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Parallel Exchange Rates Models:
The Case of Korea

Muhammad Mazharul Islam*,
Joonmo Cho**
and
Ashraf Nakibullah***

In this paper foreign exchange markets are characterized as "gray" and black markets. A gray market is referred to as the market where controls on foreign currency transactions are loose or minimal, whereas in the black market laws are strictly enforced and lawbreakers receive harsh sentences when caught. We develop parallel foreign exchange rates models by explicitly incorporating a penalty structure that makes a distinction between gray and black markets. We have performed the empirical tests for the resulting models in the case of Korea. The overall results are supportive to the flexible price gray market model since the penalty or risk factor was found statistically insignificant. Our findings suggest that the relaxation of controls reduces the premium in the unofficial market and subsequently discourages transactions in this market.

I. Introduction

The dual or multiple exchange rate systems of many developing countries can be characterized by an official legal market and by an unofficial illegal market known as the parallel foreign exchange market. This parallel foreign exchange market arises mainly from various types of controls on foreign currency transactions as well as restrictions on foreign trade and sector of the economy. If the costs of transactions in an illegal market are not prohibitive, the excess demand for foreign currencies is being met at a premium price in this market. In many countries such illegal foreign currency markets exist openly with little or no government

* IT Division, Laredo State University, Laredo, Texas, U.S.A.
** Department of Economics, University of Oklahoma, Norman, Oklahoma, U.S.A.
*** Department of Finance and Economics, Georgia Southern University, Statesboro, Georgia, U.S.A.

enforcement of laws prohibiting such actions. We refer to such markets as "gray" markets. In other countries laws are strictly enforced and lawbreakers receive harsh sentences when caught. The markets where restrictions are strictly observed are characterized as black markets.

Often the government sets an official exchange rate that deviates greatly from what the free market would establish. Literature on black market exchange rates [see, for example, Culbertson (1975), Blejer (1978), Dornbusch et al. (1983), Nowak (1984), and Phylaktis (1992)] seems to assume that a deviation of an official exchange rate from the free market is invariably characterized as black market. In other words, they seem to ignore the inherent penalty structure that makes a difference between a gray and black market.

It is a known fact that many developing countries facing economic hardship, have allowed the illegal markets to perform normal economic activities through a steady supply of foreign exchange. In other words, gray markets are operative in many countries.[1] In this paper we develop models, which are variants of the monetary approach to exchange rate determination, by making a clear distinction between a gray market and a black market.[2] This constitutes, we believe, a major difference with the existing literature on the black market exchange rates.

Note control on foreign exchange transactions gives rise to a parallel market for foreign exchange. We divide this parallel exchange market into gray and black markets depending on how laws are enforced when transacting in the parallel market. In light of this different, our purposes in this paper are as follows. Our main purpose is to specify determinants of gray and black markets exchange rates applicable to some developing countries. In particular, we allow interaction of both monetary and real factors in the determination of the gray and black markets exchange rates. Here we incorporate a risk factor to differentiate the black market model of exchange determination from the gray market. We then empirically implement our models of exchange rate determination using (South) Korean quarterly data for the period 1974:I-1987:I. We argue that if the penalty factor in the determination of black market exchange rate is em-

1 In many Latin American countries the post office is a center for illegal market trading. In Guatemala, the government allows such open activity, and foreign currency traders often call people leaving the post office offering to buy dollars. In this paper, this sort of government-tolerated alternative to the official exchange market is referred to as a gray market.

2 In this paper we are only interested in the theoretical implications and empirical testing of such models. We do not discuss the effects of such differences on the balance of payments and economic welfare. See, for example Lizondo (1987), for discussion of such issues.

pirically insignificant, the gray market is operative where transactions involve no legal risk.

The organization of the paper is as follows. Section 2 presents various models of parallel market exchange rate determination. Here we show that factors determining the black market exchange rate also depend on whether goods prices are flexible or sticky. This we believe to be a further contribution of our study because studies on black market exchange rate models assume goods prices are always flexible. The results of an empirical analysis of the experience of South Korea are reported in section 3. Concluding remarks are presented in section 4.

II. Parallel Foreign Exchange Rates Models

Often the governments of developing countries set official exchange rates that deviate widely from what the free market would establish. Officially pegged exchange rates quite commonly overvalue national currencies. If the government will only purchase foreign exchange at the official rate while private citizens are willing to pay the market-determined rate, there will be a steady supply of foreign exchange to the parallel market. The main sources of foreign exchange supply to the parallel market are receipts from the over-invoicing of imports and under-invoicing of exports. In addition, smuggling of certain goods (mostly luxury) and assets (like gold) whose trade is not officially permitted contributes to the existence of this market.[3]

The demand of foreign currencies in the parallel market arises because of government limitations on buying foreign exchange, and the supply exists because of government-mandated official exchange rates that offer less than the free market. Knowing the existence of the illegal markets, government either can allow (overlook) or restrict transactions in the illegal markets.

In modeling the parallel market foreign exchange rates we apply monetary approach to exchange rate determination.[4] We assume a small open economy in the sense that the international prices of its traded goods are exogeneously determined and domestic and foreign bonds are perfect

[3] Other sources of foreign exchange supply to parallel markets are receipts from tourism and relatives from abroad. The presence of the U.S. military in some countries (for example, in Korea) may also provide additional funds to the dealers in this market.

[4] For this approach to exchange rates, see, for example, Kouri (1976), Dornbusch (1976), Frenkel (1976), Rodriguez (1980), and Frenkel (1983).

substitutes, i.e., uncovered interest parity holds. We also assume domestic and foreign goods are also perfect substitutes in the consumer demand function, that implies purchasing power parity conditions hold. We allow smuggling of certain goods and assets. In particular, we assume that gold is illegally traded internationally whereas goods are both legally and illegally traded.

A. Flexible Price Gray Market Exchange Rate

Here we develop a monetary model of the gray market exchange rate. we assume all goods prices are completely flexible and the parallel exchange market is the gray market. The model is a variant of the models used by Blejer (1978) and Gupta (1980). However, it is important to note that they have referred to such models as the black market exchange rate models. But we believe such a model should be referred to as a gray market exchange rate model because it does not incorporate any risk of transactions in the parallel market. Accordingly, we assume there is no legal risk involved in dealing in the parallel market since the operation of this market is tolerated by the government. In this model the exchange rate has been determined by the interaction of both the goods and the money market. The demand for real balances exerts an influence on the exchange rate in the parallel market.

An essential element of any monetary model is the specification of the basic relationships of the monetary sector. We specify the domestic money demand function in an ad hoc fashion where demand for real money balances (M^d/P) are positively related to the domestic real income (Y); and negatively related to the domestic interest rate (i), the expected rate of depreciation of the illegal foreign currency in the gray market ($\hat{S}_g^e$), and the expected rate of change of the domestic price of gold ($\hat{P}_G^e$). In logarithms the money demand equation is

$$(1) \qquad m^d = p + \alpha_1 y + \alpha_2 i + \alpha_3 \hat{S}_g^e + \alpha_4 \hat{P}_G^e$$

where p is the natural logarithm of the domestic price level, $\alpha_1 > 0$ and α_2, α_3, $\alpha_4 < 0$. Unless otherwise noted, lower-case letters denote natural logarithms of the corresponding upper-case variables, except when representing rates of interest. Superscript "e" denotes expectation operator. Note, S_g is the nominal exchange rate defined as domestic price of a unit foreign currency in the gray market. Here, a variable with a hat (^) represents the time derivative of the log of that variable so that $\hat{S}_g = d(\ln S_g)/dt = ds_g/dt$ (percentage rate of change).

The explanatory variables capture the economic environment of developing countries where substitution effects are subsumed under those financial assets and opportunity cost of holding money involving real assets such as gold is more important. When expectations of exchange rate depreciation intensify, the expected returns from holding assets denominated in foreign currency increases, as a result investors tend to alter their portfolios of real and financial assets. Since an increase in the expected returns from holding foreign assets tend to increase the opportunity cost of holding money, a decreased demand for home money may be expected. Similarly, an expected increase in gold price at home will tend to increase the holding of gold and consequently reduces the tendency to hold home money.

Stock of domestic nominal money balances is equal to the money multiplier and the monetary base which contains Central bank foreign exchange reserves (R) plus domestic credit (D):

(2) $$m^s = k + h = k + \ln(R + D).$$

Equating equations (1) and (2), the domestic money market equilibrium is

(3) $$p = k + h - \alpha_1 y - \alpha_2 i - \alpha_3 \hat{S}_g^e - \alpha_4 \hat{P}_G^e.$$

The PPP condition in the gold market states that the domestic price of gold is equal to the foreign price of gold times the gray market exchange rate:[5]

$$P_G = s_g + P_G{}^*.$$

Then individual's expectations of domestic gold price change is equal to the expected depreciation of the gray rate plus an expected rate of change of the foreign gold price as shown in equation (4) below:

(4) $$\hat{P}_G^e = \hat{S}_g^e + \hat{P}_G^{*e}.$$

The PPP condition in the goods market implies that the domestic price is equal to the foreign price level times the exchange rate. In a country

[5] Under a regime of pegged or crawling peg exchange rates where the official exchange rate can not reflect changes in the value of domestic currency relative to the foreign currency and where the parallel foreign exchange is more or less free, the PPP approach can be used to explain the behavior of the illegal market for foreign exchange. Here we assume that gold is illegally traded internationally whereas goods are both legally and illegally traded.

where an official and unofficial markets exist, the difference between the domestic and foreign price level is a weighted average of the official and unofficial rate. So the expression for the domestic price level can be written as

$$(5) \qquad p = p^* + \lambda s_0 + (1-\lambda)s_g,$$

where s_0 is the natural logarithm of the official exchange rate and $\lambda(0<\lambda<1)$ is the proportion of trade that is carried through the legal channel at the official exchange rate. The expected rate of change of equation (5) yields

$$\hat{P}^e = \hat{P}^{*e} + \lambda\hat{S}_0^e + (1-\lambda)\hat{S}_g^e,$$

which can be rearranged as follows

$$(6) \qquad \hat{S}_g^e = (1/1-\lambda)[(\hat{P}^e-\hat{P}^{*e})-\lambda\hat{S}_0^e].$$

The implication of the PPP condition in goods market in our above two-tier exchange rate system is that the expected rate of depreciation of the gray rate is positively related to expected inflation differential between the home and foreign countries and negatively related to the expected rate of depreciation of the official rate. Note, the return from holding foreign currency as an asset is a function of the expected rate of depreciation in the gray market. Indeed, when at any particular moment of time people compare the past behavior of the exchange rate with the behavior of the official exchange rate and conclude that the official exchange rate has been rising and that this has not led to a corresponding decrease in the gray market exchange rate, they will expect a large appreciation of the gray market rate. In addition, if domestic prices have been rising faster than foreign prices, people are likely to anticipate that any expected excess of domestic over foreign inflation will also be transmitted to the exchange rate.

Substituting equations (4)-(6) in the money market equilibrium condition (3) and after rearranging we obtain the following equation for the gray market exchange rate:

$$(7) \qquad s_g = (1/1-\lambda)(k + h-\alpha_1 y-\alpha_2 i-\alpha_4\hat{P}_G^{*e} -\lambda s_0-p^*)$$
$$+ [(\alpha_3 + \alpha_4)/(1-\lambda)^2][\lambda\hat{S}_0^e-(\hat{P}^e-\hat{P}^{*e})].$$

For empirical implementation of equation (7), we need to specify the expectations of the official exchange rate. Following Ujiie (1978), governments policy decisions regarding the exchange rate are likely to follow some sort of reaction function that is aimed at maximizing a government utility function. A plausible simple specification of such a reaction function will relate the official exchange rate to deviations from the relative PPP condition as follows:

$$\hat{S}_0 = \gamma(\hat{P}-\hat{P}^*)$$

where $0<\gamma<1$. This implies a crawling peg system.[6] So the expected rate of change of the official rate is

$$\hat{S}_0^e = \gamma(\hat{P}^e-\hat{P}^{*e}) \quad (8)$$

We will consider the possibility that the price level grows at the same rate as the money stock. Then we may write (8) as

$$\hat{S}_0^e = \gamma(\pi^e-\pi^{*e}), \quad (9)$$

where π is the domestic monetary growth rate. We also assume that monetary growths follow a random walk process. Then the rationally expected future relative money growth rate is equal to the current relative money growth rate. Then we can write $\pi^e-\pi^{*e} = (\pi-\pi^*)$. Then the model (7) can be written as follows:

$$s_g = \beta_1 m^s + \beta_2 y + \beta_3 i + \beta_4 s_0 + \beta_5 \hat{P}_G^{*e} + \beta_6 P^* + \beta_7(\pi-\pi^*), \quad (10)$$

where,

$$\begin{aligned} &m^s = k + h, && \beta_4 = -\lambda/(1-\lambda)<0,\\ &\beta_1 = 1/(1-\lambda)>0, && \beta_5 = -\alpha_4/(1-\lambda)>0,\\ &\beta_2 = -\alpha_1/(1-\lambda)<0, && \beta_6 = -1/(1-\lambda)<0,\\ &\beta_3 = -\alpha_2/(1-\lambda)>0, && \beta_7 = [(\alpha_3+\alpha_4)(\lambda\gamma-1)]/(1-\lambda)^2>0, \end{aligned}$$

Equation (10) gives, we believe, the principal determinants of the exchange rate in the gray market for most of the Asian countries including Korea with fixed exchange rate system. The above flexible price monetary model of gray market exchange rate determination (equation 10) implies that, other things being equal, an increase in the money supply at home

6 When $\gamma = 0$, we have a pegged exchange rate system where monetary disequilibria and domestic inflation are not transmitted to the official exchange rate. The other extreme case ($\gamma = 1$) implies a floating exchange rate system where the rate of devaluation will be fully determined by the differential between domestic and foreign inflation rate.

due either to an increase in the money multiplier, reserves or domestic credit will inflate prices at home that will cause the gray market to depreciate. An increase in the home income leads to an increase in the demand for real money balances. Given money stock, an increase in the demand for real money balances would deflate the price level at home and appreciates the gray market rate. A higher home interest rate through a reduced demand for money will cause the exchange rate in the gray market to depreciate. A higher official exchange rate would reduce the incentive to under-invoice exports or to over-invoice imports or increase the incentive to over-invoice exports and divert the flow of remittances by residents abroad from the gray market to the official market. Since the demand for the foreign exchange in the gray market depends on the supply of that to the official market, increased foreign exchange receipts would lower the demand for foreign currency in the gray market and consequently appreciates the parallel rate. Similarly, from the PPP condition in the gold market, an expectation of an increase in the world gold price depreciates the gray market rate, and an increase in foreign price level leads to an appreciation of the gray market exchange rate. Finally, an increase in expected inflation differential leads to a decrease in the demand which cause parallel exchange rates to depreciate.

B. Flexible Price Black Market Exchange Rate

A black market is defined here as an officially prohibited parallel exchange market and the restrictions are rigorously enforced. Transactions in the black market do involve legal risks. Therefore, in order to derive a monetary model for the black market exchange rate, we need to introduce some risk factors associated with dealing in this market. The risk factors are the probability of being caught and the fine or confiscation when convicted. These penalty variables could, in principle, greatly affect the volume of daily transactions and the rate of return in this market.

Let S_b be the exchange rate defined as domestic price of a unit of foreign currency in the black market. The relationship between S_b and S_g (gray market exchange rate) can be written as

$$(11) \qquad (S_b - f)\Theta + S_b(1-\Theta) = S_g,$$

where Θ is the probability of being caught in dealing in the black market and f is the penalty rate per unit of black dollar held. Equation (11) states that, at the margin, the gray exchange rate is equal the expected value of the black market rate. When $\Theta = 1$, enforcement is strictly observed; if $\Theta = 0$, we observe no enforcement as a consequence the black market turns into a gray market. So in order to generate an effective black market, the above condition ($0 < \Theta \leqslant 1$) must be satisfied. Note, equation (11) can be written as

$$(12) \qquad S_b = S_g + \Theta f.$$

Equation (12) states that the black market rate is equal to the gray market rate plus a risk or penalty factor, and for the black market exchange rate this condition must hold. Then expected rate of depreciation of the black rate is equal to the expected rate of depreciation of the gray rate plus the penalty variable:

$$(13) \qquad \hat{S}_b^e = \hat{S}_g^e + \Theta f.$$

Note, the assumption of perfect asset substitution implies uncovered interest parity (UIP) condition, $i - i^* = \hat{S}_g^e$, holds in the gray foreign exchange market. Then the uncovered interest parity condition in the black market is given as follows:

$$(14) \qquad \hat{S}_b^e = (i - i^*) + \Theta f.$$

Now if the black market is operative, PPP conditions for the goods and gold markets and equation (5) are to be modified accordingly. These modified equations are then substituted into the modified domestic money market equilibrium equation and rearranging we obtain

$$(15) \qquad s_b = (1/1-\lambda)[m^s - \alpha_1 y - \alpha_2 i - (\alpha_3 + \alpha_4)\hat{S}_b^e - \alpha_4 \hat{P}_G{}^{*e} - \lambda s_0 - p^*].$$

If the black market is operative, then equation (6) must also be modified as

$$(16) \qquad \hat{S}_b^e = (1/1-\lambda)[(\hat{P}^e - \hat{P}^{*e}) - \lambda \hat{S}_0^e] + \Theta f.$$

Substituting equation (16) into equation (15) we obtain

$$(17) \qquad s_b = (1/1-\lambda)(k + h - \alpha_1 y - \alpha_2 i - \alpha_4 \hat{P}_G{}^{*e} - \lambda s_0 - p^*)$$
$$+ [(\alpha_3 + \alpha_4)/(1-\lambda)^2][\lambda \hat{S}_0^e - (\hat{P}^e - \hat{P}^{*e})]$$
$$-[(\alpha_3 + \alpha_4)/(1-\lambda)](\Theta f)$$

Following the specification of expectations for the expected depreciation of the official exchange rate, as is done in equation (8), and also following our earlier assumptions as in equation (10), the above relation (17) turns into:

$$(18) \qquad s_b = \beta_1 m^s + \beta_2 y + \beta_3 i + \beta_4 s_0 + \beta_5 \hat{P}_G^{*e} + \beta_6 p^* + \beta_7(\pi - \pi^*) + \beta_8(\Theta f),$$

where $\beta_8 = -(\alpha_3 + \alpha_4)/(1-\lambda) > 0$, and other β's have been defined earlier in connection with equation (10). Interpretation of β_1–β_7 coefficients is the same as provided in connection with equation (10). The sign of the penalty variable is positive, implying that an increase in either the probability of being caught (Θ) or the expected fine (f) if convicted will lead to a depreciation of the home currency in the black market. Note that by comparing equations (10) and (18) we may write

$$(19) \qquad s_b = s_g + \beta_8(\Theta f).$$

Our understanding is that for the black market to be operative, relation (11) must always hold with $0 < \Theta \leqslant 1$. If this is true, the black market exchange rate must be greater than the gray market exchange rate as is evidenced in equation (19) since $\beta_8 > 0$.

C. Sticky Price Black Market Exchange Rate

Here we assume that goods prices are sticky or predetermined relative to asset prices. Because of imperfection and the existence of controls, prices do not change instantaneouly, but adjust gradually over time. Therefore, we now assume that the PPP condition holds only in the long run. All our earlier assumptions are retained here except we replace the instantaneous PPP conditions by their long run versions. We assume that the expected rate of change of the black market exchange rate is a positive function of the gap between the long-run equilibrium rate and the current rate plus the expected rate of change of the long-run equilibrium black market rate:

$$(20) \qquad \hat{S}_b^e = \delta(s_b^L - s_b) + \hat{S}_b^{Le}$$

where superscript "L" on variables signifies a relationship that holds in the long-run, $\delta(>0)$ is the speed of adjustment factor. δ is equal to one over the number of time periods the black market rate (s_b) is expected to return to its long run equilibrium rate (s_b^L) following a shock.[7] After

[7] This long run equilibrium exchange rate is defined as the rate that is consistent with the current and the expected future equilibrium values of the underlying determinants.

various substitutions, equation (20) turns into an expectation generating process:

$$(21) \qquad \hat{S}^{e}_{b} = \delta(s^{L}_{b} - s_{b}) + [(1-\lambda\gamma)/(1-\lambda)](\hat{P}^{Le} - \hat{P}^{*Le})$$

We again assume that the price level grows at the same rate as the money stock, and monetary growth follows a random walk process. Then equations (14) and (21) imply

$$(22) \qquad s_{b} = s^{L}_{b} - (1/\delta)(i - i^{*} + \Theta f) + [(1-\lambda\gamma)/(1-\lambda)](\pi - \pi^{*})$$

where s^{L}_{b} is the long-run equilibrium parallel market exchange rate and is given by (18). Then substituting (18) for s^{L}_{b} in (22), we obtain the sticky price black market foreign exchange rate as follows:

$$(23) \qquad s_{b} = \beta_{1}m^{s} + \beta_{2}y + \beta'_{3}i + \beta_{4}s_{0} + \beta_{5}\hat{P}_{G}^{*e} + \beta_{6}p^{*} + \beta'_{7}(\pi - \pi^{*}) + \beta'_{8}(\Theta f) + \beta_{9}i^{*}$$

where $\beta'_{3} = (\beta_{3} - 1/\delta)$ is indeterminate in sign,
$\beta'_{7} = [\beta_{7} + (1-\lambda\lambda)/\delta(1-\lambda)] > 0$,
$\beta'_{8} = (\beta_{8} - 1/\delta)$ is indeterminate in sign,
$\beta_{9} = 1/\delta > 0$.

Definitions and signs of all other coefficients are the same as are provided in connection with equation (10) for flexible price model. Regarding the domestic interest rate we have an ambiguous effect. If there is an instantaneous adjustment following a shock, $\delta \rightarrow \infty$ and $1/\delta \rightarrow 0$, then we get a positive relationship between the domestic interest rate and the black market rate. In this situation the flexible price model holds. Alternatively, when the adjustment is very long, $\delta \rightarrow 0$, then we get a negative relationship between the domestic interest rate and the black market exchange rate. When prices are sticky price assumption, changes in the nominal domestic interest rate reflects changes in the tightness of the monetary policy. When there is contraction in the domestic money supply relative to the domestic money demand without a proportional fall in the domestic price level, home interest rates rise relative to foreign interest rates. The higher interest rates attract capital inflows which cause the black rate to appreciate instantly. The final term in the equation (23) captures the effect of the foreign interest rate on the black market exchange rate. When the foreign interest rate rises, demand for foreign currency rises relative to the domestic currency which causes to depreciate domestic currency and as a result the black market exchange rate depreciates.

There is also an ambiguous situation with regards to the sign of the risk or penalty variable. When the speed of adjustment is instantaneous, then the coefficient of the penalty variable is positive because $1/\delta \rightarrow 0$. Increased enforcement of currency restrictions leads to an increase in the price of taking risks which causes a depreciation in the black market exchange rate. Alternatively, when the speed of adjustment is very long $(1/\delta \rightarrow \infty)$, there is an inverse relationship between the risk factor and the black rate.

III. The Empirical Results

This section presents some empirical evidence from the recent South Korean experience with parallel foreign exchange markets. The models described above are able to properly classify a country according to the degree of governmental restrictions imposed and observed either as a gray or a black market. During the 70's and most of the 80's, South Korea was governed by military rulers who severely restricted transactions in the illegal exchange market. In other words, the Korean parallel foreign exchange market during this period was expected to be that of a black market type. This presumption conforms with the 1986-1987 World Currency Yearbook's classification of currency control categories; South Korea is classified in the strict control group. However, U.S. dollars and Japanese yen have become a big item in, as the 1986-1987 World Currency Yearbook (p. 470) puts it, "Seoul's tolerated black market." Thus we cannot rule out the possibility that the parallel foreign exchange market is of the gray type. These observations make the study of the Korean illegal foreign exchange market more intriguing and interesting.

A. Data and Methodology

The seasonally adjusted quarterly data set used for the empirical work consists of fifty-three observations on various macro-economic time series from 1974:I-1987:I. The starting and ending periods were determined by the availability of the data. The empirical study uses illegal market exchange rates (won per U.S. dollar) as the dependent variable which is not available beyond 1987:I. Quarterly data for GNP were not available. Quarterly data for industrial production index were used as a proxy for GNP. Description of the data and their sources can be found in the data appendix. We treat Japan as the foreign country. This is because, as the 1986-1987 World Currency Yearbook reports (p. 470), "Illicit money transfers mainly with Japan, have increased in recent years. Over 60 percent of money illegally leaving Japan has been destined for South Korea, while at least 90 percent of money cladestinely reaching Japan has stemmed from South Korea." We also estimated equations using the U.S. variables as a proxy for foreign variables. However, Japanese variables performed better compared to the U.S. variables.

Empirical study requires the quantification of the penalty variable which was unavailable. Empirically, either of the following can be used as a proxy variable for the penalty or risk factor: Government expenditures for dealing in the illegal market, a dummy variable for a hypothesized change or an increase in currency regulation enforcement. Increasing the amount of government expenditures for counteracting illegal transactions in this market implies strict enforcement of its laws and consequently the probability of being caught is very high. If there is a regime change because of a military coup or an increased enforcement of laws during the same regime, probability of being caught will rise. However, expenditure figures for this particular purpose were not available. Therefore, a dummy variable for a regime change or suspected increase in the enforcement of laws can be used as a proxy in order to estimate the coefficient of risk or penalty variable. Accordingly, we used a dummy variable as a proxy for the penalty variable for those quarters for which the enforcement was suspected to be strict. These periods for which $\Theta f = 1$ were 1974:I-1979:III and 1980:III-1984:IV. These were the periods of President Park Chung Hee and General Chun Doo Hwan with a brief relaxation of enforcement following the killing of President Park.

Recent studies in non-stationary time series suggest that if the variables included in the regressions are not stationary, statistical inferences cannot be made on the basis of standard procedures. Indeed, all variables in the flexible and sticky price models were found to be non-stationary (see Table 1) for the period 1974:I-1987:II. Nelson and Plosser (1982) have argued that many macroeconomic time series must be differenced to induce stationarity. For this reason, we estimated both the sticky and flexible price monetary models in the (log) first difference form so that a correct statistical inference can be made on the basis of standard procedures.

B. Estimates of the Models

We have estimated both flexible and sticky price versions of parallel market exchange rate monetary models. As mentioned above, all variables in these models were found to be non-stationary. As a result we took the first difference of these variables to induce them to stationarity. Thus these models were estimated using OLS after taking the first difference of

Table 1

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Augmented Dickey-Fuller Equation $\Delta X_t = \alpha_0 + \alpha_1 t + \alpha_2 X_{t-1} + \sum_{i=1}^{n} \alpha_{3i} \Delta X_{t-i}$	
x	ADF Statistic ($\alpha_2 = 0$)
s_p	−2.02
m^s	−0.89
y	−2.27
i	−2.31
s_0	−2.69
$\hat{P}_G{}^*$	−2.69
p^*	−0.42
$(\pi - \pi^*)$	−2.17
i^*	−2.57

Note: See data appendix for definitions of these variables. The augmented Dickey-Fuller regression is estimated over the period 1974:I to 1987:I (53 observations). Here Δ is the first difference operator and t is the time trend. Four laged dependent variables are considered for all these equations. "ADF" is the augmented Dickey-Fuller statistic for testing whether a variable has a unit root. The null hypothesis is nonstationarity. The critical value for ADF statistic, in a two-sided test at the 5 percent level, is −3.22 with 50 observations (See Fuller 1976, Table 8.5.2). We can not reject the null hypothesis that these variables are nonstationary.

the variables.[8] These equations were estimated with two lagged values of the dependent variable. This is because, for all the equations estimated, the second lag of the dependent variable was found consistently to be significantly different from zero at the 1 percent level.[9] We also tried

8 One can also fit an error-correction mechanism (ECM) (Davidson et. al. 1978 and Hendry et. al. 1984) to the data which enables us to capture both the short-run and long-run behavior of the parallel market exchange rate. Some recent developments in econometrics (the theory of co-integrated variables, Engle and Granger 1987) have placed error correction upon an interesting foundation. We have a small sample and at the same time our model involves a large number of explanatory variables. Nevertheless, we fitted an ECM model to our data. We obtained statistically insignificant ECM terms. For this reason we do not report these results here.

9 Our models do not offer any theoretical reasoning that would lead to that lag structure. The sole purpose of including the two lagged values of the dependent variable here is to improve the fit of the regression. Note, excluding relevant variables from a model results in incorrect test statistics, and including irrelevant variables will at worst only reduce the power of tests and make rejections even more telling.

these equations with the lagged values of independent variables, but none of the lagged values of the independent variables were found to be statistically significant at any standard level. Results reported in Tables 2 and 3 show no sign of residual serial correlation. This was checked by regressing the residuals from each equation on their own lagged value and independent variables from reported regression and verifying that the coefficient of the lagged residual was insignificant at conventional levels.[10] According to the obtained values of the F statistic, the equations are statistically significant at the .01 level. Finally, note that parameter stability is not rejected in a split sample test for any of the equation. For example, Chow test (analysis-of-variance test) statistic for equation (I) in table 2 is .67. From the F-tables with 11 and 25 d.f. we find that 5% point is 2.2. Thus at the 5% significance level we do not rejected the hypothesis of stability.

Table 2 presents the regression results of the flexible price monetary model. Equation (I) in Table 2 corresponds to equation (18) in the text except that it is now first differenced and includes two lagged values of the dependent variable. Note also that equation (18) in the text imposes a linear equality restriction on the money supply and foreign price coefficients, that is, $\beta_1 = -\beta_6$. The F value of this test is found to be $F(1,39) = .146$. The 1 percent critical value is about 7.33. We cannot reject the null hypothesis at the 1 percent level. Therefore, we reestimated this equation over the sample period taking into account this linear constraint. Estimation results are presented in Table 2 under equation (II). The coefficient for the money supply and foreign price differential variable has the correct sign and it is significant at the 5 percent level. Note there is a little change in the parameter estimates. Standard errors of the estimated parameters are generally lower and as a result we obtain higher t-ratios. This suggests we should estimate the flexible price monetary model by imposing this linearity constraint.

We consider equation (II) in table 2. Coefficients of money supply and foreign price differential variable, interest rate, world gold price, and inflation differential show the correct sign. They (except interest rate) are also found to be statistically significant at the 5 percent level. The income variable is statistically insignificant and has an incorrect sign. This seems puzzling from the standpoint of the theory. We find the two most important determinants of parallel market exchange rates are its own two-period lagged value and official exchange rate. The official exchange rate is

10 This is simply a form of the Durbin tests for a regression containing lagged values of the dependent variable.

Table 2

THE CASE OF KOREA: ESTIMATES OF FLEXIBLE PRICE MONETARY MODEL OF EXCHANGE RATE IN PARALLEL FOREIGN EXCHANGE MARKET, 1974:I-1987:I

Dependent Variable: Δs_p — First difference in the Log of (Won/U.S. dollar) in Parallel Market

Equation	c	$\Delta s_{p,t-1}$	$\Delta s_{p,t-2}$	$+\Delta m^s$	$-\Delta y$	$+\Delta i$	$-\Delta s_0$	$+\Delta \hat{P}^*_G$	$-\Delta p^*$	$+\Delta(\pi-\pi^*)$	$+\Delta(\theta f)$
(I)	-.013 (-.78)	-.02 (-.18)	-.37 (-2.70)[a]	.20 (1.74)[b]	.40 (1.19)	-.0001 (-.02)	1.16 (3.45)[a]	.001 (1.89)[b]	-.37 (-.86)	.004 (1.62)[c]	-.008 (-.20)

R^2 = .54 $\quad \bar{R}^2$ = .42 $\quad F^a(10,39)$ = 4.61 $\quad$ D-W = 2.2 $\quad$ SE - .049 $\quad$ Chow(11,25) = .67

Equation	c	$\Delta s_{p,t-1}$	$\Delta s_{p,t-2}$	$+(\Delta m^s-\Delta p^*)$	$-\Delta y$	$+\Delta i$	$-\Delta s_0$	$+\Delta \hat{P}^*_G$	$+\Delta(\pi-\pi)^*$	$+\Delta(\theta f)$
(II)	-.012 (-.76)	-.03 (-.21)	-.38 (-2.92)[a]	.21 (1.88)[b]	.35 (1.14)	.0003 (.07)	1.08 (4.17)[a]	.001 (1.91)[b]	.004 (1.83)[b]	-.004 (-.11)

R^2 = .54 $\quad \bar{R}^2$ = .44 $\quad F^a(9,40)$ = 5.22 $\quad$ D-W = 2.19 $\quad$ SE = .048 $\quad$ Chow(10,27) = .72

Note: Variables without time subscript denote variables in period t. See data appendix for the definitions of the independent variables. Implies theoretical signs are indicated in front of respective variable. t-ratios are in parentheses. All tests are based on one-tailed test. SE = standard error of the regression.
[a]indicates significant at the 1 percent level
[b]indicates significant at the 5 percent level
[c]indicates significant at the 10 percent level.

found to be highly significant with a positive sign. Note that the dependent variable (Δs_p) is the growth rate of parallel market exchange rate [the first difference in the logarithm of (Won/U.S. dollar) in a parallel market]. Δs_0 is the growth rate of the official exchange rate. Coefficient estimate 1.08 measures the change in Δs_p due to one unit change in Δs_0. This suggests that whenever the official rate is devalued, the gray foreign exchange rate depreciates instantly. The reason is foreign exchange in the gray market is demanded irrespective of the official rate if no time lag is considered.

The other important variable, as expected, is ($\Delta m^s - \Delta p^*$). Coefficient estimate of this variable shows that it exerts a substantial effect on the variation of the Korean parallel market exchange rate. Results presented in Table 2 also indicate that we were correct when we argued that, for countries like Korea, opportunity cost of holding money involving real assets such as gold is important. Though coefficient estimate of $\Delta \hat{P}^*_G$ is small, it is statistically significant at the 5% level.

The risk factor is found not to be significantly different from zero. This suggests that the Korean parallel market for foreign exchange is a gray type. This seems surprising since for most of our sample period Korea was governed by military rulers who severely restricted transactions in the illegal exchange market. Our result implies such a control was not effected after all.

The estimation results of the sticky price model are presented in Table 3. Equations (III) and (IV) in Table 3 correspond to equation (23) in the text. The F value of the linearity test $\beta_1 = -\beta_6$ is $F(1,38) = .193$ and 1 percent critical value is 7.35. Therefore we reestimated the sticky price model by imposing this constraint. Parameter estimates of Table 3 are indistinguishable from the parameter estimates of Table 2. That is parameter estimates are the same irrespective of the inclusion or exclusion of the foreign interest rate variable. Moreover, the foreign interest rate variable, whose presence makes it a sticky price model, is not statistically significant. The coefficient of the risk factor is again statistically insignificant.

IV. Conclusion

We have estimated our above two variants (flexible and sticky price) monetary models of parallel foreign exchange rates consistent with the structure of the Korean economy. We have estimated our two reduced form equations with and without imposing linear equality constraint for

Table 3

THE CASE OF KOREA: ESTIMATES OF STICKY PRICE MONETARY MODEL OF EXCHANGE RATE IN PARALLEL FOREIGN EXCHANGE MARKET, 1974:I-1987:I

Dependent Variable: Δs_p — First difference in the Log of (Won/U.S. dollar) in Parallel Market

Equation	c	$\Delta s_{p,t-1}$	$\Delta s_{p,t-2}$	$+\Delta m^a$	$-\Delta y$	$\pm\Delta i$	$-\Delta s_0$	$+\Delta\hat{P}^*_G$	$-\Delta p^*$	$+\Delta(\pi-\pi^*)$	$\pm\Delta(\theta f)$	$+\Delta i^*$
(III)	-.012	-.02	-.37	.20	.35	.001	1.21	.001	-.40	.003	-.011	-.006
	(-.74)	(-.15)	(-2.65)[a]	(1.68)[b]	(.98)	(.11)	(3.32)[a]	(1.9)[b]	(-.90)	(1.51)[c]	(-.27)	(-.36)

R^2 = .54 $\bar{R}^2$ = .41 $F^a(11,38)$ = 4.11 D-W = 2.18 SE = .049 Chow(12,23) = .71

Equation	c	$\Delta s_{p,t-1}$	$\Delta s_{p,t-2}$	$+(\Delta m^a-\Delta p^*)$	$-\Delta y$	$\pm\Delta i$	$-\Delta s_0$	$+\Delta\hat{P}^*_G$	$+\Delta(\pi-\pi^*)$	$\pm\Delta(\theta f)$	$+\Delta i^*$
(IV)	-.012	-.02	-.38	.21	.31	.001	1.10	.001	.004	-.006	-.005
	(-.71)	(-.18)	(-2.88)[a]	(1.84)[b]	(.90)	(.18)	(4.01)[a]	(1.89)[b]	(1.76)[b]	(-.16)	(-.28)

R^2 = .54 $\bar{R}^2$ = .42 $F^a(10,39)$ = 4.60 D-W = 2.18 SE = .049 Chow(11,25) = .82

Note: [a]indicates significant at the 1 percent level,
[b]indicates significant at the 5 percent level, and
[c]indicates significant at the 10 percent level. t-ratios are in parentheses.
All test results are based on one-tailed test. See notes to Table 2 for other notations.

the money supply and foreign price level since according to the F test the null hypothesis of equality of two coefficients can not be rejected. The overall results are supportive of our flexible price gray market foreign exchange monetary model since the penalty variable is found to be statistically insignificant in all estimations.

This study has important and useful findings that may be considered for policy prescriptions. Depreciation of the official exchange rate instantly depreciates the parallel market rate but in the next period it will narrow the margin between these two rates. If the government's intention is to close or narrow the margin between these two rates there should be a relaxation of restrictions or controls on the transactions in parallel markets because increased premium is directly related to the penalty or risk factor. This seems to be what had happened in South Korea against the prior of strict control. So a decrease in the premium in the parallel market can be achieved through a reduction in domestic money supply and a depreciation of official exchange rate.

Data Appendix

Definitions and Sources

Korea

s_p = log of price of one dollar in won in parallel market — *World Currency Yearbook 1984 and 1986-1987 World Currency Yearbook.*

m^s = log of stock of money (M1) (seasonally adjusted) — *International Financial Statistics (IFS).*

s_0 = log of price of one dollar in won in the official market — *IFS.*

y = log of index of industrial production (1980 = 100, seasonally adjusted), proxy for GNP — *IFS.*

i = Central bank discount rate — *IFS.*

P = Consumer price index (1980 = 100) — *IFS.*

π = Percentage change in P.

Θf = A dummy variable used as a proxy for government restrictions. $\Theta f = 1$ for periods 1974:I-1979:III and 1980:III-1984:IV.

Foreign (Japan) Variables

p^* = log of consumer price index (P^*) (1980 = 100) used as proxy of foreign price level — *IFS.*

i^* = Central bank discount rate — *IFS.*

π^* = Percentage change in P^*.

$\hat{P}_G^{*e}$ = Expected rate of change of foreign gold price is proxied by actual rate of change of gold price based on London gold market (US$/fine ounce) — *IFS Supplement on Price Statistics,* 1986.

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