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Korean Exchange Rate Regime Change and Its Impact on Inflation in Comparison to Japan and Australia

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한국 환율제도의 변화가 국내물가상승에 미치는 영향: 일본 및 호주와의 비교분석

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ABSTRACT

This paper examines the macroeconomic structural differences of the free floating exchange rate regime and the managed float exchange rate regime focusing on the Korean economy, and compares it to the two benchmark economies, Japan and Australia. Korea's shift to the free floating exchange rate regime from the managed float exchange rate regime came after the 1997 economic crisis. Korea's exchange rate policy provides a unique opportunity to study the different behaviors or roles, if any, of managed float and free floating exchange rate regimes. Based on a simple monetary model, we find that the exchange rates of Korea are more sensitive to the economic fundamentals under the free floating regime than under the managed float regime. Impulse response analysis shows that exchange rate pass-through into domestic variables, especially inflation rate, has a bigger short-term impact under the floating regime than under the managed regime. This finding is consistent with the view that the managed (or fixed) regime provides the domestic price stability necessary for the economic growth for the developing countries.

본 논문은 한국의 근본적인 거시경제변수가 두 가지 다른 환율제도(자유변동 환율제도와 시장평균 환율제도)하에서 어떻게 다르게 반응하는가를 분석·연구한다. 이와 아울러 같은 기간 동안의 일본과 호주의 거시경제구조에 대한 비교 분석도 곁들인다. 한국은 1997년의 경제위기를 전후하여 환율정책을 시장평균 환율제도에서 자유변동 환율제도로 전환하였다. 이 시점을 계기로 한 한국의 외환정책 변경은 두 가지 환율제도를 비교 분석하는 데 아주 좋은 기회를 제공한다. 화폐경제이론에 기초한 환율결정 모델을 사용하여 대미환율과 거시경제변수에 대한 관계를 분석해 본 결과, 대미환율은 시장평균 환율제도하에서보다 자유변동 환율제도하에서 근본적인 거시경제변수에 더 민감하게 반응하는 것으로 나타났다. Impulse Response Analysis 분석결과에 의하면, 환율변동이 물가상승률에 미치는 영향은 시장평균 환율제도하에서보다 자유변동 환율제도하에서 단기적으로 더 큰 것으로 나타났다. 이러한 결론은 개발도상국가에서는 안정적인 관리 환율제도가 경제성장을 위해 필요하다는 일반적인 견해와 일치하는 것이다.

I. Introduction

After the recent Asian economic crisis of 1997, many Asian countries, including Thailand, Malaysia, Indonesia and Korea among others, were forced to devalue their local currencies and resorted to a free floating exchange rate system. They abandoned the hard or soft peg exchange rate systems to adopt the free floating exchange rate system mainly because of their inability to maintain the pegs. It is widely believed that fixed or pegged exchange rate regimes are ultimately destined to collapse, thus resulting in an economic crisis. Therefore, the solution to economic crises lies in increased exchange rate flexibility in the long term (Obstfeld and Rogoff 1995, Larrain and Velasco 2001).

Even with the possibility of the ultimate failure of the fixed exchange regime, many developing and emerging countries still favor fixed exchange rate regime to the flexible exchange regime. The advantages of the fixed regime, especially for developing countries, are well summarized in Frankel (2003). They are: providing a nominal anchor to monetary policy, encouraging trade and investment, precluding competitive depreciation and avoiding speculative bubbles. In short, the fixed exchange regimes provide the stability that the developing countries need to maintain their economic growth. However, as the countries manage to maintain a fixed exchange rate with occasional interventions, it is inevitable that a large gap arises between the fixed exchange rate and economic fundamentals such as expansionary monetary policy, low foreign reserves and current account deficits to support the fixed rate. When this gap finally collapses, it brings the sudden and violent currency depreciation which results in economic crisis. This line of reasoning is the basis of numerous economic crisis analyses such as Flood and Garber (1984) for the first generation crisis model, Obstfeld (1994) for the second generation crisis model, and Flood and Marion (2002) for the third generation or twin crisis model. Frankel (2003) also provides four advantages of the free floating exchange rate regime: independent monetary policy, automatic adjustment to trade shocks, seigniorage and lender of last resort ability, and ability to avoid speculative attacks. However, as Frankel points out, it is not completely clear whether the majority of developing countries can, or are willing to take advantage of the free floating exchange rate regime.

There is an increasing trend for many developing countries to adopt free floating exchange rate regimes after economic crisis. However, in reality, the officially declared exchange rate regimes often times are not what they claim to be. Calvo and Reinhart (2002) investigated 39 countries of wide geographic differences during the period of January 1970-November 1999, and found that countries that claim to float their exchange rates mostly do not. It is the so-called phenomena of the "fear of floating." From this evidence, it is clear that many developing countries prefer to have their exchange rates stable regardless of their officially declared exchange rate regimes. This then begs the question, why do they prefer to have fixed exchange rate regime to the flexible regime? It is widely believed that the fixed exchange rate regime will provide domestic relative price stability and thus promote higher economic growth. However, Levy-Yeyati and Sturzenegger (2003) show results quite to the contrary. They found that the floating exchange rate regimes, other things being equal, actually yield higher economic growth than either the intermediate regimes or the fixed regimes. Dissatisfied with the official *de jure* IMF classifications of exchange rate regimes for each country, they developed their own exchange rate regime classification, *de facto* classification, for the period from 1974-2000, and found that among non-industrialized countries, the flexible exchange rate regime provides higher economic growth. Meanwhile, among the industrialized countries, exchange rate regimes do not appear to explain the economic growth, one way or another, in a statistically significant manner.

This paper investigates the macroeconomic structural differences of the Korean economy under the free floating exchange rate regime after the economic crisis and compares to the managed float exchange rate regime before the crisis. Baxter and Stockman (1989), and Flood and Rose (1995) studied the relationship between exchange rate regimes and macroeconomic volatilities, and found that macroeconomic volatilities are not particularly dependent on exchange rate regimes. This paper follows a similar line of research and focuses on a single country, Korea. More specifically, we are interested in determining whether the Korean exchange rates are more closely following economic fundamentals, comparing two different exchange rate regimes in recent years. Even with the well-documented difficulties of explaining exchange movement, there are at least two reasons that it is a worthwhile effort to study the Korean exchange rate based on the standard monetary model of exchange rate determination. First, this paper focuses on Korean exchange rate regimes. The Korean economy has grown rapidly in the last 30 years. Even with the recent economic crisis and setbacks, Korea is currently the 12th largest economy in the world and a model economy for achieving greater economic success. Korea attained the world's exclusive economic status by joining the OECD in 1996, and becoming a key player in international trade. Most of the previously mentioned exchange rate determination analyses focused on major currencies in developed countries. Major currencies in developed countries have mostly been freely determined by the market since the collapse of the Bretton Woods Accord in 1973, and their data is readily available. This paper investigates similar exchange rate behavior focusing on the small developing Korean *Won*-U.S. *Dollar* nominal exchange rates. Second, Korean exchange rate regimes provide a recent opportunity to study the different behaviors or roles, if any, of a managed float and a floating regimes in the same economy. Since the regime change has occurred in a relatively recent period, it provides a unique opportunity to empirically verify the advantages or disadvantages of different regimes as postulated by Frankel (2003). More specifically, one of the advantages of the fixed rate regime is the stability of the domestic price level, which in turn leads to higher economic growth. We will investigate the effect of exchange rate pass-through to domestic variables such as inflation rate under the two different regimes. The results of this paper provide a useful guideline for emerging economies to properly set their exchange rate systems to achieve stable economic growth.

The next section introduces a simple monetary model of exchange rate determination based on purchasing power parity. Section 3 describes the data set and presents empirical results. Section 4 concludes the paper with some suggestions on the future direction of the current study.

II. Theoretical Framework of Exchange Rate Determination

It is well documented that the exchange rate is very difficult to predict using any theoretical models of exchange rate determination, first studied by Meese and Rogoff (1983). They tested the 1970s floating exchange rates for three major currencies, and found that none of the theoretical exchange rate determination models could outperform a simple random walk model in the root mean square criteria. In short, they found that exchange rates closely follow a random walk process, and is unpredictable during their sample period. A recent study by Cheung, Chinn and Pascual (2002) affirms the Meese and Rogoff (1983) result that any specific model or theory is not very successful in improving exchange rate predictability. There have been other studies, such as Mark (1995), Chinn and Meese (1995) and MacDonald and Taylor (1994), claiming modest success in predicting exchange rate movements, but their results are largely limited to particular periods or currencies. None of their results are robust enough to consistently predict exchange rates. Engel and West (2003) approached the exchange rate determination through reverse causation. They claim that they were able to predict economic fundamentals using the exchange rates for the G7 countries. Viewing the exchange rate as an asset price influenced by future expectations, they demonstrated that the exchange rate follows a process arbitrarily close to the random walk if (1) at least one of the underlying fundamental variables is I(1), and (2) the discount factor is near one. If expectations reflect information about future fundamentals, the exchange rate will likely be useful in predicting these future economic fundamentals.

The theoretical framework of our model is based on the simple monetary model used by various authors including MacDonald and Taylor (1994), Mark (1995), Obstfeld and Rogoff (1996), Mark and Sul (1999), and Wu and Chen (2001), among others. This model consists of four behavioral equilibrium equations: the domestic and foreign money market equilibriums, the purchasing power parity condition and the uncovered interest parity condition.

$m_t - p_t = \lambda y_t - \phi i_t$ domestic money market equilibrium (1)

$m_t^* - p_t^* = \lambda y_t^* - \phi i_t^*$ foreign (ROW) money market equilibrium (2)

$s_t = p_t - p_t^*$ purchasing power parity (PPP) (3)

$i_t - i_t^* = E_t s_{t+1} - s_t$ uncovered interest parity (UIP) (4)

where,

$m_t(m_t^*)$: domestic (foreign) money supply in natural log

$p_t(p_t^*)$: domestic (foreign) price level in natural log

$y_t(y_t^*)$: domestic (foreign) GDP in natural log

$i_t(i_t^*)$: domestic (foreign) interest rate

s_t : nominal exchange rate (local currency price of one foreign currency) in natural log

$E_t s_{t+1}$: expectation of s_{t+1} at time t.

$0 < \lambda < 1$: income elasticity to money demand

$\phi > 0$: interest semi-elasticity to money demand

From equations (1) to (3), we have

$$s_t = m_t - m_t^* - \lambda(y_t - y_t^*) + \phi(i_t - i_t^*) = f_t + \phi(i_t - i_t^*) \tag{5}$$

where $f_t = m_t - m_t^* - \lambda(y_t - y_t^*)$ is the economic fundamentals consisting of domestic and foreign countries.
By substituting the UIP equation (4) into equation (5), the equilibrium condition is:

$$s_t - f_t = \phi(i_t - i_t^*) = \phi(E_t s_{t+1} - s_t) \tag{6}$$

Under the rational expectations hypothesis with no bubble solutions for the exchange rate process, we will have the fundamental solution for s_t as:

$$s_t = \frac{1}{1+\phi} E_t\left(\sum_{j=0}^{\infty}\left(\frac{\phi}{1+\phi}\right)^j f_{t+j}\right) \tag{7}$$

Exchange rate is expressed as the discounted value of the future economic fundamentals. This is a characteristic of the monetary model viewing the exchange rate as the asset price of the future economic fundamentals. Assume that the economic fundamentals series $\{f_t\}$ follows a driftless random walk process, $I(1)$. Then, we have $s_t \sim I(1)$, $\Delta s_t \sim I(0)$. Since $s_{t+1} = E_t s_{t+1} + v_t$, where v_t is a white noise forecasting error, nominal exchange rate and fundamentals, $\{s_t, f_t\}$, must be cointegrated by equation (6). Rearrange equation (6) to construct the econometric model of the exchange rate changes and fundamentals such that:

$$\Delta s_{t+1} = \beta_0 + \beta_1 z_t + \varepsilon_t \tag{8}$$

where $z_t = s_t - f_t = \phi(i_t - i_t^*)$ is the nominal exchange rate deviations from the economic fundamentals. We expect $\beta_1 < 0$ because when s_t is undervalued relative to the economic fundamentals ($(s_t - f_t)$ increases), nominal exchange rate should correct downward (appreciation: Δs_t decreases) to restore equilibrium.

This is the basic model used to perform the exchange rate forecasting ability based on the monetary model. This model has been used by MacDonald and Taylor (1994), Mark (1995) to test the predictability of exchange rates. They claimed modest success in predicting exchange rates for a longer horizon. Mark and Sul (2001) use panel data set of 19 industrialized countries while Wu and Chen (2001) estimated equation (8) using nonlinear Kalman filter allowing for the time-varying nature of the slope parameter.

In this paper, we adopt the same model for the purpose of linking economic fundamentals to the exchange rates. However, we would like to extend the analysis to examine equation (8) on how economic fundamentals explain the exchange rates on different exchange rate regimes. Based on the reasons explained in the introduction, the Korean exchange rate policy is an ideal candidate for this study.

Ⅲ. Korean Exchange Rate Regimes

The Korean exchange rate system has evolved through several stages in recent history. Until 1980, the government strictly regulated foreign exchange transactions, and the Korean *Won* was pegged to the U.S. dollar. In 1980, as a result of the introduction of a multiple-basket pegged exchange rate system, the Korean *Won* started to float in reflection of general trends in the international foreign exchange markets, even though it was still tightly managed by the government. The market average exchange rate (MAR) system, as a variant of managed floating exchange rate regime, was first adopted in March 1990. Since then, the Korean *Won*-U.S. *Dollar* rate began to be determined on the basis of underlying demand and supply conditions of the interbank market, although daily fluctuations were limited within certain bands. However, the Bank of Korea still intervened frequently, and the exchange rate was still not completely determined by the market. In late 1997, the Asian economic crisis broke out and Korea turned to the IMF for rescue efforts. Taking advantage of the opportunities presented by the economic crisis, Korea has accelerated the speed of the economic restructuring including the capital account liberalization. Korea shifted to a free-floating exchange rate system on December 1997. The ceiling on foreign investment in Korean equities was entirely abolished in May 1998, and the local bond markets and money markets were completely opened to foreign investors. In June 1998, the Korean government announced a plan to liberalize all foreign exchange transactions in two stages. The first stage of liberalization took effect on April 1, 1999 with the introduction of a new Foreign Exchange Transaction Act. The second stage of liberalization took effect on January 2001. The remaining ceilings on current account transactions by individuals have been eliminated.

1. Data Description

All our data comes from the IMF International Financial Statistics (IFS) (on a CD-ROM). Data frequency is listed on a monthly basis except for the GDP and GDP deflator series, which are available only on a quarterly basis. We converted the quarterly series into monthly frequencies by linearly interpolating quarterly observations into monthly observations.

We used the bilateral nominal exchange rates per U.S. Dollars for Australia, Japan and South Korea for the period of January 1980 to December 2003. These exchange rates are nominal domestic currency prices per U.S. Dollar at the end of each month. The Japanese Yen and Australian Dollar are introduced here as benchmarks for Korean exchange rate regimes. Japan is one of Korea's largest trading partners, and Korea has sustained a chronic trade deficit with Japan. In addition to the close economic relationship between Korean and Japan, the Japanese Yen has been freely floating since the collapse of the Bretton Woods Accord. As Calvo and Reinhart (2002) observed, the Japanese Yen serves as one of the reserve currencies of the world. Therefore, its free floating regime characteristics may be different from those of small developing economies. In this regard, Australia is chosen because the Australian Dollar is also freely floating, but because the Australian economy is much smaller than that of Japan, it more closely resembles typical small developing economies. In the Calvo and Reinhart (2002) study, the Australian Dollar is used as a benchmark currency for the floating exchange rate regimes. Calvo and Reinhart (2002) report that the probability of the Australian Dollar fluctuating within the prescribed 2.5% band for the free floating regime was about 70% during the monthly period of January 1984 to November 1999. Therefore, we also used the Australian Dollar as the benchmark currency for a small open economy to study the characteristics of the free floating exchange rate of the Korean Won.

Other economic variables in our analysis are as follows: Money supply: M2 measure of nominal money supply. Interest rate: short-term government bond rates for Australia and Japan, short-term (90 days) deposit rate for Korea, and 3-month U.S. Treasury bill rate. General price level: manufacturing output prices for Australia, consumer price indices for Japan, Korea and the U.S. Reserves are measured as total reserves minus gold in U.S. dollar terms.

We divide our data into three periods. The first period is from January 1980 to the beginning of the Korean economic crisis, September 1997 (period 1). During this period, Korean exchange rates were managed and controlled by the Bank of Korea. The second period is the crisis period, October 1997 to September 1998, when the first round of financial restructuring was completed following the IMF recommendations to recover from the economic crisis. During the crisis period, the nominal exchange rates were unstable and they fluctuated widely. Thus, we exclude this period from our analysis. The last period, starting October 1998 to the end of the sample period, December 2003, is the post-crisis free floating exchange rate regime (period 2). Korean exchange rates were allowed to move freely during this period with minimal market intervention from the banking authority.

2. Exchange Rates and Economic Fundamentals

First, we will examine the volatilities of two closely related variables for the exchange rate regimes, the nominal exchange rate and the foreign reserves. We compare the rate of return volatilities measured as the standard deviation of the percentage change of the bilateral nominal exchange rates and foreign reserves so that, ($\log S_t - \log S_{t-1} = s_t - s_{t-1} = \Delta s_t$, $\log R_t - \log R_{t-1} = r_t - r_{t-1} = \Delta r_t$), where s_t is the natural log of the nominal exchange rate S_t, and r_t is the natural log of foreign

<Table 1> Volatilities for Nominal Exchange Rates and Reserves for Each Period

	Managed Float Regime, Period 1 January 1980 – September 1997		Free Floating Regime, Period 2 October 1998 – December 2003	
	Δs_t	Δr_t	Δs_t	Δr_t
Korea	0.8685	7.5047	2.6289	1.6631
Japan	3.3865	3.4587	3.4807	2.4418
Australia	2.8541	9.4771	3.2037	7.3335
	Test Statistics for $H_0 : \sigma^2_{AS} = \sigma^2_J = \sigma^2_K$			
Bartlett	313.920(0.0000)	185.963(0.0000)	4.4275(0.1093)	126.71(0.00)
Levene	80.4854(0.0000)	32.3659(0.0000)	1.4095(0.2471)	25.3006(0.00)
Brown-Forsythe	72.1956(0.0000)	32.2831(0.0000)	1.4737(0.2320)	20.5717(0.00)

Note: Test statistics are for the null hypothesis that volatilities are the same for all three countries. p-values are in parenthesis.

reserves, R_t. Table 1 compares the return volatilities of three exchange rates for two distinct periods, before the economic crisis for the managed float regime and after the economic crisis for the free floating regimes. Volatility is measured as the standard deviation of each variable. This table also provides three different, yet similar test statistics to test the equality of the variance of the returns of nominal exchange rates during this period. These statistics are for the three way equality tests.

Table 1 clearly shows that the Korean *Won* is much less volatile during the managed float regime, and its volatility is much smaller than that of Australian *Dollar* and Japanese *Yen*. During the free float regime, the Korean *Won* is still less volatile than those other exchange rates, but their difference is now statistically insignificant with p–values ranging from 0.11 to 0.25. All three test statistics reject the equivalence of return variances during Korean *Won*'s managed float regime, while all three statistics accept that their volatilities are statistically equivalent under the free floating regime. The Korean *Won* fluctuates as freely as other floating exchange rate currencies after adopting the free floating regime in period 2. Korean foreign reserve holdings are much more volatile under the managed float than those of free floating period. This is an expected result that under the managed float, reserves are often used to maintain stable nominal exchange rates (Interest rate is another policy tool to manage exchange rates). Therefore, by comparing the reserve volatilities of two periods, we observe that the reserves have become increasingly stabilized under the recent free floating exchange regime, especially for Korea.

We can also observe from this table that while the nominal exchange rates for all three countries have been more volatile in recent years than in the 1980s and the late 1990s, the volatilities of foreign reserves show the opposite trend. Korean exchange rates have become more volatile and reserves have become more stabilized because of her exchange rate regime changes. In order to investigate whether there have been any other macroeconomic regime shifts causing other currencies, including the Korean

<Table 2> Volatilities for Different Periods for Nominal Exchange Rates and Reserves ($H_0 : \sigma_{i,1}^2 = \sigma_{i,2}^2$)

	Korea		Japan		Australia	
	Period 1	Period 2	Period 1	Period 2	Period 1	Period 2
Δs_t	0.8685	2.6289	3.3865	3.4807	2.8541	3.2037
F-test	9.1617(0.0000)		1.0563(0.8298)		1.2600(0.3082)	
Bartlett	141.4332(0.0000)		0.0669(0.7959)		1.2268(0.2680)	
Δr_t	7.5047	1.6631	3.4587	2.4418	9.4771	7.3335
F-test	20.3638(0.0000)		2.0063(0.0005)		1.6700(0.0109)	
Bartlett	106.8419(0.0000)		9.1142(0.0025)		5.1377(0.0234)	

Note: Test statistics are for the null hypothesis that volatilities are the same for all three countries. *p*-values are in the parenthesis.

Won to be more volatile in recent years, we compared the equivalence of return volatility for two periods. Table 2 reports the test statistics for the volatilities for nominal exchange and foreign reserve before and after the Korean economic crisis.

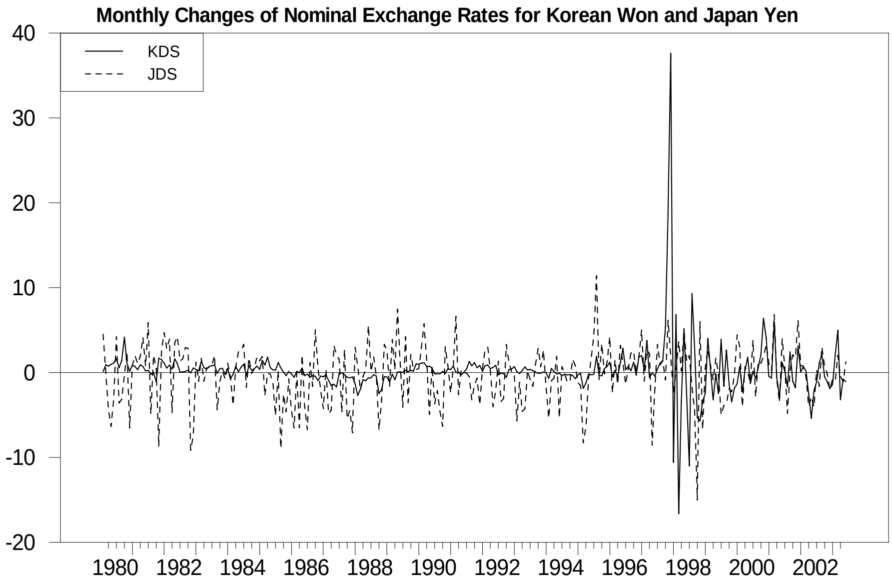
Table 2 shows the expected results. The Japanese *Yen*, serving as the reserve currency for the world shows little change in its volatility during these two periods even with the recent Asian economic crisis. Test statistics also show little evidence of changes of the *Yen* volatility. The Australian *Dollar* also shows that the volatilities remain the same between two periods. The Korean *Won*, on the other hand, shows strong evidence of volatility change during this period. Table 2 also reports foreign reserve volatilities for each country for two periods, and its test statistics. We reject the null hypothesis that reserve volatilities remain the same for the entire period for all three countries. We can see that the reserves for all three countries have become much more stable in recent years than in the 1980s and early to mid 1990s. We also observe that the reduction of the reserve volatility is much more noticeable for Korea than for other two countries. The main reason for the stability of the reserves for Korea is the exchange rate regime changes from the actively managed regime to the free floating regime.

The exchange rate volatilities can be best illustrated using the figures. To avoid cluttering the figures, Figure 1 plots the nominal exchange rate returns for two currencies, the Korean *Won* (solid line) and the Japanese *Yen* (broken line) against the U.S. *Dollar* for the entire sample period. The Australian *Dollar* returns could also be plotted in the same figure, but it is not included in Figure 1 to simplify the presentation.

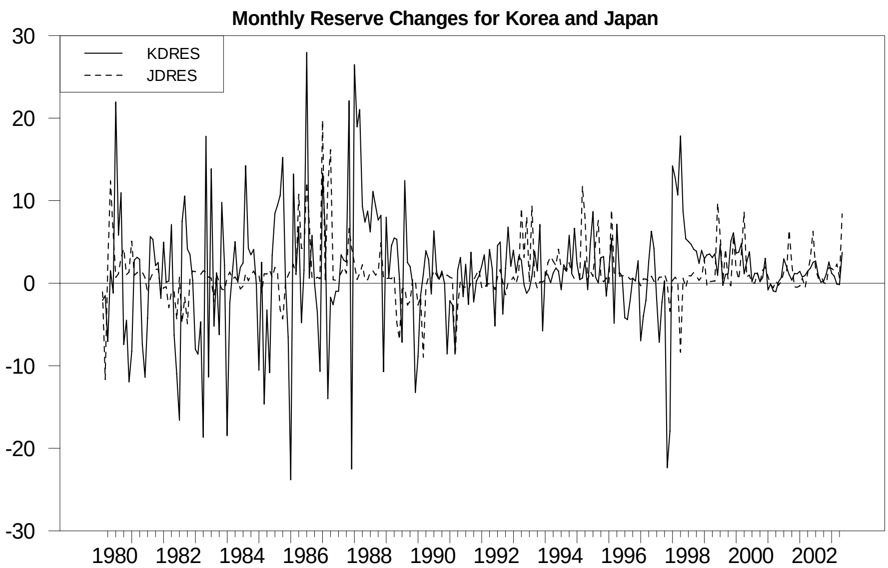
The Japanese *Yen* is more volatile during Period 1 when the Korean *Won* was under the managed float regime. During Period 2 when the Korean *Won* is under the floating exchange rate system, the currency volatilities of the two countries appear to be quite similar, and they are not statistically different as seen from Table 1.

Another measure of contrasting different exchange rate regimes is the change of

[Figure 1] Monthly Percentage Changes of the Nominal Exchanges per U.S. Dollar



[Figure 2] Monthly Percentage Changes of the Reserves for Korea and Japan



<Table 3> Exchange Rate Behavior (Δs_t): ARCH(1) LM Test

Country	Korea			Japan	Australia
Period	All	Period 1	Period 2	All	All
F-statistic	27.4152 (0.0000)	6.3088 (0.0128)	0.7890 (0.3783)	0.9362 (0.3341)	0.3684 (0.5444)
Asymptotic χ^2	25.0881 (0.0000)	6.1825 (0.0129)	0.8064 (0.3692)	0.9398 (0.3323)	0.3705 (0.5427)

Note: This table reports only ARCH(1) LM tests. Different lag lengths of ARCH model produce qualitatively similar results. p-values are in the parenthesis.

the reserves. Reserves are often used to control and manage nominal exchange rates under the fixed and managed exchange rate regimes. Figure 2 plots the volatility of reserve changes for Japan (broken line) and Korea (solid line). It is very clear that the Korean reserves were much more volatile than that of Japan during the managed float regime of Period 1, and they are also more volatile under the managed float regime than under the free floating regime. This shows the clear evidence of exchange rate management schemes. While there are criticisms that Korean exchange rates are still managed and controlled by the central bank, the reserve volatility tells otherwise. The recent volatility of the Korean nominal exchange rate shows very similar characteristics of other free floating exchange rates. In fact, Korean reserves remain relatively stable, and exchange rates are comparably more volatile during this period. Australia has relatively volatile reserve changes throughout the period. In fact, even with the free floating exchange rate regime, the probability of reserve changes stay within 2.5% band is only about 50% by Calvo and Reinhart (2002). Australian central bank intervention is very active even with free floating exchange rate policy. According to their study, Japan maintains the most stable reserves together with Singapore. The Korean reserve levels were highly volatile during the managed regime, but her reserve volatility has decreased significantly under the free floating regime. Korean reserve volatility is even more stable than those of Japan after the economic crisis of Period 2. Table 1 also reports the test statistics for the equality of reserves volatilities for three countries, but they are all rejected for all period. Korean reserves remain more stable than those of free floating regimes of Australia. Absolute comparison of the reserve volatilities does not seem to be a good measure of distinguishing exchange rate regimes for these three countries.

Instead of comparing the volatilities of different countries, it is more meaningful to compare the reserve volatilities for the different time periods. From Table 2 statistics, we can see that the reserve volatilities have reduced significantly in Period 2 compared to those of Period 1 for all three countries. Since Korea has changed her exchange regime from Period 1 to Period 2, the reserve volatility of Korea has reduced dramatically.

Exchange rates, like many other asset prices, often show the pattern of ARCH behavior in their evolutions. Before we specify and estimate the econometric model of Equation (8), we need to investigate the behavior of our sample currencies. Table

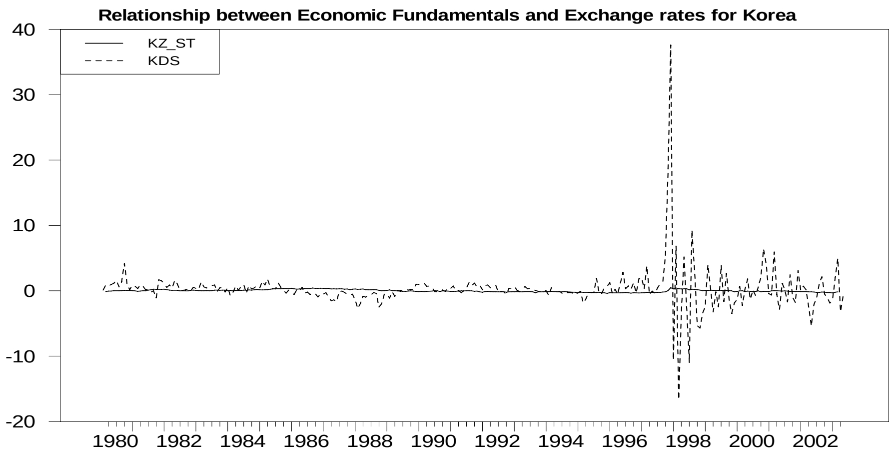
3 is a summary statistic for the ARCH residuals for the three currencies.

The Korean *Won* shows the ARCH residuals for Period 1 and for the entire period, while there is no evidence of ARCH residuals during the free floating Period 2. Even though the analysis periods exclude the crisis period of October 1997 to December 1998, there are several episodes of ARCH residuals (persistent volatilities) under the managed float regime during the late 1980s and the middle of 1990s leading to the economic crisis. Australian *Dollar* and Japanese *Yen* do not show the ARCH residuals either for the entire period or for two periods separately. It is interesting to observe that the ARCH residuals appear only during the managed exchange rate regime.

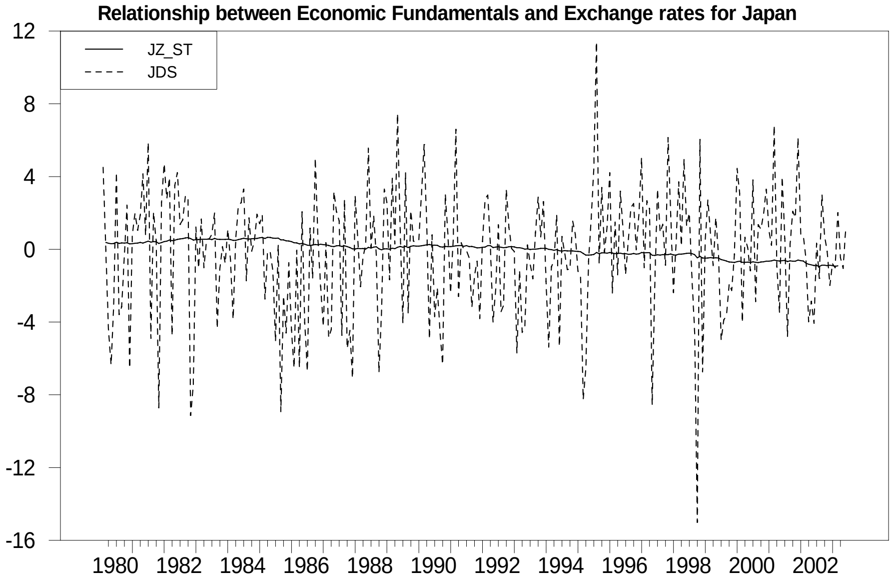
The following two figures, Figures 3 and 4, show that the exchange rates are widely fluctuating around the deviations from the economic fundamentals (z_t is standardized to have mean zero) for Korea and Japan, and it is not an easy task to predict the exchange rates using economic fundamentals. The relationship between exchange rates and the fundamentals for Australia show similar patterns to other countries, but it is not shown here to conserve space. Meese and Rogoff (1983) have shown that none of the theoretical exchange rate determination models outperform a simple random walk model in the root mean square criteria. Our objective here is not to predict the exchange rate using the economic fundamentals, but to investigate the causal relationship of the economic fundamentals to the nominal exchange rates focusing on the exchange rate regime shifts of the Korean *Won*, and compare it to other flexible exchange rate regimes.

The basic econometric model to examine the relationship between exchange rates and economic fundamentals is the equation (8) from the monetary model introduced in Section 2. Table 4 shows the OLS estimation results for three countries. Since the Korean *Won* shows the ARCH(1) behavior from Table 3, we also estimated the equation (8) for Korea by GARCH(1,1) model and present the results in Table 5.

[Figure 3] Economic Fundamentals and the Nominal Exchange Rates for Korea



[Figure 4] Economic Fundamentals and the Nominal Exchange Rates for Japan



<Table 4> OLS Estimation: $\Delta s_{t+1} = \beta_0 + \beta_1 z_t + \varepsilon_t$

		Korea	Japan	Australia
Period 1 (210)	β_0	7.6374 (1.8104)***	20.3091 (9.7455)**	-4.8247 (4.0508)
	β_1	-1.2151 (0.2961)***	-1.8436 (0.8696)**	-0.6741 (0.5890)
	SSR	146.7716	2345.6732	1706.1781
Period 2 (55)	β_0	37.3255 (18.7351)**	55.6487 (32.9761)*	-12.8023 (20.3014)
	β_1	-6.2151 (3.0986)**	-5.4044 (3.1894)*	-1.6037 (2.5256)
	SSR	358.8634	640.8513	546.2578
Both periods (265)	β_0	8.8816(2.9107)***	8.3921 (5.3762)	-2.8878 (2.2715)
	β_1	-1.4375(0.4772)***	-0.7903 (0.4873)	-0.3869 (0.3184)
	SSR	535.4058	3042.1483	2258.0679
F-statistic		7.6836 (0.0006)	2.4306 (0.0900)	0.3263 (0.7219)

Note: Standard errors in the parenthesis. *, **, *** indicate statistical significance at 10%, 5% and 1%, respectively. *F*-statistic tests the structural equivalence of two periods. *p*-values in the *F*-statistics.

<Table 5> GARCH(1,1) Estimation: $\Delta s_{t+1} = \beta_0 + \beta_1 z_t + \varepsilon_{t+1}$, $\sigma_t^2 = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \gamma_1 \sigma_{t-1}^2$, **where** $\sigma_t^2 = Var(\varepsilon_{t+1}|\Omega_t)$ **and** Ω_t **is an Information Set at Time** ***t*****.**

	Korea			Japan	Australia
	Period 1	Period 2	Both periods	Both periods	Both periods
β_0	7.1204	37.4090	5.2379	10.4660	-1.5484
	(1.4019)***	(16.8511)*	(1.3075)***	(5.3132)**	(2.3635)
β_1	-1.1268	-6.2424	-0.8281	-0.9849	-0.1943
	(0.2286)***	(2.7726)*	(0.2140)***	(0.4760)**	(0.3289)
α_0	0.1241	1.4185	0.0854	21.5476	0.4711
	(0.0409)***	(0.8827)	(0.0258)***	(2.1823)***	(0.2934)
α_1	0.6585	-0.1527	0.9250	0.0307	0.0799
	(0.1525)***	(0.0556)***	(0.0940)***	(0.0100)***	(0.0448)*
γ_1	0.3388	0.9246	0.3994	-1.0136	0.8707
	(0.0967)***	(0.1203)***	(0.0371)***	(0.0159)***	(0.0702)***

Note: Standard errors in the parenthesis. *, **, *** indicate statistical significance at 10%, 5% and 1%, respectively.

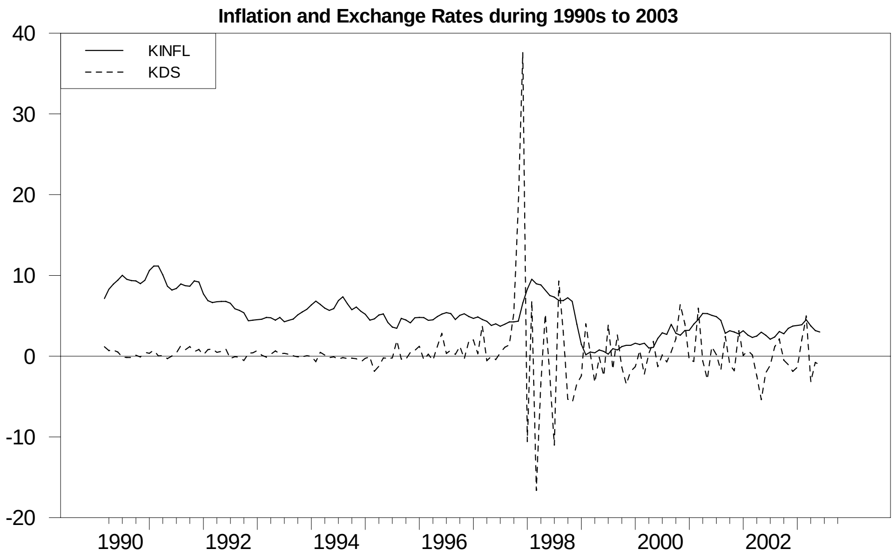
From these results, the Korean *Won*'s fluctuation in response to the deviations from the economic fundamentals has increased significantly from Period 1 to Period 2 (-1.22 vs. -6.22). Estimates of both OLS and GARCH show qualitatively similar results. In addition, we can see that the impacts of the deviations from the fundamentals to the nominal exchange rates are much bigger in magnitude during Period 2 than during Period 1. From the OLS results, this appears to be common phenomena for all three currencies (-6.22 vs. -1.22 for Korea, -5.40 vs. -1.84 for Japan, and -1.60 vs. -0.67 for Australia) even though the response to the Australian *Dollar* is not statistically significant for all periods. This shows that the speed of the nominal exchange rate adjustments to the deviations from the economic fundamentals has increased in recent years for all three countries. Since $z_t = s_t - f_t = \phi(i_t - i_t^*)$ from equation (6), β_1, the slope parameter of z_t to Δs_{t+1}, can also be interpreted as the sensitivity of the nominal exchange rates to the interest rate differentials. From Table 4, we can see that the Korean exchange rates respond to the deviations from the economic fundamentals and interest differentials much more sensitively under the free floating regime than under the managed regime. During Period 1 when the Korean *Won* was under the managed regime, the Japanese *Yen* had been more sensitive to the economic fundamentals and interest rate differentials (-1.22 vs. -1.84). However, since the Korean *Won* has become freely floating during Period 2, it has been more sensitive to the economic fundamentals (-6.22 vs. -5.40). The Australian *Dollar* is not very sensitive to the economic fundamentals. Table 4 also shows that the Korean exchange rate has the greatest sensitivity to the interest rate differentials among all three countries. Chow test statistics are calculated for each country, and we reject the null hypothesis of the parameter stability between the two periods for the Korean *Won* due to the regime change in these periods as we expected. The structural relationship between nominal exchange rates and the fundamentals has not significantly changed during these periods for Japan and Australia.

3. Exchange Rates and Inflation

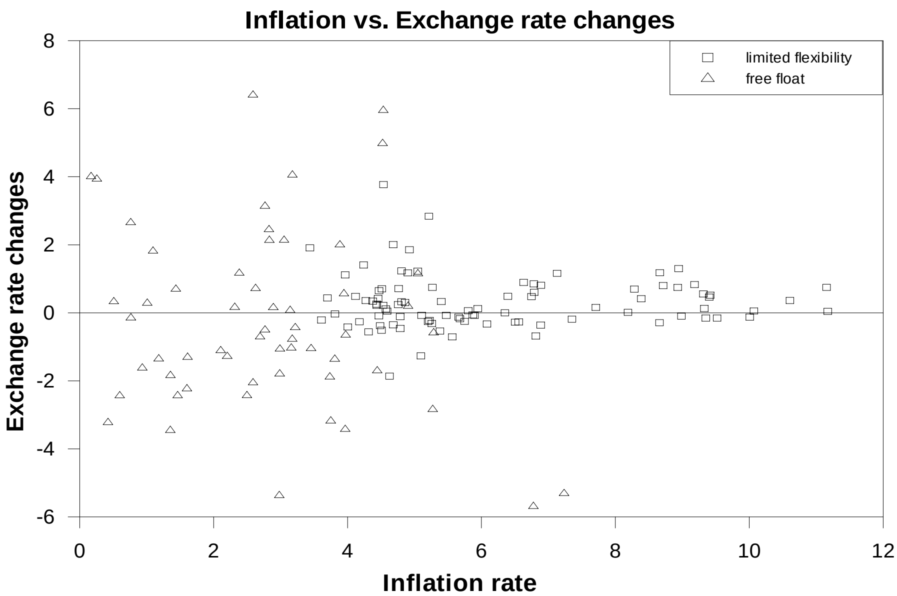
We now turn our attention to investigate the impact of the exchange rate pass-through to the domestic economic variables. From the purchasing power parity condition (PPP) of equation (3), there is a one-to-one relationship between the domestic inflation rate and the nominal exchange rate assuming constant foreign inflation. Therefore, we would like to see how the change of the nominal exchange rate affects the domestic inflation rate. This paper focuses on the effects of the exchange rate regimes on domestic inflation for the Korean economy in reference to the benchmark economies of Japan and Australia. An important objective of the fixed exchange rate regime for a developing economy is to maintain stable domestic price levels to help increase foreign trade. However, the intended objective could also prove to be wrong for the developing country. The rigid exchange regime may excessively drain foreign reserves, and it may bring further pressure for depreciation and domestic inflation. The vicious cycle may ultimately result in economic crisis. First, we will examine the relationship between inflation and the change of exchange rates since the 1990s. Figure 5 plots these two variables on the time span, inflation (solid line) and the return of the nominal exchange rate (broken line). Figure 6 is a scatter gram of these two variables. In Figure 6, the circle represents the plots under the managed exchange regime (1990:03-1997:09) period before the economic crisis, while the square represents the plots for the free floating regime (1998:10-2003:12) after the economic crisis.

As we can see from these figures, exchange rates have become much more volatile, while the inflation rate has become more stable under the free floating regime than under the managed regime. For the statistical regression analysis, I will limit my data for two distinctive periods of exchange rate regimes, from March 1990 to September 1997 for the market based managed exchange rate regime (MAR system) and from October 1998 to December 2003 for the free floating exchange rate. We selected the post-crisis period starting from October 1998 when the turmoil of the economic crisis had settled down a little bit. Inflation and exchange rates are analyzed using bivariate VAR model focusing on the purchasing power parity of Equation (3) with additional exogenous lagged variables of the percentage change of money supply (Δm_t) and the real GDP growth rate ($\Delta rGDP_t$). Lag length of two for the endogenous variables was chosen according to the Schwarz criteria. Other lag length selection did not change the qualitative relationship between these variables. Inflation rate appears to show strong time trend, but the Dickey-Fuller test with time trend rejects the unit root hypothesis for Period 1, Period 2 and the two periods combined. Bivariate VAR model may be too simple to analyze the complete exchange rate determination model introduced in Section 2, but the main objective of this analysis is focusing on the pass-through of the exchange rate to the inflation contrasting two different exchange rate regimes. Therefore, the estimated bivariate VAR model is:

[Figure 5] Inflation and the Changes of the Korean Exchange Rates



[Figure 6] Scattergram of the Inflation and the Exchange Rate Changes



$$\Delta s_t = \beta_{10} + \beta_{11} Infl_{t-1} + \beta_{12} Infl_{t-2} + \beta_{13}\Delta s_{t-1} + \beta_{14}\Delta s_{t-2} + \beta_{15}\Delta m_{t-1} + \beta_{16}\Delta rGDP_{t-1} + \varepsilon_{1t}$$

$$Infl_t = \beta_{20} + \beta_{21} Infl_{t-1} + \beta_{22} Infl_{t-2} + \beta_{23}\Delta s_{t-1} + \beta_{24}\Delta s_{t-2} + \beta_{25}\Delta m_{t-1} + \beta_{26}\Delta rGDP_{t-1} + \varepsilon_{2t}$$

where $\varepsilon_{1t}, \varepsilon_{2t}$ are uncorrelated white-noise random shocks.

This model is estimated for two periods separately, and combined for Korea. Since Japan and Australia did not experience exchange rate regime changes during the period, Japan and Australia are estimated for the entire period. The following table presents estimation results.

From these results, we can see that exchange rates are largely unaffected by domestic inflation for all three countries (Table 6.1). The exchange rate has a significant impact on the domestic inflation rate for Korea for all periods, but Japanese Yen and Australian Dollar, free floating currencies, do not have any statistically significant impact on their respective domestic inflations (Table 6.2). This shows that the Korean economy is more susceptible to exchange rate movement than those of Japan and Australia. However, we can observe that as the Korean exchange rate policy moves from managed exchange rate regime to free floating regime, the impact of exchange rate to inflation becomes smaller as an evidence of exchange rate adjustment mechanism. As the Korean economy matures with free floating exchange rate regime, we expect that the impact of exchange rate to inflation will be smaller. Money supply and real GDP growth rate do not appear to contribute to the inflation rate for Korea and Australia. Real GDP growth is mildly inflationary to Japan. Granger causality tests confirm the causal relationship

<Table 6.1> Exchange Rate Equation

	Korea			Japan	Australia
	Period 1	Period 2	Both periods	Both periods	Both periods
β_0	0.1872	1.1456	0.0319	-0.1292	-0.5908
	(0.2625)	(0.8856)	(0.3665)	(0.3330)	(0.4557)
$Infl_{t-1}$	0.0672	-0.7207	-0.0587	-0.3422	-0.2439
	(0.1472)	(0.6001)	(0.2570)	(0.8096)	(0.4115)
$Infl_{t-2}$	-0.0835	0.4550	0.0848	0.2119	0.3193
	(0.1481)	(0.5528)	(0.2534)	(0.8030)	(0.3981)
Δs_{t-1}	0.1791	0.2126	0.2243	0.0806	0.0827
	(0.0998)*	(0.1431)	(0.0867)**	(0.0847)	(0.1108)
Δs_{t-2}	0.2110	-0.1027	-0.1556	0.0294	-0.1974
	(0.1023)**	(0.1491)	(0.0866)*	(0.0842)	(0.1100)*
Δm_{t-1}	0.1424	-0.4882	-0.0552	-0.3510	0.1252
	(0.0562)**	(0.2738)*	(0.1069)	(0.2897)	(0.2754)
$\Delta rGDP_{t-1}$	-0.1548	0.1218	0.0082	0.8184	1.2724
	(0.0701)**	(0.1754)	(0.0942)	(0.8522)	(0.9206)
$Adj\ R^2$	0.1600	0.0473	0.0222	0.0350	0.0804

Note: Standard errors in the parenthesis. *, **, *** indicate statistical significance at 10%, 5% and 1%, respectively.

<Table 6.2> Inflation Equation

	Korea			Japan	Australia
	Period 1	Period 2	Both periods	Both periods	Both periods
β_0	0.2559 (0.1790)	0.5415 (0.2037)***	0.2213 (0.1007)*	-0.0047 (0.0345)	0.1420 (0.1033)
$Infl_{t-1}$	1.3297 (0.1004)***	1.0951 (0.1383)***	1.2768 (0.0800)***	0.9847 (0.0839)***	1.4814 (0.0933)***
$Infl_{t-2}$	-0.3724 (0.1001)***	-0.2710 (0.1272)***	-0.3258 (0.0789)***	-0.0297 (0.0832)	-0.5618 (0.0902)***
Δs_{t-1}	0.1423 (0.0681)**	0.1040 (0.0329)***	0.1219 (0.0270)***	-0.0073 (0.0088)	-0.0325 (0.0251)
Δs_{t-2}	-0.0784 (0.0698)	0.0469 (0.0343)	0.0128 (0.0270)	-0.0028 (0.0087)	0.0290 (0.0249)
Δm_{t-1}	-0.0086 (0.0383)	-0.0391 (0.0630)	-0.0100 (0.0325)	0.01759 (0.0300)	0.0659 (0.0624)
$\Delta rGDP_{t-1}$	-0.0287 (0.0478)	-0.0229 (0.0403)	-0.0205 (0.0293)	0.1524 (0.0883)*	-0.1084 (0.0286)
$Adj\ R^2$	0.9390	0.8578	0.9518	0.9716	0.9441
D-F	-5.9601 (0.0000)	-3.6254 (0.0364)	-3.8386 (0.0172)	-4.2230 (0.0047)	-3.9280 (0.0127)

Note: Standard errors in the parenthesis. *, **, *** indicate statistical significance at 10%, 5% and 1%, respectively. D-F is Augmented Dickey-Fuller statistics for the inflation rate. *p*-value is in the parenthesis.

<Table 6.3> Granger Causality Test Statistics (*F*-statistics)

Null Hypothesis	Korea			Japan	Australia
	Period 1	Period 2	Both	Both	Both
Δs_t Not Grange cause $Infl_t$	2.5374 (0.0850)	7.3884 (0.0015)	11.7043 (0.0000)	0.8408 (0.4334)	1.3663 (0.2607)
$Infl_t$ **Not Grange cause** Δs_t	0.2255 (0.7986)	0.6218 (0.5410)	0.1558 (0.8559)	0.3488 (0.7061)	0.2713 (0.7631)

Note: * Values in the parenthesis are *p*-values for *F*-statistic.

between inflation and exchange rate. Table 6.3 reports Granger causality test statistics for each period and the two periods combined, and the whole period for Japan and Australia.

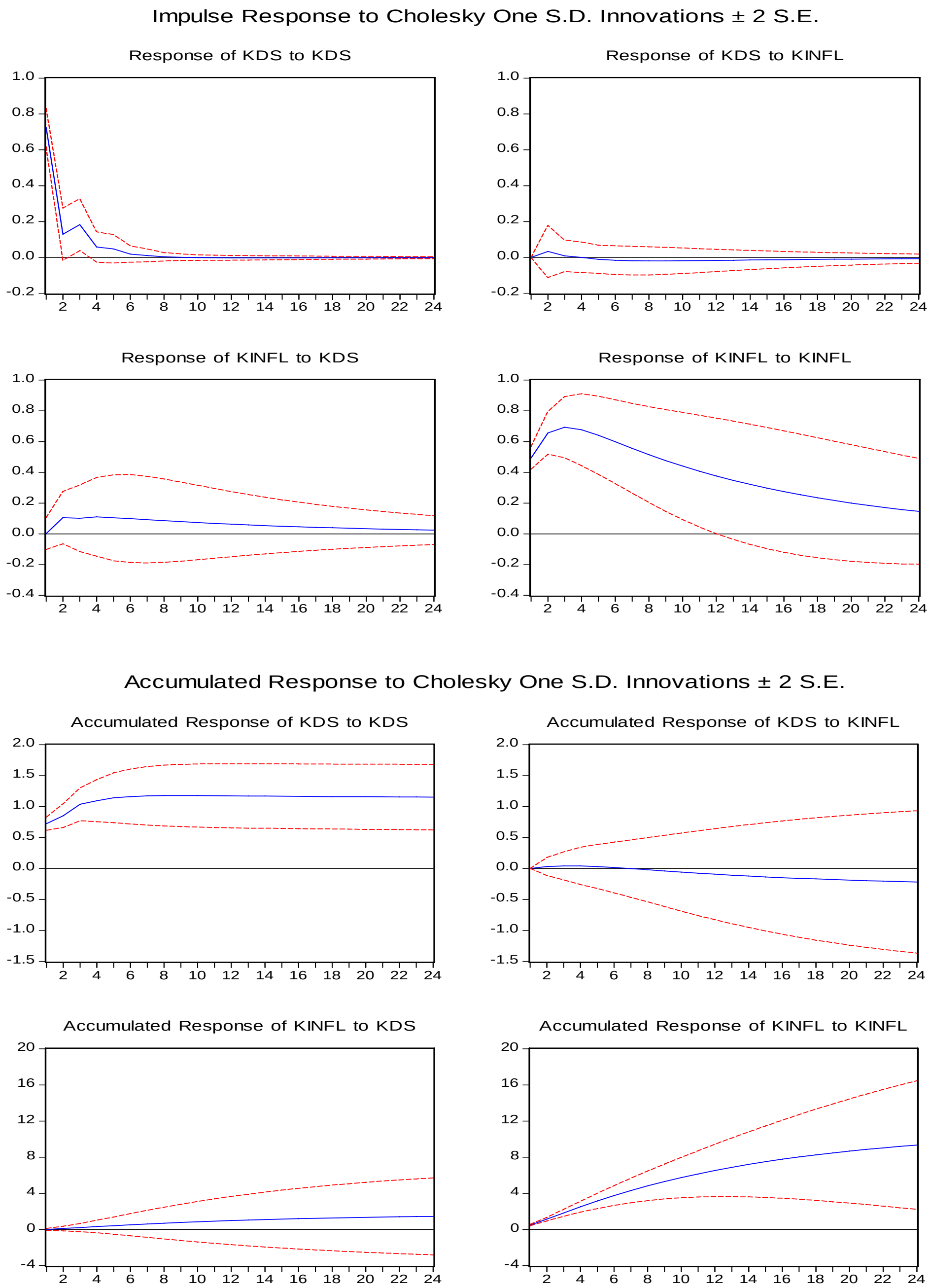
It is interesting to observe that the domestic money supply and the real GDP growth rate do not have statistically significant impacts on the inflation rate, and the Korean *Won* depreciation has positively contributed to the inflation rate throughout the entire sample period. From the VAR estimates, we can infer that one percent depreciation of the one period lagged Korean *Won* (Δs_{t-1}) contributes about 0.12% increase of the inflation rate for the entire period. This could be an unfortunate consequence of the small open economy which is heavily dependent on the import of intermediate goods to promote exports. Currency depreciation would boost export, but it also causes worsening terms of trade, and higher import prices of intermediate goods triggers higher domestic inflation. It is more evident that the export boosting policy through the managed exchange rate regime was pursued at the expense of domestic inflation. The impact of the currency depreciation to the inflation has been reduced to 0.10% under the free floating regime from the 0.14% under the managed float regime. Changing various lag length of Δs_t did not alter the qualitative relationship between the inflation and the exchange rate change. As expected from VAR results, Japan and Australia do not show statistically significant Granger causality between exchange rate and inflation.

Having established the causal relationship between exchange rate and inflation, we would like to see the impact of external shocks of one variable to one another. Figures 7 and 8 are impulse response functions (IRF) and accumulated response functions (ARF) for Period 1 and Period 2 using the Cholesky decomposition for two years (24 months). Since Cholesky decomposition is sensitive to the order of shocks to the VAR system, we produced two sets of IRF and ARF by rotating shock orderings. These two sets of response functions are remarkably similar to the point of being virtually identical.

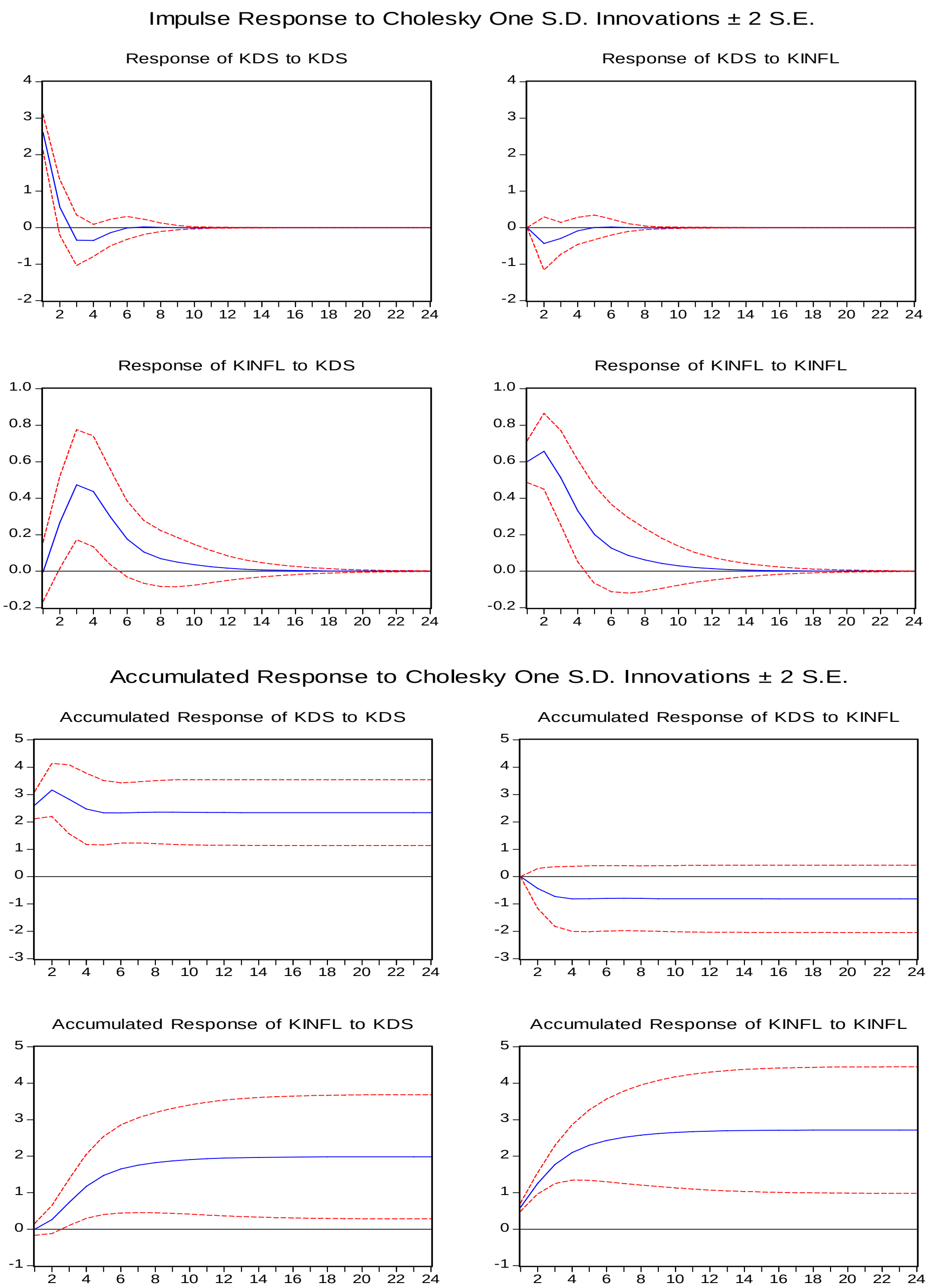
Figure 7 and 8 are IRF (upper panel) and ARF (lower panel) using the shock ordering of $\left(\Delta s_t, Infl_t\right)$. The lower-left corner of IRF and ARF are responses of inflation to the one standard deviation shock of the nominal exchange rates. Under the managed exchange rate regime (Figure 7), the impulse responses and accumulated responses are quite mild in magnitude, and they are statistically insignificant. Under the free-floating regime (Figure 8), the initial impact is relatively large and statistically significant for two to five months. The accumulated impulses remain positive and statistically significant in the long term. This shows that under the managed exchange rate regime, the exchange rate shock does not directly transmit to other macroeconomic variables, especially the inflation rate. Under the floating exchange rate regime, the nominal exchange rate depreciation directly passes through the domestic price level. However, this difference is largely due to the different size of the shocks between two periods. The upper-left corner graphs of IRFs from both figures show the size of the exchange rate shocks. Observe that two graphs show different scales reflecting the size of shocks for each period. Exchange rate shock is much bigger under the free float regime than that of managed exchange rate regime. Under the managed exchange rate regime, exchange rate policy effectively limited the size of the exchange rate shocks, and minimized the impact to domestic inflation. The accumulated impulses remain positive and statistically significant in the long-term under the free float regime. The upper-right corner of IRF and ARF are the responses of exchange rate to the external shock of inflation factors. As we demonstrated previously by VAR results and Granger causality tests, the impact of the inflation shock to the exchange rates are statistically insignificant for both periods.

The last two figures, Figures 9 and 10, show the impulse response functions for Japan and Australia. Exchange rate shocks have no statistically significant impact on domestic inflation rates for Japan. Australian exchange rate shocks have a verystatistically insignificant.

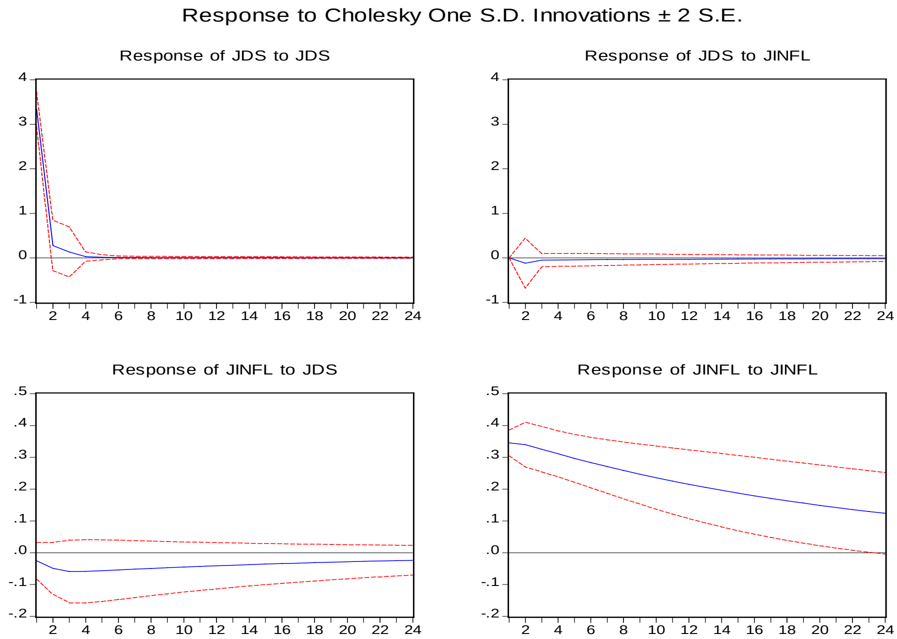
[Figure 7 (Period 1)] IRF and ARF of Korean for Managed Float Period

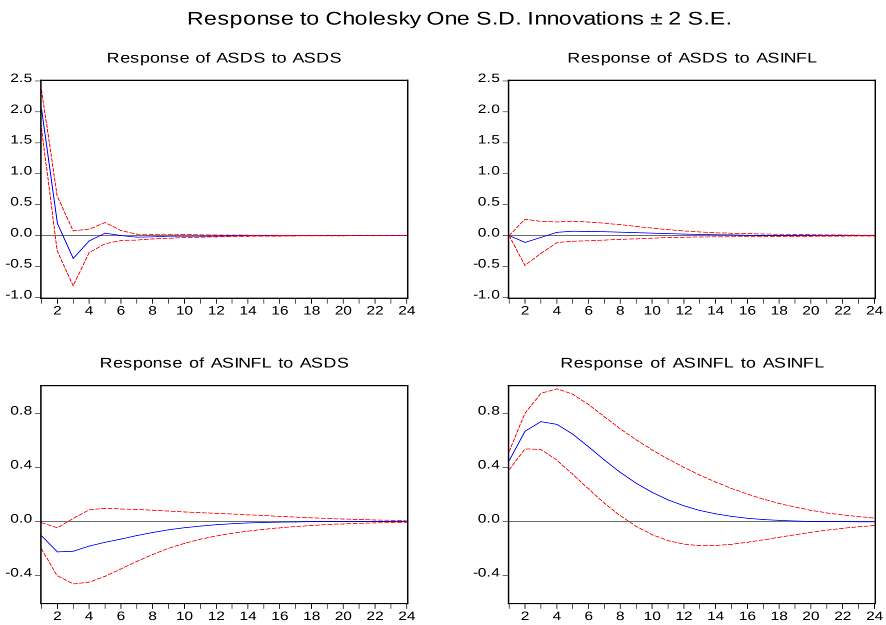


[Figure 8 (Period 2)] IRF and ARF of Korea for Free Float Period



[Figure 9 and Figure 10] Impulse Response Function of Japan and Australia





Ⅳ. Conclusion

This paper investigated the role of economic fundamentals on exchange rate determination of different exchange rate regimes focusing on the Korean economy and its comparison to the two benchmark economies of Japan and Australia. This paper found that the economic fundamentals have influenced exchange rates much more significantly under the flexible regime than under the managed exchange rate regime. Korean exchange rates under the floating regime are more sensitive to the economic fundamentals than those of Japan and Australia. Exchange rate pass-through into domestic variables, especially inflation rate, has a smaller impact under the floating regime than under the managed regime. However, the size of the shock is much bigger under the free floating regime than that of managed regime. This finding is consistent with the traditional arguments for the managed regime. In short, the movements of the exchange rates under the free floating regime directly reflect the underlying economic fundamentals.

It is true that the exchange rate has become more volatile under the flexible exchange rate system than under the managed regime. While the flexible regime may help to promote healthy economic growth in the long-run, the exchange rate volatility may prevent foreign investment or stable growth in the short-run. The Korean government needs to pursue an exchange rate policy to reduce short-run volatilities of the flexible exchange rate system to promote the stable economic growth. However, we expect that the exchange rate impact will become less prominent as the Korean economy matures, as evidenced by comparisons to Japan and Australia.

It is still an open question regarding which exchange rate regime is better for economic growth in the long run especially for the developing economies. My future research will expand the current topic to investigate the relationship between different exchange rate regimes and other macro economic performance, especially economic growth.

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