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THE RELATION BETWEEN NATIONAL STOCK PRICES AND EFFECTIVE EXCHANGE RATES: DOES IT AFFECT EXCHANGE RATE EXPOSURE?

Abstract:

There is twofold contribution in this paper. First, by using monthly data for 8 industrialized countries for the period 1973-2011 we find evidence of time-varying cointegration relationship between effective exchange rates and national stock market indices. Second, we show that stock markets react differently on exchange rate changes depending on the connection between exchange rate and stock market. More specifically, we provide statistically significant evidence that the effect of the exchange rate exposure varies with the cointegration relation between stock and foreign exchange rate markets. This leads us to conclude that the exchange rate exposure is a time-varying non-linear process that follows exchange rate and stock market movements.

Keywords:

Exchange rate exposure, stock market returns, ARDL, cointegration, threshold

JEL Classification: F31, F37, G15

1. Introduction

The relation between foreign exchange rate and stock markets has attracted much attention in both international finance and macroeconomics literature. In recent decades there have been enormous changes in international financial system such as emergence of new currencies, gradual relaxation of foreign capital flow barriers and more flexible exchange rate mechanism. It is clear that after all these changes the interdependency between stock and currency markets has markedly changed. This implies that the movements in exchange rates have different effects on national stock market returns than previously. Hence, it is important to explore the effect of exchange rate changes to stock market returns in a time-varying context.

Exchange rate exposure links stock market returns and exchange rates changes. Specifically, it predicts an impact of foreign exchange rate risk on stock prices. The empirical literature on the exchange rate exposure presents only a weak evidence of exposure effect. Early results (see e.g. Adler and Dumas 1984, Jorion 1990 and Bodnar and Gentry 1993) show that exchange rate fluctuations influence firms' profits to a very low extent in the U.S. For other countries, the literature shows somewhat stronger effect (see e.g. Khoo 1994 and He and Ng 1998). Recently, Dominquez and Tesar (2001 and 2006) have established significant impacts of exchange rate movements on stock market returns at both firm and industry level. However, these results are still inconclusive. For example, Griffin and Stulz (2001) show that for a large number of countries and industries that the exchange rates do not matter much for the stock market returns. Overall, the empirical findings suggest that exchange rate fluctuations affect stock prices mainly in the case of non-US stocks and that the risk exposure patterns are to a large extent industry-specific and tend to vary with the time horizon.

There is a growing literature proposing that the linear models are not the appropriate way for estimating exchange rate exposure. Some scholars have presented significant non-linear relations between exchange rate changes and stock market returns (see e.g. Bartov and Bodnar 1994, Kanas 1997, Miller and Reuer 1998, Williamson 2001 and Bartram 2004). The nonlinearities arise mainly due to the differences between the eras of exchange rate depreciation and appreciation and the presence of different impacts according to the magnitude of the exchange rate movement. The intuition behind non-linearities is that the investors may find it difficult to interpret the persistence of exchange rate shock. This may lead to incorrect conclusions of the real impact of the exchange rate shocks on the firm value.[1]

We explore the national stock market exchange rate exposure[2] in a non-linear threshold cointegration context. We argue that the exchange rate exposure varies over time and it depends on the long-run comovement between stock markets and exchange rate markets. Some authors argue that failure to reveal exposure effect is due to the use of short-run analysis (see e.g. Chow et al. 1997). By using longer horizon analysis we are able to detect the full exposure effect. There are some previous empirical studies that examine time-varying or asymmetric exchange rate exposure (see e.g. Koutmos and Martin 2003, Kizys and Pierdzioch 2007 and Pierdzioch and Kizys 2010). We differ from these papers in that we will use a more direct link between stock markets and exchange rates. We argue that in analysing exposure effects it is crucial to examine exchange rates and stock market prices comovement as emphasized in Adler and Dumas (1984). However, as far as we know the joint effect has not been taken into account in previous empirical exposure literature.

We use autoregressive distributed lag (ARDL) cointegration methods introduced by Pesaran et al. (2001), and discover that a cointegration relation emerges between exchange rates and national stock market indices. We emphasize that this relation is asymmetric in the sense that there are periods when it exists and other periods when it disappears. We find that there exists threshold cointegration between effective trade weighted exchange rate and national stock market indices for 8 industrialized countries

[1] Furthermore, financial derivatives can generate non-linear payoffs caused by fluctuations of exchange rates. For example, Muller and Verschoor (2006) states that the use of options allows firms make asymmetric gains, thereby influencing the firm's currency exposure in accordance with the magnitude of the exchange rate fluctuation.

[2] There are only a few studies that examine exchange rate exposure at the national level. Friberg and Nydahl (1999) examined the valuation of the stock market and effective exchange rate for 11 industrialized countries. They find that the more open the economy is, the stronger is the relationship between return on the stock markets and exchange rates. Pierdzioch and Kizys (2010) have reported evidence of a cointegration relation between national exchange rate exposure and the industry composition of a country's import and somewhat weaker evidence of a cointegration relation between exchange rate exposure and openness to trade. Entorf et al. (2011) evaluate 27 countries and show that the national foreign exchange rate exposures are significantly related to the current and financial account balance variables of corresponding economies.

during the time period 1973-2011. We further show that stock markets react differently on exchange rate changes depending on the connection between exchange rate and stock market. More specifically, we provide statistically significant evidence that the effect of the exchange rate exposure varies with the cointegration relation between stock and foreign exchange rate markets. This leads us to conclude that the exchange rate exposure is a time-varying non-linear process that follows exchange rate and stock market movements. This is reasonable, since the investors behave differently according to exchange rate risk when there is more predictability in the markets.

The rest of the paper proceeds as follows. Section 2 presents the theoretical consideration of our approach and section 3 gives description of our data set and the empirical results. Finally, section 4 concludes.

1. The threshold model for foreign exchange rate exposure

There is no theoretical consensus on the existence of the relationship between stock prices and exchange rates. There are, however, two main theoretical links that connects national stock market prices with exchange rates. The first link is the traditional goods market theory or flow-oriented model (see e.g. Dornbusch and Fisher 1980), which suggests that a depreciation of a currency makes domestic firms more competitive. This leads to increasing export, which in turn affects current and future cash flows of domestic firms and, finally, their stock prices[3]. Hence, the traditional view presents a positive correlation between exchange rates and stock prices. The second link is the portfolio approach (see e.g. Frankel 1983), which suggests that an increase in stock prices induces investors to demand more domestic assets, which causes an appreciation of the domestic currency. Hence, the portfolio approach leads to a negative correlation between exchange rates and stock prices.

We propose the following type of non-linear specification for exchange rate exposure

[3] Exchange rates will affect the value of firms whether or not they are directly involved in foreign operations. For example, the firms that use imported intermediate products see their profits shrinking as a consequence of increasing costs of production due to exchange rate depreciation. Even firms that are not directly engaged in international transactions may see their profits change through competition from foreign firms in domestic market.

$$
\begin{aligned}
r_{t,j} &= (\gamma_{01,j} + \gamma_{11,j}\Delta s_{t,j} + \gamma_{21,j} r_{W,t} + \gamma_{31,j}\Delta b_{t,j}) \times (1 - I_{t,j}) \\
&+ (\gamma_{02,j} + \gamma_{12,j}\Delta s_{t,j} + \gamma_{22,j} r_{W,t} + \gamma_{32,j}\Delta b_{t,j} + \delta_{12} ecm_{t-1}) \times I_{t,j} + \varepsilon_{t,j}
\end{aligned}, \qquad (1)
$$

where $r_{t,j}$ is the national stock market return for a country *j*, $\Delta s_{t,j}$ is the return based on a nominal effective rate index, and $\varepsilon_{t,j}$ denotes an approximately normally and independently distributed error term with zero mean and constant variance. We include return of world market portfolio $(r_{W,t})$ and long-term interest rate return (Δb_t) in the regression.[4] Forbes and Rigobon (2002) provide evidence that the stock market can exhibit a high degree of changes after a shock in one of these markets. By including the world stock market index into the regression we try to eliminate the effect of one important exogenous variable changes in the domestic country *j* stock returns. Based on this same argument we have included the long-term bond rate in the regression. Moreover, there are several studies indicating that bond rates have an important impact on stock returns (see e.g. Fama 1981 and Campbell 1987).

The indicator variable I_t takes value zero (I_t= 0), for the periods of no cointegration between exchange rate and stock market price and value one (I_t= 1) when the cointegration exists. Hence, the above equation (1) can be seen as a threshold error-correction model for the exchange rate exposure. This implies that we have different exposure coefficients depending on whether the stock and currency markets are comoving or not.[5] The error correction term (ecm_{t-1}) is one-period lagged residual term ($u_{t,j}$) from the regression

[4] All variables are transformed into logarithmic values and their first differences correspond to growth rates of variables.

[5] Only few empirical studies have examined the relationship between exchange rates and stock prices. This is surprising, since the above presented theoretical considerations imply that a cointegration relation between the two price series should exist. Bahmani-Oskooee and Sohrabian (1992) use monthly data on the S&P 500 index and the US dollar effective exchange rate for the period 1973-1988. Their study suggests that there is no comovement between stock prices and exchange rates. Recently, Phylaktis and Ravazzolo (2005) analyzed a group of Pasific Basin countries over the period 1980-1998 and find that stock and foreign exchange markets are positively related. Nieh and Lee (2001) utilized daily data from October 1, 1993 to February 4, 1996 and find that there is no long-run relation in the G-7 countries. Yau and Nieh (2009) employ threshold cointegration models and find asymmetric information only for Taiwanese financial market. Lin (2012) analyzed Asian emerging markets and suggests that the comovement between exchange rates and stock prices becomes stronger during crisis period.

$$\Delta \ln SP_{t,j} = \beta_{0,j} + \lambda_{1,j} \ln SP_{t,j} + \lambda_{2,j} \ln Eerate_{t,j} + \sum_{k=1}^{k_1} \beta_{1,j} \Delta \ln SP_{t-k,j} + \sum_{l=0}^{l_1} \beta_{2,j} \Delta \ln Erate_{t-l,j} + u_{t,j}, \quad (2)$$

where SP_t is the stock market index, and $Eerate_t$ is the effective foreign exchange rates in country *j*. The lag lengths for the differenced variables are denoted by *k* and *l*.

To reveal the possible long-run relationship between stock prices and exchange rates we use autoregressive distributed lag (ARDL) cointegration approach proposed by Pesaran et al. (2001). The ARDL approach is the most efficient cointegration method when it comes to small sample sizes as is the case in our study. Furthermore, it has a methodological advantage over the conventional approaches (i.e. Engle-Granger and Johansen), since it does not require that variables of interest need to be of the same order of integration. Hence, we can test the existence of cointegration between variables irrespective of whether the regressors are non-stationary or stationary series. Moreover, the approach allows simultaneous estimation of the long-run and short-run parameters.

The first step in the ARDL approach is to estimate the above linear long-run relationship (2) between stock market and currency market returns for country *j*. The above ARDL(*k,l*) model can be estimated by the ordinary least squares (OLS) method.

The second step in the ARDL approach is to test the joint hypothesis that the long-run multipliers of the lagged level variables are zero (i.e. $H_0 : \lambda_1 = \lambda_2 = 0$). The cointegration is present if the null hypothesis can be rejected by F statistic, which has a non-standard distribution because of non-stationarity of the variables. However, Pesaran et al. (2001) and Narayan (2005) present the critical values.

The exposure coefficients ($\gamma_{11,j}$) and ($\gamma_{12,j}$) in equation (1) present the average exposures of the national stock markets to changes in effective exchange rates. A statistically significant value for either exposure coefficients implies that the effective exchange rate changes affect stock price returns. The sign, however, can be either positive or negative depending whether the particular country is export or import-oriented. We expect to see positive signs for the export-oriented countries and negative signs for the import-oriented countries. The exposure coefficient is expected to be near zero if the industrial sector for some country is not vulnerable to exchange rate changes.

In the next section we test the null hypothesis ($H_{01}:\gamma_{11}=\gamma_{12}$) for the same parameter value of exposure coefficient in both cointegrating and non-cointegrating regimes. Rejecting the null hypothesis implies that the exchange rate exposure is dependent on the relationship between the exchange rate and stock price for a particular country *j*. It should be noted that we allow the effects of constant term, return of world market portfolio $(r_{W,t})$ and long-term interest rate return (Δb_t) differ between the regimes, too. In empirical analysis we test whether the effects of the world stock market return ($H_{02}:\gamma_{21}=\gamma_{22}$) and domestic bond rate return ($H_{03}:\gamma_{31}=\gamma_{32}$) are similar in both regimes.

2. Empirical results

We collected monthly data for the period from January 1973 to December 2011 for the following 8 industrialized countries: Australia, Canada, Finland, Italy, Japan, the United Kingdom, the United States and Sweden. The data include G-7 countries, excluding Germany due to data problems before the re-union. We have also included two small open economies, Finland and Sweden in our analysis. These countries are especially interesting, since they have very similar economical structure but they use different currencies. We use national stock market indices to compute countries stock market returns at the national level. The MSCI world stock market Index from the Thompson Financial Datastream presents the world stock market return $(r_{W,t})$ presented in the domestic currency units. The effective exchange rates ($\Delta s_{j,t}$) are the trade-weighted exchange rate indices. Bond rates (Δb_t) are monthly government long-term (10 years) bond rates. They are obtained from the OECD Main Economic Indicator data base.

As we stated in the previous section, the ARDL cointegration approach does not require that all the variables considered are stationary or unit-root processes, but the critical values of F-statistics provided in Pesaran (2001) and Narayan (2005) are based on whether the variables are I(0) or I(1). Hence, we provide the results of the ADF unit root tests in Table 1. We find that all the stock prices and most of the effective exchange rates appear to be nonstationary at the 10% level for the full sample period. The null hypothesis of unit-root can be rejected only for the effective exchange rates of Australia and Italy. The lag lengths were chosen based on the Schwartz-Bayesian information criterion.

[INSERT TABLE 1 HERE]

To test whether that the relationship between exchange rates and stock market indices may have changed over time, we use rolling regression to estimate the bivariate relation (2). The second column in Table 2 gives F-statistics for the linear ARDL bound tests for cointegration over the full sample period. The ARDL tests show that there is a long-run relationship in three countries (Finland, Italy and the U.S.) at 5% level. We present the results of the same cointegration tests also for three sub-periods in Table 2. These results show that the long-run relationships between stock prices and effective exchange rates are mixed. For some sub-periods cointegration relation exists but results regarding for some other sub-periods vanishes. This suggests that exchange rates and stock markets are not sharing a common stochastic trend for all sub-periods.

[INSERT TABLE 2 HERE]

To analyze the time-varying cointegration relation we utilize a rolling estimation. We set the window length to 10 years[6] to compute F-statistic for the ARDL bound test of the null hypothesis of no cointegration. The cointegration test under the bounds framework involves the comparison of the F-statistic against the asymptotic critical values for small sample size provided in Narayan (2005). We used 5% critical values and if the F-test result for no co-integration exceeds the critical level we assumed that there is cointegration between variables. The lag lengths are selected by using the Akaike information criteria (AIC) and they varies between one and four set.

The results of rolling estimation for cointegration analysis are summarized in Figure 1. The straight line presents 5% critical value. Whenever the F-statistic exceeds the critical value, the null of no cointegration is rejected. As we can see the null

[6] In this we follow Pierdzioch and Kizys (2010). We have also used different window lenghts, but the results were qualitatively similar. The result are available upon a request from the author.

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hypothesis of no relation can be rejected for all countries for some sub-periods. Interestingly, when the cointegration relation emerges it seems to be present for many years. Thus, for these time periods there exists short-run predictability between stock market and currency market returns.

[INSERT FIGURE 1 HERE]

The results of the rolling cointegration suggest that there are two distinct regimes between variables. The first regime is one where the stock and exchange rate markets are moving together and the other regime is when they are not. In Table 3 we present the estimation results for the threshold error-correction model for the exchange rate exposure (3). The results show significant results for three countries, namely Finland, Italy and Japan. For other countries we could not find statistically significant error correction parameter. However, for these countries we estimate threshold exchange rate exposure relationship with no error-correction term. We, thus, are able to present also for these countries the changes in effective exchange rates have a different effect on national stock markets, depending whether the stock and exchange rate markets are co-moving or not.

The exposure coefficients are significant almost in all countries. The only exception is the U.S. This is probably due to the role of U.S. dollar in the world economy. The individual estimates show that the impact of exchange rate exposure is greater for more open countries, such as Finland and Italy. This result is expected. However, we see that the exposure coefficient varies markedly in time. The null hypothesis for the same parameter value in both regimes can be rejected in 4 cases out of 8 at 5% significance level.

It seems that the return on the world stock market is an important determinant of the return on national stock markets, since it is significant in all regressions and in both regimes. However, this effect does not seem to change between regimes. The only exception is Japan, for which the null hypothesis of no changes in parameter value can be rejected at 1% significance level in both regimes. The long-term interest rate return (bond) is also significant for many countries' exposure regressions, but the null for the same parameter value in both regimes can only be rejected for the UK at 5% level.

[INSERT TABLE 3 HERE]

For the analysis of time variation in the exposure effects presented in Table 4 we use the same three sub-periods as in Table 2. We notice that the average exposure effect changes markedly during the sample period. Especially for small open economies such as Canada, Italy, Finland and Sweden the exposure coefficients varies greatly during the sample period. This is in line with the previous studies. For example, Solnik (1987) find a negative relation between stock return differentials and changes in real exchange rates over a period 1973-1983 and a weak positive relation over the sub-period 1979-1983. Also, Vygodina (2006) suggested that the relation between stock prices and exchange rates changes over time.

As we mentioned previously, it would be interesting to compare the exposure effect between small open EMU and non-EMU economies. In Finland (EMU country) the exposure effect is .23 in the 1970-1980s, increasing to almost 1 during the 1990s and then decreasing to .61 after 2000, i.e., during the EMU period. Interestingly, in Sweden (non-EMU country), which has rather similar economic structure as Finland, the variation is much lower from -.15 in 1970-1980s to .20 after 1990. This reflects that the Finnish stock market is more vulnerable to exchange rate changes than the Swedish stock market. This might also suggests the fact that Finland is unable to use any exchange rate policy because of common monetary policy with other Eurozone countries.

For the big economies the variation is much more modest. For example, in the UK the exposure coefficient varies from the minimum of .31 to the maximum of .34 during the sample period. Similarly, there are small movements in Australia, Japan and the U.S. This implies that the exposure effects reflect countries industries' dependency on exchange rate changes.

[INSERT TABLE 4 HERE]

3. Conclusions

We have examined the effective exchange rate exposure of national stock markets by using monthly data on 8 industrialized countries for the sample period 1973-2011. We developed a time-varying threshold cointegration model for the exposure effect. First, we investigated the time-varying cointegration relationship between nominal effective exchange rate and stock prices, and find that the relationship exists but that it is not always present. This suggests that these financial variables seem to have a time-varying long-run relationship. This result is in line with the previous studies.

Second, we provide new evidence that the exchange rate exposure of stock market varies with the connection between stock prices and effective exchange rates. We provide evidence that comovement between exchange rates and stock prices have important effects on the exchange rate exposure. In efficient markets, stock returns should adjust instantaneously to an unexpected exchange rate shock. An important finding is that the stock and exchange rate markets' joint role is an important aspect of the international risk sharing.

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Appendix

Table 1. The results of the ADF unit root tests

Country	Stock prices	Exchange rates	Stock returns	Exchange rate returns
Australia	-.774 (1)	-2.621* (1)	-19.977*** (1)	-15.847*** (0)
Canada	-.516 (2)	-1.605 (3)	-19.485*** (3)	-17.096*** (0)
Finland	-1.767 (3)	-2.164 (1)	-15.276*** (1)	-17.178*** (1)
Italy	-1.587 (1)	-2.722* (3)	-15.776*** (2)	-15.615*** (1)
Japan	-1.774 (1)	-1.439 (4)	-16.457*** (0)	-14.773*** (0)
United Kingdom	-.9255 (0)	-2.156 (2)	-20.725*** (1)	-15.739*** (1)
United States	-.2618 (1)	-2.392 (1)	-16.645*** (1)	-14.593*** (1)
Sweden	-1.068 (3)	-1.553 (1)	-18.372*** (3)	-15.450*** (0)

Note: *,**,*** presents 10%, 5% and 1% critical values, respectively. The numbers in parentheses present the selected lag length.

Table 2. F-statistics for testing the ARDL cointegration

Country	full sample	1973-1989	1990-1999	2000-2011	1990-2011
Australia	2.737	9.246***	.233	1.280	-.966
Canada	1.219	4.796	1.140	4.451	.909
Finland	6.166**	4.511	8.630***	2.490	4.217
Italy	6.900**	3.405	1.561	1.196	3.013
Japan	1.989	5.454*	4.292	4.634	4.993*
United Kingdom	3.551	.332	.422	3.631	1.878
United States	6.453**	3.824	.576	3.002	2.904
Sweden	5.273*	2.416	3.156	1.972	2.756

Notes: *,**,*** presents 10%, 5% and 1% critical values, respectively. The asymptotic critical values for ARDL bound test for cointegration are 4.895 (10%), 5.930 (5%) and 8.260 (1%).

Table 3. The parameter estimates for the model (4)

Parameters	Australia	Canada	Finland	Italy	Japan	United Kingdom	United States	Sweden
γ_{01}	.003	.001	.001	.002	.000	-.000	.005	-.001
γ_{11}	.035	-.849***	-.307	1.857***	.310*	.311***	-.262	-.237
γ_{21}	.593***	.736***	.579***	.671***	.462***	.863***	.481***	1.013***
γ_{31}	-.006	-.021**				-.003	.017	-.004
γ_{02}	.000	.000	.001	-.000	.001	-.000	.002	.005
γ_{12}	-.145*	-.190*	1.316***	-.387	.096	.341**	.089	.474*
γ_{22}	.758***	.735***	.552***	.445***	.538***	.729***	.556***	.858***
γ_{32}	-.038	-.014*			.000	-.039***	.089	-.037**
δ_{12}			-.013***	-.017***	-.023***			
DW	2.161	2.154	1.615	1.809	1.742	2.196	2.282	2.106
$H_{01}:\gamma_{11}=\gamma_{12}=0$	1.394	5.242**	9.075***	9.506***	1.372	.021	2.108	3.177**
$H_{02}:\gamma_{21}=\gamma_{22}=0$	.804	.002	.020	2.058	24.41***	1.479	.632	1.013
$H_{03}:\gamma_{31}=\gamma_{32}=0$	4.347*	.333		2.278		7.961***	2.321	2.089

Note: *,**,*** presents 10%, 5% and 1% critical values, respectively.

Table 4. Exposure effect

Country	full sample	1973-1989	1990-1999	2000-2011	[min, max]
Australia	-.078	-.145	-.092	-.028	[-.145, .035]
Canada	-.442	-.284	-.668	-.345	[-.849, -.189]
Finland	.547	.234	.911	.611	[-.261, 1.388]
Italy	.643	2.193	.611	1.368	[-.387, 1.866]
Japan	.430	.429	.414	.443	[.311, .538]
United Kingdom	.322	.312	.331	.321	[.312, .342]
United States	-.092	-.020	-.216	-.031	[-.263, .087]
Sweden	.115	-.152	.189	.208	[-.237, .474]

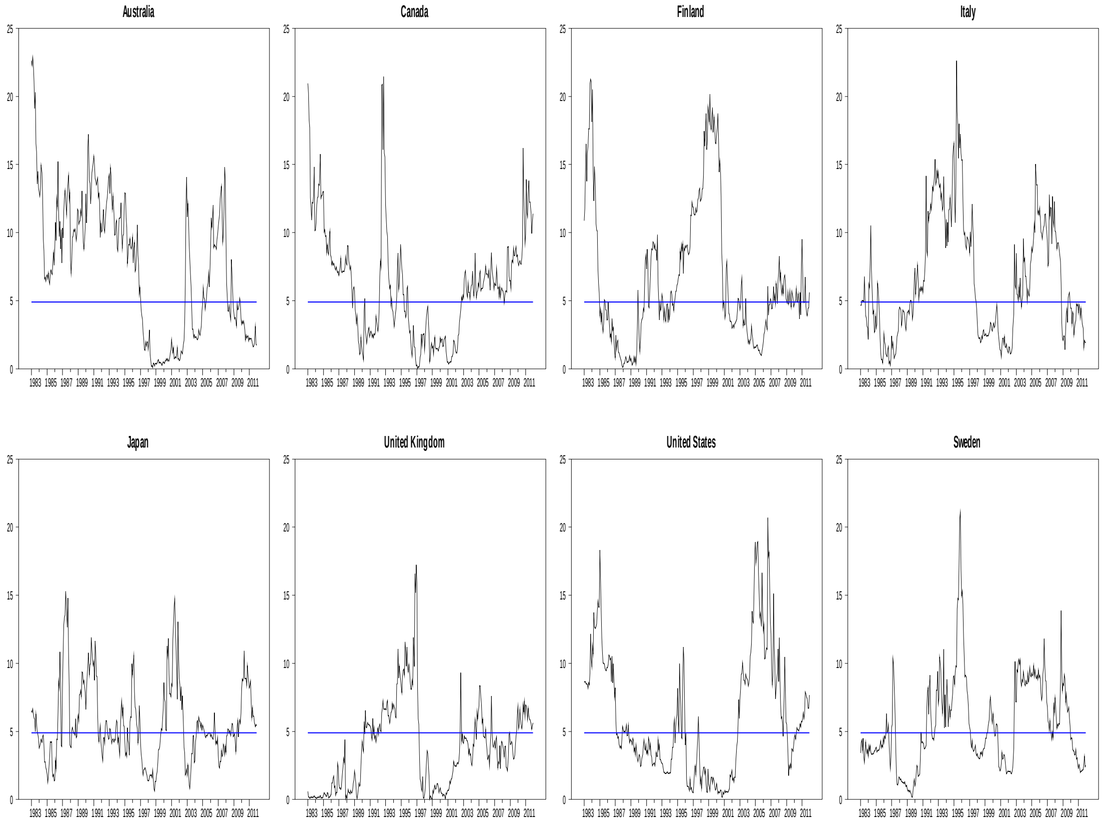

Figure 1. The rolling F-statistics for the ARDL cointegration with its 10% critical value (F = 4.895).