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The Relationship between Inflation and Real Exchange Rate: Comparative Study between ASEAN+3, the EU and North America

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Abstract

Inflation has always been one of the most important macroeconomic issues. Due to this importance, a study concerning the factors associated with the behavior of inflation needs to be done. This paper will be devoted to analyze the relevance of inflation with the exchange rates. The research will try to compare the response or sensitivity of inflation to the changes in real exchange rates in Asia (ASEAN +3) and compare the result with those of the EU and North America.

Using explorative statistical analysis and Granger-causality test, we found that there is a strong correlation between the movements of inflation with real exchange rate in most countries to be analyzed. For Asia, there is a significant one-way causal relationship, where the nominal and real exchange rates have a significant impact on the rate of inflation. On the other hand, in the Non-Asian regions, the causal relationship seems to be in the opposite direction. Furthermore, using panel data model with fixed effects, we found that the response or sensitivity of inflation to the changes in exchange rates in Asia is higher in compare to those in the EU and North America.

Keywords: Inflation, exchange rates, panel data
JEL Classification Codes: C23, E31, E52

1. Introduction

Basic macroeconomic indicators can be used as an illustration of a country's economic condition. One of the basic macroeconomic indicators is inflation. Generally, the inflation rate is used to measure the

price stability in the economy. Conceptually, the inflation can be divided into two sides, namely: demand side inflation (demand pull inflation) and supply side inflation (cost push inflation).

For open-economy countries, inflation comes from domestic factors (internal pressure) and also overseas factors (external pressure). The sources of external factors are the increase in the world commodity prices or exchange rate fluctuation. The influence of exchange rate towards inflation itself depends on the choice of exchange rate regime in the country.

Exchange rate system has an important role in reducing or minimizing the risk of fluctuations in exchange rates, which will have an impact on the economy. Any changes in exchange rates will have a great impact on the economy. As an example, when the Thailand government's decide to float the Thai Baht in mid-1997, it caused the financial crisis that pervade (contagion effect) in ASEAN, which is also known as the Asian financial crisis. The crisis is causing the exchange rate of domestic ASEAN countries and even some East Asian countries sharply depressed.

In the system of floating exchange rates, exchange rate fluctuations can have a strong impact on the level of prices through the aggregate demand (AD) and aggregate supply (AS). On the aggregate supply, depreciation (devaluation) of domestic currency can affect the price level directly through imported goods that domestic consumers pay. However, this condition occurs if the country is the recipient countries of international prices (international price taker). Non direct influence from the depreciation (devaluation) of currency against the price level of a country can be seen from the price of capital goods (intermediate goods) imported by the manufacturer as an input. The weakening of exchange rate will cause the price of inputs more expensive, thus contributing to a higher cost of production. Manufacturers will certainly increase the cost to the price of goods that will be paid by consumers. As a result, the price level aggregate in the country increases or if it continues it will cause inflation.

Studies concerning the relation between inflation and exchange rates have been done for several decades. Using the Granger Non-Causality Test based on Kenyan Data during the period of 1970-1993, Ndungu' (1997) showed that the level of domestic inflation and exchange rate changes affect each other. Ndungu's conclusions are as follows:

1. The level of inflation and changes in exchange rates affect each other,
2. Domestic credit affects the level of inflation without the return effect of inflation back to domestic credit,
3. The level of domestic inflation and reserve changes affect each other,
4. Changes in exchange rates and reserve changes affect each other,
5. Changes in domestic credit and international reserves affect each other.

Rana (1983) showed that the changes in exchange rates do not affect the inflation rate in ASEAN, except Thailand. On the otheer hand, Kamin and Klau (2003) empirically found the relationships between inflation and the real exchange rates in most countries of Asia and Latin America. Furthermore, they found that the effect of exchange rates changes on inflation in Latin America was significantly higher than those in Asia and industrialized countries.

The previous studies so far show an inconclusive results. Therefore further research in this topic is needed. This paper is devoted to explore the relation between inflation and exchange rates in ASEAN+3 countries. Together with the European Union (EU) and North America, those three areas is currently the regional center of the world economy. In this paper we will compare the results of the study in Asian countries with those of the EU and North American regions. Comparing with previous studies, this research will include more regions (countries) using the new data. Moreover, this paper will also include two dummy variables in the analysis, they are area dummy (Asia and Non-Asia) and the crisis dummy (before and after the Asian Crisis).

The rest of the paper will be organized as follows: In section 2 literature review related to the problem will be summarized. Section 3 will then explain the data and research methodology, followed by a discussion on section 4. Summary of the results and the policy implications will be provided in section 5.

2. Data and Methodology

This research is carried out using secondary annual data from ASEAN+3, EU and North America in the period of 1991 to 2005. Due to the completeness of the data, we include only these selected countries in our analysis, they are:

Asian Region : Indonesia, Malaysia, Singapura, Thailand, the Phillipines, Japan, China and South Korea

Non-Asia Region : United Kongdom, France, Germany, the Netherland, Belgium,Danemark, Sweden, Norway, The USA, Canada and Mexico.

The data ontained from the International Financial Statistic (IFS), World Economic Statistic and Bloomberg. Calculation process was done using statistical package SPSS 13.0, Minitab 14 and Evies 5.1.

At the beginning, we use the exploratory data analysis to study the behavior of the data in a simple way, especially to see the graphical comovement between inflation and the exchange rates. We will then the employ the Granger-causality test to explore the direction of the relationships between the two variables. In the final step, we will use the panel data model to see whether there are difference between Asia, the EU and Noth America.

In this paper, we adopt the model of Kamin and Klau (2003), and the inflation can be formulated as follows (all variables are in narural logarithms):

$$\Delta p_t = -\alpha\lambda\psi + \lambda rer_{t-1} + \alpha\lambda\varepsilon\left(q_H - \overline{q}_H\right)_{t-1} + \left(1-\alpha\right)\Delta p^*_t + \left(1-\alpha\right)\Delta e_t + \beta\Delta p_{t-1}$$

where:

$rer_{t\text{-}1}$ = lag of real exchange rates (increase of $rer_{t\text{-}1}$ means depreciation)

$(q_H - \overline{q}_H)_{t\text{-}1}$ = lag of output gap

Δp^*_t = foreign inflation

Δe_t = the changes of domestic currency (against US$)

$\Delta p_{t\text{-}1}$ = lag of domestic inflation.

The output gap is calculating using Hodrick-Prescott (HP) Filter using this formula:

$$Min\sum_{t=0}^{T}(y_t - s_t)^2 + \lambda\sum_{t=2}^{T-1}((s_{t+1} - s_t) - (s_t - s_{t-1}))^2$$

where λ is the level of smoothness of the trend, s is trend of output and y is actual output. The process of calculation is carried out using the software Eviews 5.1, where the trend of real GDP is assumed to be potential GDP.

3. Estimation Results

In this section, we will present the results of the descriptive statistics, the granger causality test and the panel data as well. Moreover, the scientific explanation of the resulrs will also be provided.

3.1. Explorative Data Analysis

The exploratory data analysis shows the behaviour of inflation and real exchange rates in Asia. The Apendix 1 presents the time series plot of real exchange rates and inflation in eight Asian countries. From the figure, it seems to be clear that there is a correlation between the inflation and real exchange rate movements, with exception for Malaysia. After the crisis Malaysia practices fixed exchange rates regime, so that the exchange rates of Malaysian Ringgit becomes more stable or even constant. The depreciation of exchange rates is therefore in line with higher inflation.

Moreover, we can see that there may be different behavior of the exchange rates and inflation in all countries before and after the Asian financial crisis 1997. The two variables (inflation and exchange rates) seem to be more volatile following the crisis,

3.2. Granger Causality Test

In this section, we employ the Granger Causality test to explore the causal relationship between the two variables. The result of the analysis is presented in Table 1.

Table 1: Results of the Granger Causality Test

Null Hypothesis	All region			Asia			Non Asia		
	Lag 2	Lag 4	Lag 6	Lag 2	Lag 4	Lag 6	Lag 2	Lag 4	Lag 6
$\Delta\log(E) \not\rightarrow \Delta\log(P)$	√	√	√	√	√	√	√		
$\Delta\log(P) \not\rightarrow \Delta\log(E)$	√	√	√				√	√	√
$\Delta\log(RER) \not\rightarrow \Delta\log(P)$	√	√	√	√	√	√	√		
$\Delta\log(P) \not\rightarrow \Delta\log(RER)$	√	√					√	√	√
$\Delta\log(YGAP) \not\rightarrow \Delta\log(P)$	√	√	√	√	√	√	√		√
$\Delta\log(P) \not\rightarrow \Delta\log(YGAP)$	√							√	

Notes:

1. Sample period 1991-2005; P=consumer price index; E=nominal exchange rates; RER=real exchange rates; YGAP=((real GDP – potential GDP) /potential GDP)
2. "√ " indicates that the null hypothesis is rejected, that means the causality is happened.

From the table, it can be seen that there is a bi-directional causality between the nominal exchange rates changes (Δlog(E)) and inflation (Δlog(P)). That means, the nominal exchange rate depreciation will affect the inflation and the inflation will result in nominal exchange rate depreciation. The similar results were also found for the relationships between real exchange rates (Δlog(RER)) and inflation. However, when we separated the analysis into two regions --Asia and Non-Asia-- we found a different results. In Asia region, exchange rates depreciation has a significant impact on the inflation, but not in the opposite direction. In contrast, inflation has significant impact on the exchange rates in Non-Asia region, but not in the opposite direction. These results indicate that Asian countries have a higher vulnerability to exchange rates shocks in compare to European and North American countries. than the exchange of non-Asian.

Concerning the relationships between output gap (log(YGAP)) and inflation, we found that there is one direction relationship from output gap to inflation. That means, output gap significantly influences inflation, but inflation has no significant impact on output gap. This relation seems to be consistent for all over the three regions --Asia, Europe and North America.

3.3. Data Panel Analysis

Furthermore, we also employ the panel data analysis to explore the relationship between inflation, exchange rates and output gap in an integrated system. Preliminary analysis using Hausman-Test shows that the H-statistics (108.750 for all region, 52.449 for Asia and 13.883 for Non-Asia region) are greater than $\chi 2$ from the table (11.070). The complete results are presented in Appendix 2. Based on these results, we conclude that the fixed effect model is the most appropriate one for our further analysis. The result is presented in Table 2.

In the model presented in Table 2, we include two dummy variables --namely Area dummy DA (DA=1 for Asia and DA=0 for Non-Asia) and Crisis Dummy DC (DC=0 for the period before the Asian crisis and DC=1 for the period after the Crisis) to capture and compare the behavior on inflation between two regions and two periods.

Table 2: The estimation of inflation function using thr fixed effect model with weight (Cross Section Weights) and white heteroscedasticity for the all regions.

Variable	Coefficient	Standard Error	t-Statistic	Prob.
RER1?	0.046752	0.010840	4.312862	0.0000
YGAP1?	0.003611	0.011221	0.321826	0.7479
DPF?	0.457999	0.049634	9.227548	0.0000
DE?	0.020221	0.007389	2.736620	0.0067
DP1?	0.335427	0.102315	3.278372	0.0012
DA?*RER1?	-0.044973	0.011452	-3.926882	0.0001
DA?*YGAP1?	-0.005081	0.018135	-0.280176	0.7796
DA?*DPF?	-0.639722	0.153956	-4.155216	0.0000
DA?*DE?	-0.020993	0.013267	-1.582309	0.1149
DA?*DP1?	0.015914	0.148033	0.107503	0.9145
DC?	-0.007259	0.001471	-4.936225	0.0000
Weighted Statistics				
R-squared	0.606783	*Mean dependent var*		0.051838
Adjusted R-squared	0.558464	*S.D. dependent var*		0.035306
S.E. of regression	0.023460	*Sum squared resid*		0.129888
F-statistic	12.55785	*Durbin-Watson stat*		1.936611
Prob(F-statistic)	0.000000			
Unweighted Statistics				
R-squared	0.568384	*Mean dependent var*		0.035534
Adjusted R-squared	0.515346	*S.D. dependent var*		0.047819
S.E. of regression	0.033290	*Sum squared resid*		0.261547
Durbin-Watson stat	1.983705			

Note: RER1=Lag of real exchange rates (*domestic currency*/US$); YGAP1=Lag output gap; DPF=Foreign inflation rate; DE=Nominal exchange rates change (*domestic currency*/US$) and DP1=Lag of domestic inflation rate.

From the table, we learn that the coefficient of determination (R-Square) is 0.606783, which means more than 60% of the inflation variability inflation can be explained by the explanatory variables – output gap, nominal exchange rates and foreign as well as domestic inflation. The results also show that there are no multicollinearity and autocorrelation problems in the model. More detail analysis shows that inflation is significantly influenced by the lag of real exchange rates and domestic inflation, nominal exchange rates and foreign inflation. The output gap, however, have no significant impact on inflation. Coefficients of the model suggest that foreign and domestic inflation have the stronger impact in compare to real and nominal exchange rates. One percent increase in foreign inflation, for example, will be followed by about 0.46 percent increase in domestic inflation. One percent depreciation of exchange rates, on the other hand, will be followed by about 0.05 inflation rates.

Furthermore, the results also show that the behavior of inflation in Asian Region seems to be different with those of the European Union and North America. The coefficient of the interaction of area dummy variables with RER1 and DPF are statistically significant. Therefore, we further analyze and divide the model into two models, namely model for Asian Region and model for Non-Asian Region. The results are presented in Table 3 and Table 4[1].

[1] We also find that the crisis dummy has also significant impact on the inflation. However, we could not establish the model before and after the Asian financial crisis due to the limited data availability.

Table 3: The estimation of inflation function using the fixed effect model with weight (Cross Section Weights) and white heteroscedasticity for Asian Region.

Variable	Coefficient	Standard Error	t-Statistic	Prob.
RER1?	0.015888	0.005976	2.658655	0.0092
YGAP1?	0.004472	0.009526	0.469454	0.6398
DPF?	-0.176465	0.128071	-1.377875	0.1714
DE?	-0.008382	0.008632	-0.971068	0.3339
DP1?	0.280412	0.083203	3.370223	0.0011
DC?	-0.015963	0.001875	-8.515069	0.0000
Weighted Statistics				
R-squared	0.655219	*Mean dependent var*		0.065779
Adjusted R-squared	0.609483	*S.D. dependent var*		0.058659
S.E. of regression	0.036657	*Sum squared resid*		0.131683
Log likelihood	289.3251	*F-statistic*		14.32603
Durbin-Watson stat	2.007940	*Prob(F-statistic)*		0.000000
Unweighted Statistics				
R-squared	0.429816	*Mean dependent var*		0.043779
Adjusted R-squared	0.354180	*S.D. dependent var*		0.056079
S.E. of regression	0.045067	*Sum squared resid*		0.199040
Durbin-Watson stat	2.052433			

From the Table 3, we learn that the inflation in Asian countries is significantly influenced by real exchange rates and the previous domestic inflation. Furthermore, we can learn from the Table 4 that inflation in the Non-Asian countries is significantly influenced by domestic and foreign inflation. The exchange rates, however, have no significant impact on inflation. This result is consistent with our previous descriptive analysis that the exchange rates have significant influence on the inflation in Asia, but not in EU and North America.

Furthermore, our analysis also shows different results concerning the impact of Asian financial crisis 1997. The crisis has significant impact on the inflation behavior in Asian countries, but it has no influences on the inflation behavior in the EU and North America. Both models, however, show that the output gap and nominal exchange rates do not play a significant role in explaining the inflation behavior in Asia as well as the EU and North America.

4. Concluding Remarks

Our analysis concerning the relationships between inflation and real exchange rate in Asia (ASEAN +3) and Non-Asia (EU and North America) give two important conclusions. First, there is a strong relationship between inflation and real exchange rates in Asian countries, but there is no such relation in the EU and North America. Second, the Asian financial crisis seems to have local impact in Asian countries, but it has no significant global impact in the EU and North America.

Table 4: The estimation of inflation function using the fixed effect model with weight (Cross Section Weights) and white heteroscedasticity for Non-Asia Region.

Variable	Coefficient	Standard Error	t-Statistic	Prob.
RER1?	0.025043	0.016495	1.518174	0.1313
YGAP1?	-0.015905	0.015635	-1.017288	0.3108
DPF?	0.505089	0.068653	7.357158	0.0000
DE?	0.019847	0.010704	1.854270	0.0659
DP1?	0.342132	0.158479	2.158846	0.0326
DC?	-0.002736	0.002362	-1.158389	0.2487
Weighted Statistics				
R-squared	0.604167	*Mean dependent var*		0.036090
Adjusted R-squared	0.557938	*S.D. dependent var*		0.018470
S.E. of regression	0.012281	*Sum squared resid*		0.020661
Log likelihood	554.1964	*F-statistic*		13.06909
Durbin-Watson stat	1.839641	*Prob(F-statistic)*		0.000000
Unweighted Statistics				
R-squared	0.746972	*Mean dependent var*		0.029537
Adjusted R-squared	0.717421	*S.D. dependent var*		0.039913
S.E. of regression	0.021217	*Sum squared resid*		0.061673
Durbin-Watson stat	1.406880			

The results of this study emphasize the importance of managing inflation as one of economic stability indicator. The management of inflation in Asia becomes more complicated in compare to the EU and North America due to the high impact of their exchange rate changes. The Central Bank in Asian countries, therefore, should consider their exchange rate as the main indicators to achieve the inflation target.

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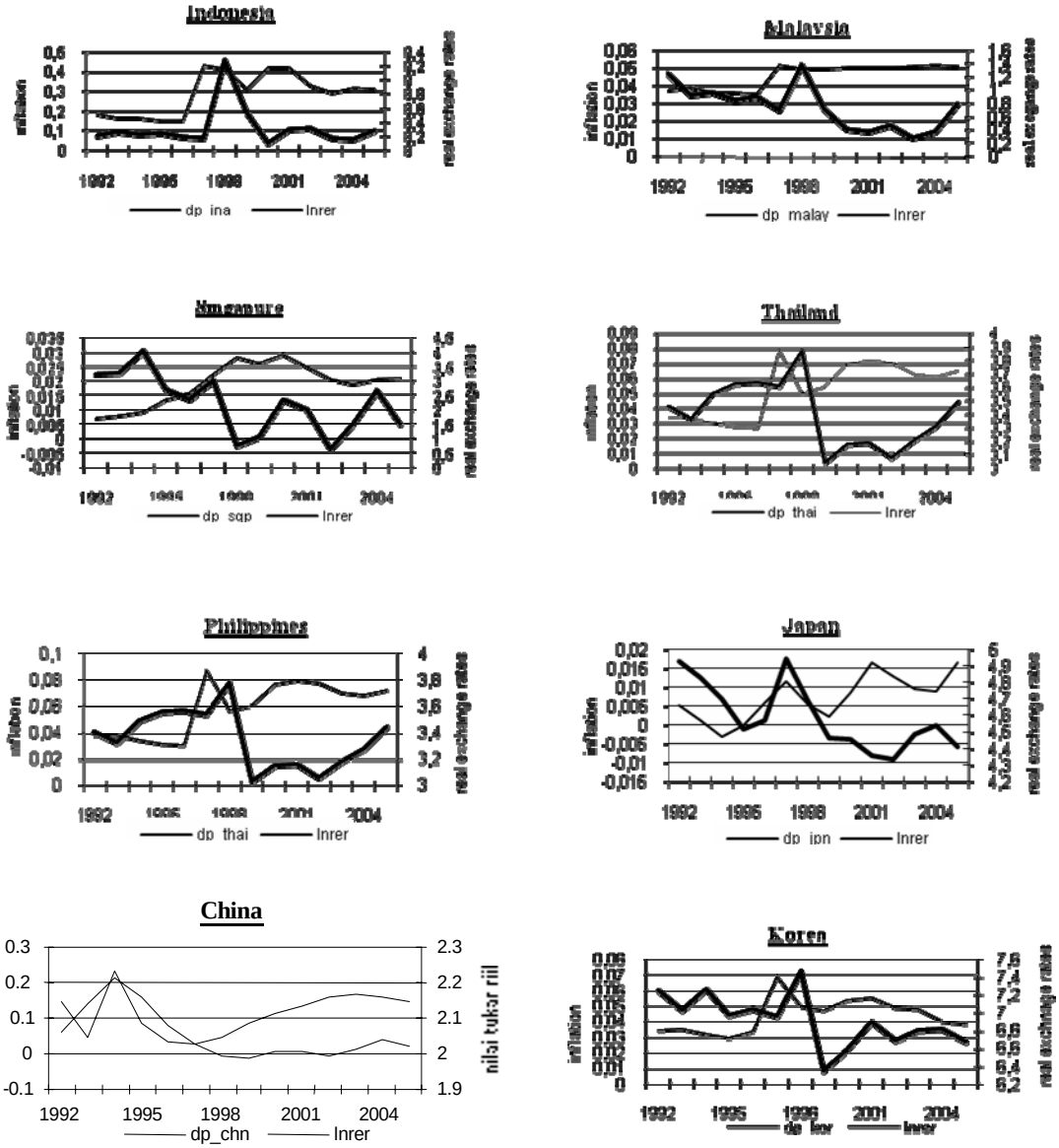
Appendix 1

Time series plot of Inflation and Real Exchange Rate in Asia



Appendix 2

The results of the *Hausman Test*

	Region		
	All countris	**Asia**	**The EU and North America**
Chi-Square χ^2 table	11.070	11.070	11.070
H-statistic	108.750	52.449	13.883

Note: the Chi-Square χ^2 is calculated for the α =0.05