1998. Error-correction mechanism tests for cointegration in a single-equation framework. Journal of Time Series Analysis 19(3), 267-283.

Bartov, E., Bodnar, G.M., 1994. Firm valuation, earnings expectations, and the exchange rate exposure effect. Journal of Finance 49, 1755-1785.

Bodnar, G.M., Dumas, B., Marston, R.C., 2002. Pass-through and exposure. Journal of Finance 57, 199-231.

Bodnar, G.M., Gentry, W.M., 1993. Exchange rate exposure and industry characteristics: evidence from Canada, Japan, and the USA. Journal of International Money and Finance 12, 29-45.

Bodnar, G.M., Wong, M.H.F., 2003. Estimating exchange rate exposures: Issues in model structure. Financial Management 32, 35-67.

Boudoukh, J., Richardson, M., 1994. The statistics of long-horizon regressions revisited. Mathematical Finance 4, 103-119.

Bredin, D., Hyde, S., 2011. Investigating sources of unanticipated exposure in industry stock returns. Journal of Banking and Finance 35, 1128-1142.

Britten-Jones, M., Neuberger, A., Nolte, I., 2011. Improved inference in regression with overlapping observations. Journal of Business Finance & Accounting 38, 657-693.

Brun-Aguerre, R., Fuertes, A.-M., Greenwood-Nimmo, M., 2013. Heads I win, tails you lose: New evidence of long-run asymmetry in exchange rate pass-through by exporting firms. Available at SSRN: http://ssrn.com/abstract=2365275 .

Bussiere, M., 2007. Exchange rate pass-through to trade prices: The role of non-linearities and asymmetries. European Central Bank Working Paper 822.

Calvo, G., Reinhart, C., 2000. Fixing for your life. National Bureau of Economic Research Working Paper 8006.

Campa, J.M., Goldberg, L.S., 2002. Exchange rate pass-through into import prices: A macro or micro phenomenon? National Bureau of Economic Research Working Paper 8934.

Campbell, J.Y., 2001. Why long horizons ? A study of power against persistent alternatives. Journal of Empirical Finance 8, 459-491.

Campbell, J.Y., Shiller, R.J., 1988. The dividend-price ratio and expectations of future dividends and discount factors. Review of Financial Studies 1(3), 195-228.

Ca'Zorzi, M., Hahn, E., Sánchez, M., 2007. Exchange rate pass-through in emerging markets. European Central Bank Working Paper 739.

Chamberlain, S., Howe, J.S., Popper, H., 1997. The exchange rate exposure of US and Japanese banking institutions. Journal of Banking and Finance 21, 871-889.

Choi, J.J., Elyasiani, E., 1997. Derivative exposure and the interest rate and exchange rate risks of US banks. Journal of Financial Services Research 12, 267-286.

Choudhri, E.U., Hakura, D.S., 2006. Exchange rate pass-through to domestic prices: Does the inflationary environment matter? Journal of International Money and Finance 25, 614-639.

Chow, E.H., Chen, H.L., 1998. The determinants of foreign exchange rate exposure: evidence on Japanese firms. Pacific Basin Finance Journal 6, 153-174.

Chow, E.H., Lee, W.Y., Solt, M.E., 1997a. The exchange-rate risk exposure of asset returns. The Journal of Business 70, 105-123.

Chow, E.H., Lee, W.Y., Solt, M.E., 1997b. The economic exposure of US multinational firms. The Journal of Financial Research 20(2), 191-210.

Chue, T.K., Cook, D., 2008. Emerging market exchange rate exposure. Journal of Banking & Finance 32, 1349-1362.

Coulibaly, D., Kempf, H., 2010. Does inflation targeting decrease exchange rate pass-through in emerging countries? Centre d'Economie de la Sorbonne Working Papers 49.

Crabb, P.R., 2002. Multinational corporations and hedging exchange rate exposure. International review of economics and finance 11, 299-314.

Dahlquist, M., Robertson, G.,2001. Exchange rate exposures, risk premia and firm characteristics, Duke University, Working paper.

Delatte, A-L., Lopez-Villavcencio, A., 2012. Asymmetric exchange rate pass-through: evidence from major countries. Journal of Macroeconomics 34, 833-844.

Devereux, M.B., Yetman, J., 2010. Price adjustment and exchange rate pass-through. Journal of International Money and Finance 29, 181-200.

Di Iorio, A., Faff, R., 2001.The effect of intervaling on the foreign exchange exposure of Australian stock returns. Multinational Finance Journal 5, 1-33.

Doidge, C., Griffin, J.M., Williamson, R., 2006. Measuring the economic importance of exchange rate exposure. Journal of Empirical Finance 13, 550-576.

Dominguez, K.M.E., Linda L.T., 2006. Exchange rate exposure. Journal of International Economics 68, 188-218.

Dumas, B., 1978. The theory of trading firm revisited. Journal of Finance 33, 1019-1029.

Edwards, S., 2006. The relationship between exchange rates and inflation targeting revisited. National Bureau of Economic Research Working Paper 12163.

Eichengreen, B., 2002. Can emerging markets float? Should the inflation target?. Banco Central Do Brasil Working Paper Series 36.

El bejaoui, H.J., 2013. Asymmetric effects of exchange rate variations: An empirical analysis for four advanced countries. International Economics 135-136, 29-46.

El-Masry, A.A., 2006. The exchange rate exposure of UK nonfinancial companies: industry level analysis. Managerial Finance 32(2), 115-136.

Fama, E.F., French, K.R., 1988. Dividend yields and expected stock returns. Journal of Financial Economics 22(1), 3-25.

Fama, E.F., French, K.R., 1989. Business conditions and expected returns on stocks and bonds. Journal of Financial Economics 25, 23-49.

Feenstra, R.C., Gagnon, J.E., Knetter, M.M., 1996. Market share and exchange rate pass-through in world automobile trade. Journal of International Economics 40, 187-207.

Flamini, A., 2007. Inflation targeting and exchange rate pass-through. Journal of International Money and Finance 26(7), 1113-1150.

Fraga, A., Goldfajn, I., Minella, A., 2004. Inflation targeting in emerging market economies. NBER Macroeconomics Annual 2003 Vol.18.

Frankel, J.A., Parsley, D.C., Wei, S-J., 2005. Slow pasthrough around the world: A new import for developing countries? National Bureau of Economic Research Working Paper 11199.

Froot, K., Scharfstein, D., Stein, J., 1993. Risk management: Coordinating Corporate Investment and Financing policies. Journal of finance 52, 1323-1354.

Gagnon, J.E., Ihrig, J., 2004. Monetary policy and exchange rate pass-through. Federal Reserve System, International Finance Discussion Paper 704.

Gao, T., 2000. Exchange rate movements and the profitability of US multinationals. Journal of International Money and Finance 19, 117-134.

Goldfajn, I., Werlang, S., 2000. The pass-through from depreciation to inflation: A panel study. Departmento de Economia PUC-Rio Working Paper 423.

Hansen, L.P., Hodrick, R.J., 1980. Forward rates as predictors for future spot rates: an econometric analysis. Journal of Political Economy88, 829-853.

He, J., NG, L.K., 1998. The foreign exchange exposure of Japanese multinational corporations. Journal of Finance 53, 733-753.

Herzberg, V., Kapetanios, G., Price, S., 2003. Import prices and exchange rate pass-through: theory and evidence from the United Kingdom. The Bank of England's Working Paper Series 82.

Hjalmarsson, E., 2011. New methods for inference in long-horizon regressions. Journal of Financial and Quantitative Analysis 46, 815-839.

Hodder, J.E., 1982. Exposure to exchange rate movements. Journal of International Economics 13, 375-386.

Hutson, E., O'Driscoll, A., 2010. Firm-level exchange rate exposure in the Eurozone. International Business Review 19(5), 468-478.

Hutson, E., Stevenson S., 2010. Openness, hedging incentives and foreign exchange exposure: A firm-level multi-country study. Journal of International Business Studies 41(1), 105-122.

Ihrig, J., Marazzi, M., Rothenberg, A., 2006.Exchange rate pass-through in the G7 countries. Board of Governors of the Federal Reserve System, International Finance Discussion Paper 851.

Jorion, P., 1990. The exchange rate exposure of US multinationals. Journal of Business 63, 331-345.

Jorion, P., 1991. The pricing of exchange rate risk in the stock market. Journal of Financial and Quantitative Analysis 26(3), 363-376.

Junttila, J., Korhonen, M., 2012.The role of inflation regime in the exchange rate pass-through to import prices. International Review of Economics and Finance 24, 88-96.

Killian, L., 1999. Exchange rates and monetary fundamentals: what do we learn from long-horizon regressions? Journal of Applied Econometrics 14, 491-510.

Knetter, M. M., 1994. Is export price adjustment asymmetric?: Evaluating the market share and marketing bottlenecks hypotheses. Journal of International Money and Finance 13(1), 55–70.

Krishnamoorthy, A., 2001. Industrial structure and the exchange rate exposure of industry portfolio returns. Global Financial Journal 12, 285-297.

Krugman, P., 1986. Pricing to market when the exchange rate changes. National Bureau of Economic Research Working Paper 1926.

Levi, M.D., 1994. Exchange rates and the valuation of firms in Y. Amihud and R. Levich, eds.: Exchange rate and corporate performance (Irwin Professional Publishing, New York), 37-48.

Levi, M.D., 1996. International Finance: The markets and financial management of multinational business, New York: McGraw-Hill.

Lin, C.H., 2011. Exchange rate exposure in the Asian emerging markets. Journal of Multinational Financial Management 21, 224-238.

Marazzi, M., Sheets, N., Vigfusson, R.J., Faust, J., Gagnon, J., Marquez, J., Martin, R.F., Reeve, T., Rogers, J., 2005. Exchange rate pass-through to US import prices: Some new evidence. Board of Governors of the Federal Reserve System Discussion Paper 833.

Marston, R.C., 1990. Pricing to market in Japanese manufacturing. Journal of International Economics 29(3-4), 217-236.

Martin,A.D., Mauer, L.J., 2003. Transaction versus economic exposure: which has greater cash flow consequences? International Review of Economics and Finance 12, 437-449.

McCarthy, J., 2000. Pass-through of exchange rates and import prices to domestic inflation in some industrialized economies. Staff reports No.11. Federal Reserve Bank of New York.

Melvin, M., Taylor, M.P., 2009. The crisis in the foreign exchange market. Journal of International Money and Finance 28, 1317-1330.

Mihaljek, D., Klau, M., 2001. A note on the pass-through from exchange rate and foreign price changes to inflation in selected emerging market economies. BIS paper 8, 69-81.

Mishkin, F.S., 1992. Is the Fisher effect for real? A re-examination of the relationship between inflation and interest rates. Journal of Monetary Economics 30. 195-215.

Mishkin, F.S., 2004. Can inflation targeting work in emerging market countries? National Bureau of Economic Research Working Paper 10646.

Mishkin, F.S., 2008. Exchange rate pass-through and monetary policy. National Bureau of Economic Research Working Paper 13889.

Muller, A., Verschoor, W.F.C., 2006. Foreign exchange risk exposure: survey and suggestions. Journal of Multinational Financial Management 16, 385-410.

Muller, A., Verschoor, W.F.C., 2007. Asian foreign exchange risk exposure. Journal of the Japanese and International Economies 21, 16-37.

Nance, D.R., Smith, C.W., Smithson, C.W., 1993. On the determinants of corporate hedging. Journal of Finance 48, 391-405.

Nelson, C.R., Kim, M.J., 1993. Predictable stock returns. Journal of Finance 48(2), 641-661.

Newey, W.K., West, K.D.,1987. A simple, positive definite, heteroscedasticity and autocorrelation consistent covariance matrix.Econometrica 55, 703-708.

Nguyen, H., Faff, R., 2003. Can the use of foreign currency derivatives explain variations in foreign exchange exposure? Evidence from Australian companies. Journal of Multinational Financial Management 13, 193-215.

Nogueira Junior, R.P., 2006. Inflation targeting, exchange rate pass-through and fear of floating. Department of Economics Discussion Paper 06(05), University of Kent.

Nogueira Junior, R.P., 2007. Inflation targeting and exchange rate pass-through. Economia Aplicada 11(2), 189-208.

Nydahl, S., 1999. Exchange rate exposure, foreign involvement and currency hedging of firms: some Swedish evidence. European Financial Management 5(2), 241-257.

Pesaran, H., Smith, R., Shin, Y., 1996. Testing for the existence of a long-run relationship. DAE, University of Cambridge, Working Paper 9622.

Pesaran, H., Shin, Y., Smith, R., 2001. Bounds testing approaches to the analysis of level relationships. Journal of Applied Econometrics 16(3), 289-326.

Pollard, P.S., Coughlin, C.C., 2004. Size matters: Asymmetric exchange rate pass-through at the industry level. Federal Reserve Bank of St.Louis Working Paper 2003-29C.

Pavasuthipaisit, R., 2010. Should inflation-targeting central banks respond to exchange rate movements? Journal of International Money and Finance 29, 460-485.

Prasertnukul, W., Kim, D., Kakinaka, M., 2010. Exchange rates, price levels, and inflation targeting: evidence from Asian countries. Japan and the World Economy 22, 173-182.

Rasche, R.H., Williams, M.M., 2005. The effectiveness of monetary policy. Federal Reserve Bank of St. Louis Working Paper Series 2005-048B.

Rees, W., Unni, S., 2005. Exchange rate exposure among European firms: evidence from France, Germany, and the UK. Accounting and Finance 45, 479-497.

Reyes, J., 2007. Exchange rate passthrough effects and inflation targeting in emerging economies: What is the relationship? Review of International Economics 15(3), 538-559.

Schmidt-Hebbel, K., Werner, A., Hausmann, R., Chang, R., 2002. Inflation targeting in Brazil, Chile, and Mexico: Performance, Credibility, and the exchange rate [with comments]. Economia 2(2), 31-89.

Sekine, T. 2006. Time-varying exchange rate pass-through: experiences of some industrial countries. Bank for International Settlements Working Paper Series 202.

Shapiro, A.C., 1975. Exchange rate changes, inflation and the value of multinational corporations. Journal of Finance 30, 485-502.

Shin, H-H., Soenen, L., 1999. Exposure to currency risk by US multinational corporations. Journal of Multinational Financial Management 9. 195-207.

Shin, Y., Yu, B., Greenwood-Nimmo, M., 2013.Modelling asymmetric cointegration and dynamic multipliers in an ARDL framework. SSRN Working Paper 1807745.

Smith, C.W., Stulz, R.M., 1985. The determinants of firms' hedging policies. Journal of financial and quantitative analysis 20(4), 391-405.

Stulz, R., Williamson, R., 1996. Identifying and quantifying exposures. Fisher College of Business, The Ohio State University.

Taguchi, H., Sohn, W-K, 2010. Inflation targeting and pass-through rate in East Asian Economies. Policy Research Institute Discussion Paper Series No.10A-08.

Taylor, J.B., 2000. Low inflation, pass-through, and the pricing power of firms. European Economic Review 44, 1389-1408.

Ware, R., Winter, R., 1988. Forward markets, currency options and the hedging of foreign exchange risk. Journal of International Economics 25, 291-302.

Warner, J., 1997. Bankruptcy costs: Some evidence. Journal of Finance 32, 337-348.

Webber, A.G., 2000. Newton's gravity law and import prices in the Asia Pacific. Japan and the World Economy 12, 71-87.

White, H., 1980.A heteroscdasticity-consistent covariance matrix estimator and direct test for heteroscedasticity.Econometrica 48, 817-838.

Williamson, R., 2001. Exchange rate exposure and competition: evidence from the automotive industry. Journal of financial Economics 59, 441-475.