The Parallel (Black) Exchange Market in China

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1 Introduction

China has become one of the largest exporting countries in the world. Together with its rapid development and the large surpluses accumulated from international trade and investment, this has aroused intensive debates concerning the foreign exchange rate price of its currency, the Renminbi (RMB). Because during certain periods of its history the RMB exchange rate has been restricted to a fixed currency price under a fixed exchange rate regime. Although recently more free-market policies have been applied in the foreign exchange market, even today it is still not a completely free market. Therefore, if the data from the official market, which is the so-called official rate, are used in models designed under free market assumptions, test results might be misleading.

In this situation, an exchange rate data series which mimics free market features is required to patch the deficiencies of the official rate. Hence, the data from the parallel market of foreign exchange, which co-exits with the official market in China, has been considered. In fact there have been two parallel markets operating in China: the swap exchange market and the underground black exchange market. The first of these was also fixed in a range by the authorities and so does not fit the free market requirement. Therefore, the latter which is not manipulated by the authorities directly has been selected to test whether or not it can be taken in place of the official rate over certain periods of time. The results of these investigations can inform a wide range of research questions and policy issues.

For the reasons given above, it is necessary to show a link between the fixed official exchange market and the black exchange market rates, but also to establish that the black

market satisfies the requirements of a free market. Then we may be able to take the black market series as a suitable indicator of the value of the currency.

So first, the possible casual relationship between the official exchange rate and the black market rate must be investigated. If evidence of a causal link is found, the connection between the official price and a free underground market will be confirmed. Secondly, we investigate whether fluctuations in the black market rate are associated with the major social and economic events that have affected China. If the evidence suggests that the series does respond appropriately we may take this as an indication that the black market approximates to a free market. The analysis can be developed further in a quantitative manner by examining the extent to which the black market premium can be explained by various factors including policy interventions (captured through the use of dummy variables).

This paper is organised as follows. In the next section we review the history of the Chinese parallel market, focussing on reasons for parallel market fluctuations. Section 3 reviews the empirical literature, and introduces the model to be used in our study. A more detailed discussion of the methodology and information about the data is given in section 4, and this is followed by the results of the analysis. A brief discussion and conclusion completes the paper.

2 A review of the development of Chinese parallel exchange markets

New China (the Peoples' Republic of China) led by the Communist Party was established in 1949. During the 1950s, as China recovered from World War II, only small scale foreign exchange deals through foreign trade, or private money transfers took place. In that period Yinyuan (Silver coin) still played the role as the hard currency and most of the private foreign exchanges used the silver price rather than the new Chinese Renminbi (RMB) Yuan. Entered 60s, it came the 10-year's Great Proletarian Cultural Revolution, during which any private foreign exchange action was defined as espionage under the misshaped social economy. This situation lasted until the reforms of the 1970s. Similar as in some other developing countries, the move to marketisation gradually formed the foreign exchange market. However, because the official market was still tightly controlled by the authorities, and better prices were offered by unofficial markets, most private foreign exchange transactions took place through these underground channels. These markets, such as the underground black market that co-existed with the official market, were beyond authority surveillance and are often referred to as parallel exchange markets.

There were in fact two parallel markets in operation. The black market, the illegal underground market which still exists today, and the swap exchange market which was established for exchange trading between some enterprises and the appointed banks by the authorities. A review of the history shows, from 1979 to 1994, the swap market appeared twice, first between 1979 and 1985 and then again from 1991 to 1994. The foundation of the swap exchange market was the foreign exchange retention policy, which allowed Chinese exporters to retain a certain quota of foreign exchange. The swap exchange rate was higher than the official one to encourage more exports (foreign currencies were more expensive in

terms of RMB). The swap rate was partly officially determined and partly free, but it only existed in selected areas. For these reasons the swap exchange rate will not be discussed further in this paper and we will focus on the underground black market rate.

Lindauer (1989, pp.1987) defines the black market as "the structure generated in response to government interventions that create a situation of excess supply or demand in a particular product or factor market." Therefore the basic reason for a black market is the imbalance of supply and demand. Because of the tight foreign exchange trading limitations in the early period, the official supply could not satisfy market demand. These imbalances reflect the deviations between the official and black market rates. The marginal revenue from the underground transactions stimulated the growth of the black market.

In China, the black market originally started in some coastal cities especially in the south. Under the "centralised control and unified operations" foreign exchange policy, nearly all the private exchange transactions and some involving enterprises (above an authority regulated quota) were not permitted. But there was an inflow of foreign currencies that people were willing to exchange for RMB and this formed the Chinese black market.

On the supply side, Ding (1998) indicates that one of the major sources of foreign currency is the overseas Chinese. Through both remittance and visits, foreign currencies flow into China and take a major proportion of the supply on the black market. Another large part of the supply comes from the domestic enterprises that used smaller amounts of foreign currencies than the authority's quota. The final supply source is currency brought in by foreigners entering the country. On the demand side, the first element comes from the smuggling from Hong Kong, Macao, Taiwan and some developed countries. Second, domestic residents may for some reasons need foreign currency, for example people going abroad for education or work, or people saving foreign currency in an attempt to maintain the value of their personal assets. Third, enterprises engaging in international trade need currency to facilitate the importation of goods and services from foreign countries.

Based on these various sources of supply and demand, and if the black exchange market can be seen as a free market, the next questions to consider concern the determination of the prices of foreign exchange in this market. Are the fluctuations what one would expect under free market principles or not? When the official exchange rate remains fixed due to controls by the authorities, to what extent does the black exchange rate reflect underlying market movements? To answer these questions, the prices of the official exchange market and the black exchange market need to be analysed.

The series used to measure the official exchange rate is the price of RMB in US dollars (because in both the official market and the black market it is the main transaction currency). The US dollar is the most common and popular currency in the underground market. Plus in the official market RMB price is pegged to the dollar. Over a very long period the dollar is

the key currency for international settlement. Also the U.S. is the most important trading partner for China[1].

Figure 1 shows that the official RMB/USD exchange rate did not change until January 1972. As mentioned before, during this period China experienced a nationwide political movement and nearly the whole social economy was paralysed. After 1996, both the official exchange rate and black rate lines are quite steady, much smoother than the period before. The reason is that China had gradually reduced the foreign exchange restrictions through a series of regulations and rules after 1996. The market has permitted conditional foreign exchange for international payments and transfers for current account transaction from 1996. On 1st January 1996, the implementation of "Regulations of the People's Republic of China on the Management of Foreign Exchanges" eliminated the restriction on non-trade exchanges on the current account. Later on 13th May, the state administration of foreign exchange used the "Residents within the Borders Foreign Exchange for Private Purpose Use Methods" to release the restriction on personal foreign exchange acts. Then on 20th June, the Chinese central bank: the People's Bank of China, enacted the "Provisions for Management of Foreign Exchange Settlements, Sales, and Payments", announcing the lifting of restrictions on small quantities of foreign exchange on the current account. Therefore, from the end of the year 1996, the RMB was fully convertible on the current account, and the demands on the black market were reduced. Consequently the black market shrank to a low level after 1996, reaching a trough in 2002.

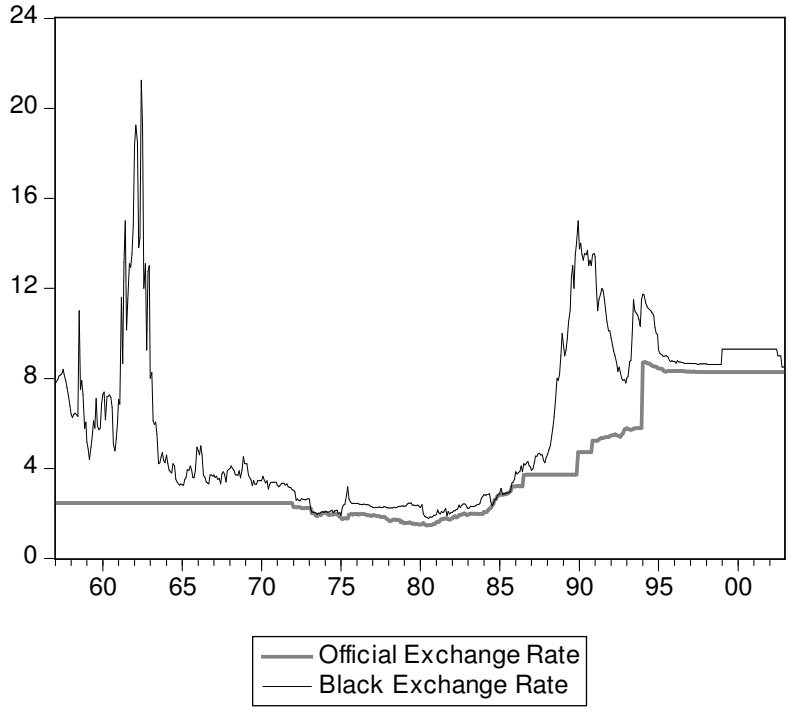

Figure 1 The Official Market rate and the Black market rate USD/CNY (1957M1~ 2002M12)

[1] The United States is the third largest trading partner with China, plus the foreign trade via Hong Kong, which ranks the second, should have the highest proportion in Chinese foreign trade.

The research in this paper is an attempt to quantify the relationship between the official rate and the black rate. Therefore, it does not make sense to use the data before 1972 because no matter how the black exchange rate changed, the official rate was always fixed on 2.4618Yuan per Dollar by the authority, and this lasted for more than 25 years. In the analysis a lagged variable will be used in the model, so the data range must start one year earlier, in January 1971. By 2002 most of the black market foreign exchange had disappeared. Therefore, the comparison covers the period from 1972 to 2002, and analyses the difference between the black market price and the official market price. This is the so-called "black market premium". (Figure 2)

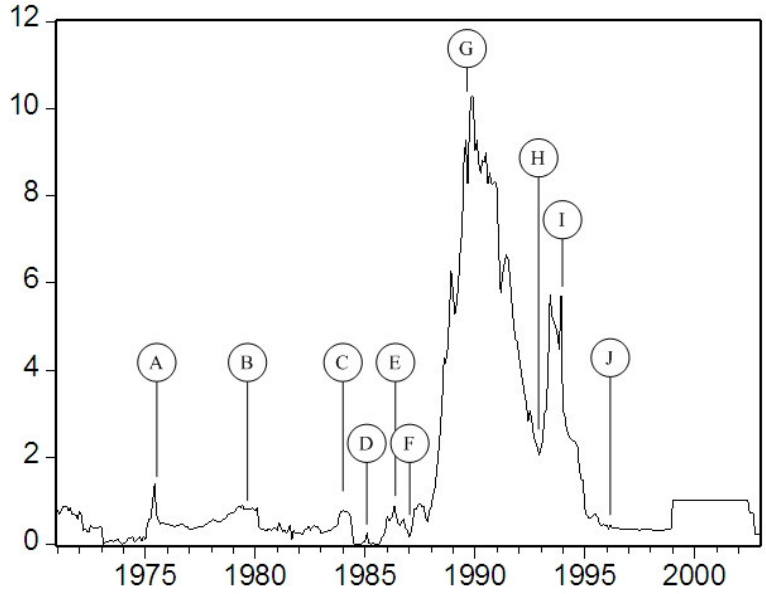

Figure 2 the Black Market Premium in Different Periods

Based on the comments of Yin and Stoever (1994), further more specific explanations are given about each noticeable fluctuation in the black market premium over this period, linked to specific events as listed below:

A. From the fifth month of 1975, the negative influences on the economy by the political movement the "Cultural Revolution" had been reversed by Mr. Deng Xiaoping, who was the actually leader[1] of the Communist Party at that time. The difference between the official price and black market price was reduced.

B. After the end of the "Cultural Revolution", from 1979, the essential focus of the party was in developing the economy. After the stimulation provided by the related policies, the black market had a certain extent of development.

[1] Deng was selected as one of the vice-presidents on 8th Jan, 1975 in the second session of the Tenth Central Committee of the Party. Because of the poor health of the president Mao Zedong and the Premier Zhou Enlai, Deng became the effective leader of the party. After Mao and Zhou both died in 1976, Deng was selected as the president in 1978.

C. In January 1984, the Committee of Economic Trade for Foreign Countries [1] provisioned the restricted importation of 28 categories of merchandise and freed other categories. In March that year, the government decided to open up 11 coastal cities, and a further 15 coastal cities were added in May. In addition the central government adopted a report about the reform of the foreign trade system in September 1984, removing the state power centralisation and nationalised foreign trade company monopolisation, and allowed province-level organisations to undertake foreign trade transactions. The freeing of restrictions on the imports and the opening of the ports helped to increased demand for foreign currency to facilitate foreign trade and pushed up the black market premium value during this period.

D. As mentioned before, from 1985 the unification of the swap exchange rate and the official exchange rate also reduced the black market premium.

E. The foreign currency supplied by the government could not satisfy market demand. The increases requirement by the development of large scale foreign trade pushed the growth of underground market and induced price differences.

F. The first Foreign Exchange Adjustment Centre (FEAC) was established in November 1985 at Shenzhen, a coastal city near Hong Kong. This kind of adjustment centre was used for the enterprises to undertake foreign exchange transactions and the adjustment centre managed the exchange price through the supply and demand pressures. Because in 1986 there was an expansion of such adjustment centres all over the country, which cut the demand source of the black market from the enterprises, hence at the end of 1986 and the beginning of 1987 the black market premium fell. However, large demands from the foreign trade companies above the quota of the adjustment centre occurred because of the adoption of "the Enterprise Operation Responsibility System" from March 1987. This policy, that enterprises were able to keep half of the profit amount but were responsible for losses, stimulated foreign trade. The premium increased sharply again.

G. The Tiananmen Square incident happened in 1989, and the government cracked down on the movement of students. This had a marked effect on the reputation of the government. There was a loss of confidence in the RMB and as a result a big fall in the price of the currency in the black market. The premium reached an historical peak.

H. The central government began the Strike-hard Campaign at the beginning of 1992, focussing on rampant crime. As one form of criminal behaviour, black market activity was restrained during this period.

I. The Chinese authorities reformed the exchange rate system on 1st January 1994. The RMB price was unofficially pegged against the US dollar. Then the official market was under a managed floating exchange rate system based on market demand and

[1] The former Ministry of Foreign Trade and Economic Cooperation

supply. This form of regulation, close to that of a free market, gradually reduced the difference between the official rate and the black market rate.

J. In preparation for joining the World Trade Organisation (WTO), the Chinese government announced the acceptance of the 8th item of IMF coordination on 1st December 1996. This marked the start of free convertibility for current account items. From then on the black market premium kept on a stable value for the dealers' profit in only small scale transactions.

Because of its nature as an underground illegal market, the size of the black foreign exchange market has depended on the degree of control exerted by the authorities, such as in the "Great Cultural Revolution" period and the "Strike-hard" period, when the black market transactions were sharply reduced. On the other hand, when the central bank did not have sufficient supplies of foreign currency to meet the demand, the black market became more developed and highly organized. For example in the 1990s when foreign trade was growing rapidly the shortage of foreign currency led to a boom on the black market. Similarly, when the degree of foreign demand was low on the official market, this only had a marginal effect on the black market. After 1996 the opening of exchange movements on the current account cut the demands of the black market from both enterprises and private individuals.

As we can see from these reflections on the link between the black market premium and the major economic and political events of the period, it can be accepted that the black market did indeed have the features of a free market. To test the hypothesis more formally, that the black market rate can be used as a free market rate to replace the official market price in economic models, further econometric analysis is required.

3 Economic models and empirical research

An early model of the black market model was built by Boulding (1947) and Michaely (1954) looked at the foreign currency demand for purchasing imports or supplying them from illegal sources. In this way, long-run equilibrium occurs in the black market when both legal and illegal imports and exports are balanced. An imbalance of supply and demand may lead to illegal foreign import activities such as smuggling. Also, as it noted by Sheikh (1976), and Pitt (1984), the role of the black market is to balance the demand for smuggled imports and exports. Because the black market appears in some circumstances to be a way of hedging the expansion of illegal markets by the government, it can be ineffective in the face of excess demand or supply in the legal restriction or the official ceilings. Therefore, the black market plays an essential role in the foreign exchange market, and as Agénor (1992) notes, it reacts to macroeconomic policies, or unstable political and social conditions.

3.1 Causality tests

In empirical research, the analysis of black market rates usually starts by testing for a causal link to the official exchange rate. The common methodologies adopted are Granger-causality test and co-integration tests. Akgiray et al. (1989) conduct tests for the US dollar and the West German mark, and the results shows that a causal relationship does exist between the

official rate and the black rate. Many studies of developing countries have also found that causality and a co-integrating relationship exists between the official and black rates. Agénor and Taylor (1993) test a group of 19 developing countries and find a causal relationship exists for 11 countries, finding that on one side, the official rate affects the black market rate and on the other side, the black market rate sometimes can react to changes of the official rate.

Studies of the Chinese market find similar evidence. Lu and Zhang (2000) use the model of Agénor and Taylor and test the relationship between the Chinese swap exchange market rate and the official exchange rate (from October 1988 to December 1992). Using the Granger causality test, augmented by an the Error Correction term, they find that the Chinese swap market rate "Granger Causes" the official rate, but not vice versa.

Two directions of Granger causality are possible in a bivariate model. On the one hand the official exchange rate might Granger-cause the parallel exchange rate. This can happen for example when, observing key macroeconomic variables (especially in short-run), private agents have imperfect information compared with the central authority. But it is also possible for the parallel rate to Granger-cause the official rate. Indeed this situation may be more common. When exchange rate policy is endogenous the official exchange rate is set to react to any inflationary trend. In this situation, the black market exchange rate can help to forecast the official exchange rate. The causality test used in this paper will follow the Agénor and Taylor approach. In our bivariate model, the variables analysed are the Chinese official exchange rate and the underground black market rate. Using the Granger causality model incorporating an ECM term we will identify any causal relationship and its direction.

3.2 ARIMA models and interventional analysis

The black market premium is defined as the amount by which the parallel rate exceeds the official rate (Figure 2). It is one of the most important measures that been discussed in the previous research. Agénor (1992) compares the parallel market premium of some typical developing countries in 1980s and indicates that a negative black market premium was rarely found. Examining the data from these developing countries, a negative premium appears only when there is a revaluation of the official rate, or it is the result of "laundering charging" (Dornbusch et al., 1983) by commercial banks which had been paid from selling foreign currency to parties with no right to buy. Other than for these exceptions the black market premium was always positive. The reason is, as Boulding (1947) pointed out, that the black market yield can only exist when the official rate is below the theoretical free market price. Actually, in China, a negative premium has never happened in the history of foreign exchange.

If the black market premium varied too much, the government would adjust the official rate to fit the market. A high black market level would to some extend weaken the balance of payments and also limit the effectiveness of capital controls (Agénor, 1992). Generally, the authorities use a one shot devaluation of the official rate to unify the official and black market rates. The black rate establishing balance of payments equilibrium in the long-run should be equal to the rate under a floating regime. In the short-run, the rate is largely associated with

the expectations of private agents. For most developing countries research suggests that the unification between the parallel markets (e.g. official and black market, or official and swap market) is achieved by the authorities, where the analysis interestingly shows that the post unification exchange rate is close to the pre-reform black rate. This is what happened in China in 1985, when the authorities used the real time black market rate to unify the official market, replacing the coexistence of a swap and official market.

Yin and Stoever (1994) conducted empirical research on the black market premium in China. They use monthly data on the black market premium from January 1975 to June 1991 in an ARIMA model, adding two independent variables (the real exchange rate, adjusted interest rate differential) based on the approach of Dornbusch *et al.* (1983), thus combining interventional analysis with three impulse dummy variables. This model tests five hypotheses using an ARIMA(1,1,1) model: the linear relationships of black market premium and the real exchange rate (negative), the interest rate differential (positive), the issuance of Foreign Exchange Certificates(FEC) (negative), the large-scale importation of consumer goods (negative), and the large-scale operation of the Foreign Exchange Adjustment Centres (FEACs) (negative). The results confirm the significant relationships with the real exchange rate, and the three dummies: the issuance of FEC, the large-scale importation, and the large-scale FEACs.

In this paper, a similar model will be applied for a longer range of data. After selecting a suitable ARIMA model we add the real exchange rate and an intervention dummy relating to the unification policy of the authorities. The aim is to establish the nature of the relationship between the black market and the official market, to see whether the official price can be replaced by the black market price or not.

4 Methodology and the test results

4.1 Granger Causality tests with an ECM

Data

The data on the RMB/USD official exchange rate is taken from the *International Financial Statistics,* various volumes. The Black market rate data is from the China section in the *World Currency Yearbook* which referenced the investigations of Shanghai peddlers and vendors[1]. Both the official rate data and the black market rate data are monthly as reported at the end day of each period. The data range is from January 1971 to December 2002.

Unit root test (Stationarity test)

For testing a bivariate relationship using the Granger causality test (Granger, 1969), a necessary, but not sufficient condition for this test is that the series involved should be

[1] Most of the empirical research on the Chinese underground market uses the same source, e.g. Ding (1998); Phylaktis & Girardin (2001);Yin and Stoever (1994), etc. Given the reputation of this organization, the data is considered reliable to use.

stationary. Here the Augmented Dickey Fuller (ADF) test is used to examine both series: the official market exchange rate and the black market exchange rate. The ADF is a primary stationarity test for time series data through the hypothesis test for the parameter β in equation 1:

$$\Delta e_t = \alpha + (\beta - 1)e_{t-1} + \sum_{i=1}^{n} \gamma_i \Delta e_{t-i} + \epsilon_t \qquad (1)$$

We wish to test the null hypothesis H_0: β-1=0, that is whether the assumption that the data series is not stationary can be rejected or not. Compared with the Dickey Fuller (DF) test, the ADF test adds lagged differences $\sum_{i=1}^{m} \gamma_i \Delta e_{t-i}$ to ensure serial independence in the disturbances.

	I(0)	*I(1)*
Official Market Exchange Rate	0.055355 (0.9619)	-19.51638 (0.0000)
Black Market Exchange Rate	-1.671168 (0.4452)	-4.357058 (0.0004)

Table 1 ADF test for the official exchange rate and the black exchange rate[1]

In Table 1 results are shown for tests conducted on both the original series and their first differences. For the official exchange rate we can see that the null hypothesis - the series is not stationary- cannot be rejected; we find the same for the black market exchange rate (with probability values of 0.9619 and 0.4452 respectively). The results for the first differenced official exchange rate and the first differenced black rate show that they are both stationary (rejecting the null with p-values of 0.0000 and 0.0004). Therefore, through the test, both series are non-stationary and have one unit root; they are *I(1)*. This means the first differenced series are stationary and can be used in the Granger causality test.

A Granger causality test for the official rate and the black rate (short-run)

The Granger causality test is based on a vector autoregressive system – see equations 2a and 2b. Δe and Δb denote the transformed (first differenced) values of the official and parallel exchange rates, e and b respectively.

$$\Delta e_t = \sum_{k=1}^{m_1} \alpha_{1k} \Delta e_{t-k} + \sum_{k=1}^{m_2} \beta_{1k} \Delta b_{t-k} + \varepsilon_{1t} \qquad (2a)$$

$$\Delta b_t = \sum_{k=1}^{m_1} \alpha_{2k} \Delta e_{t-k} + \sum_{k=1}^{m_2} \beta_{2k} \Delta b_{t-k} + \varepsilon_{2t} \qquad (2b)$$

When all the coefficients β_{1k} and at least one coefficient α_{1k} are significantly different from zero, the lagged values of Δb can help to forecast the values of Δe; this is what it called Δb Granger causing Δe. The test results are shown in Table 2 for a maximum lag of 1, 2, and 3

[1] In this paper, the econometric approach software is EViews6.

months. It can be seen that the differenced black exchange rate can help to predict the value of the differenced official exchange rate exchange, but not *vice versa*.

Null Hypothesis:	*Δe does not Granger cause Δb*	*Δb does not Granger cause Δe*
Lag1	1.47643 (0.2251)	9.4402 (0.0023)
Lag2	1.07552 (0.3422)	6.21651 (0.0022)
Lag3	1.14230 (0.3318)	5.68145 (0.0008)

Table 2 Granger causality test results

However, as Agénor and Taylor (1993) noted, quoting Geweke (1984), any transformation of the original series, such as taking the logarithm or differencing, may affect the causality structure, and so the test result cannot be guaranteed for the long run. Agénor and Taylor (1993) introduced an error correction term in each equation of the vector autoregressive when testing Granger causality. This error correction term helps us to distinguish long-run from short-run Granger causality and plays a speed adjustment role. By including these terms the model has been transformed to a cointegration VAR test function.

The Vector Autoregressive (VAR) model with an Error Correction Mechanism (ECM)

Engle and Granger first suggested the concept of cointegration in 1987. Cointegration can be defined as follows: if two series are I(1), integrated of order 1, but a linear combination of the series is I(0), stationary, then the series can be said to be cointegrated. Engle and Granger also established a link between cointegration and error correction models (the so-called Representation Theorem). If two series are cointegrated then there exists an error correction representation connecting the series.

Johansen (1988) established a more satisfactory approach to the testing of cointegration, based on maximum likelihood estimation in the context of vector autoregressive (VAR) models with error correction terms. In this section the Johansen cointegration Vector Autoregressive (VAR) framework will be used to estimate the cointegration rank between the black market rate and the official market rate. In such a model, a matrix Π can be interpreted as the long run coefficient matrix. A VAR with k lags can be written as shown in equation (3). Where, E_t is an N×1 vector variable process at time t. Π_k is an N×N parameters matrix. μ is an N×1 vector of constants and ω_t is an N×1 vector of white noise terms. In our case N equals to 2 as we are just considering the two series e (the official exchange rate) and b (the black market rate).

$$E_t = \Pi_1 E_{t-1} + \cdots + \Pi_k E_{t-k} + \mu + \omega_t \quad t = 1,2,\dots,T \qquad (3)$$

The Johansen cointegration test examines the eigenvalues of the Π matrix to confirm the cointegration relationships. The cointegration rank number in the system is equal to the number of eigenvalues that matrix Π has. A significant eigenvalue indicates a significant cointegrating vector, i.e. cointegrating relationship. The matrix Π can be zero rank which would mean that there is no cointegrating relationship in the system. Alternatively, Π can be

of full rank, which means the original series are stationary. (Johansen, 1988; Johansen and Juselius, 1990).

There are two test statistics for cointegration under the Johansen approach, which consider the λ_{trace} and λ_{max} statistics. With λ_{trace} we have a joint test for which the null hypothesis is that the number of cointegrating vectors is less than or equal to the rank of the matrix Π. The alternative hypothesis is that there are more than r cointegrating vectors. The other test is based on λ_{max}, the maximum eigenvalue statistic. It starts from testing the null hypothesis that at most r (r begins at 0) cointegration rank exist, and is conducted according to the sequence of a previous test until the null hypothesis cannot be rejected. The hypotheses for λ_{max} are:

$$H_0: r = 0 \text{ versus } H_1: 0 < r \leq g$$

$$H_0: r = 1 \text{ versus } H_1: 1 < r \leq g$$

$$H_0: r = 2 \text{ versus } H_1: 2 < r \leq g$$

$$\dots \qquad \dots \qquad \dots$$

$$H_0: r = g - 1 \text{ versus } H_1: r = g$$

If the first test for the null hypothesis of no cointegrating vectors (corresponding to Π having zero rank) cannot be rejected, it would be concluded that there are no cointegrating vectors and the testing would be completed. Otherwise, if the $H_0: r = 0$ has been rejected, the second null of there being at most one cointegrating vector would be tested and so on. The number of the cointegration rank *r* is continuously increased until the null is no longer rejected.

	Maximum Eigenvalue	Trace
None *	13.60283(0.0188)	13.78531(0.0282)
At most 1	0.182473(0.7233)	0.182473(0.7233)

Table 3 Cointegration VAR test for the black market rate and the official market rate

As the results show in Table 3, the long-run cointegration between the official exchange rate and the black exchange rate can be confirmed. Both Maximum Eigenvalue and Trace statistics reject the null of zero cointegrating vectors. There is one cointegration rank existing in this bivariate system.

Granger-causality Test with Error correction mechanism (ECM) for the Long-run

Once the cointegration vector has been confirmed, the error correction mechanism (ECM) is used to model the long-run equilibrium relationship between the two cointegrating variables. The ECM is necessary to ensure a long-run equilibrium solution linking the variables. The official exchange rate used in this paper has been controlled to take the same value for a number of years. So when this data series is differenced, there is a long sequence of zero values. The ECM, on the other hand, incorporates not only these first difference terms, but also an error correction term which is made up of lagged levels of the cointegrated variables. Thus, it is able to capture both short-run movements and the long-run relationship. The ECM

for the official exchange rate e and the black exchange rate b can be written as shown in equation (4).

$$\Delta e_t = \beta_1 \Delta b_t + \beta_2 (e_{t-1} - \gamma b_{t-1}) + u_t \qquad (4)$$

β_1 describes the short-run relationship between e and b. β_2 describes the speed of adjustment back to equilibrium, or to be more precise, it measures the proportion of last period's equilibrium error that is corrected for. This term, e_{t-1}-γb_{t-1}, is the error correction term. γ is the cointegrating coefficient, which describes the long run relationship between e and b. The next step is to construct the ECM as a normalized equation which, in our case, produces the following estimates: *ECM=1*Official rate –0.939647*Black rate*

We then use single equation least squares to test for long-run Granger-causality.

$$\Delta e_t = k_1 + \gamma_1 ECM_{t-1} + \sum_{k=1}^{n} \alpha_{1k} \Delta e_{t-k} + \sum_{k=1}^{n} \beta_{1k} \Delta b_{t-k} + \varepsilon_{1t} \qquad (5a)$$

$$\Delta b_t = k_2 + \gamma_2 ECM_{t-1} + \sum_{k=1}^{n} \alpha_{2k} \Delta e_{t-k} + \sum_{k=1}^{n} \beta_{2k} \Delta b_{t-k} + \varepsilon_{2t} \qquad (5b)$$

We then test separately to see if the coefficients of the ECM terms in these equations are significantly different from zero, as well as checking whether the lagged values of the first-differences of each variable contributes in any way to improving predictions of the other first-differenced variable. We can see from Table 4 that the black rate Granger-causes the official exchange rate in the long-run, while there is no statistical evidence of Granger causality in the other direction. The official rate and black rate in China are cointegrated and so the black rate Granger-causes the official rate in both the long-run and short run.

Short-run Granger causality from the black to the official rate	Wald test for linear restrictions F-statistic (P-probability)
γ_1=0	7.9644 (0.0050)
β_{11}=β_{12}=β_{13}=β_{14}=β_{15}=β_{16}=β_{17}=0	9.7537 (0.0000)
γ_1= β_{11}=β_{12}=β_{13}=β_{14}=β_{15}=β_{16}=β_{17}=0	10.3851 (0.0000)
Short-run Granger causality from the official to the black rate	
γ_2=0	1.3655 (0.2434)
α_{21}=α_{22}=α_{23}=α_{24}=α_{25}=α_{26}=α_{27}=0	1.3862 (0.2098)
γ_2= α_{21}=α_{22}=α_{23}=α_{24}=α_{25}=α_{26}=α_{27}=0	1.5640 (0.1341)

Table 4 Granger causality model with ECM test results

4.2 ARIMA model and Intervention Analysis for the black rate

In this section of the paper we employ an Autoregressive Integrated Moving Average (ARIMA) model, based on the work of Yin and Stoever (1994) incorporating the

interventional analysis by Box and Tiao (1975), to model the Chinese black market premium. In an ARIMA(*p, d, q*) model, *p* indicates the autoregressive (AR) order, *d* is the differencing order, and *q* is the order of moving average disturbances (MA). The order of differencing *d* is established by the number of times the series must be differenced to obtain a stationary series.

The data used in this part is the same as 4.1. The data range is the same from January 1971 to December 2002 and the frequency is monthly. The USD/RMB black market premium data, as explained before, is the difference between the black market rate and the official market rate.

The ADF test results for stationarity of the black market premium shown in Table 5 indicate that the series has to be differenced once to become stationary. Thus the order number *d* takes the value of 1.

	p(0)	*p(1)*
Black market premium	-1.317164 (0.6227)	-17.90938 (0.0000) **

Table 5 ADF test for the official exchange rate and the black market premium

Then, for deciding the AR order *p* and MA order q, the Akaike Criteria (AIC) and Schwarz Criteria (SC) will be compared between each ARMA model. Comparing the results in Table 6 it can be seen that the lowest values for both AIC and SC occurs for the ARMA(1,1) model. Based on the principle of parsimony, the ARIMA(1,1,1) model is adopted.

	Akaike info	Schwarz criterion
ARMA(1,1)	0.481330*	0.501946*
ARMA(1,2)	0.484785	0.515710
ARMA(1,3)	0.487966	0.529198
ARMA(2,1)	0.487367	0.518352
ARMA(2,2)	0.487367	0.518352
ARMA(2,3)	0.495454	0.547095
ARMA(3,1)	0.492407	0.533801
ARMA(3,2)	0.497506	0.549248

Table 6 AIC & SBC comparison for ARMA model

Following the approach of Dornbush, et al. (1983), the real exchange rate will be added into the ARIMA model to assess its effect on the black market premium. The justification for the inclusion of this variable comes from the theory of Purchasing Power Parity (PPP), which is related to the law of one price (LOOP) for a standard basket of goods. Through the PPP theory, the exchange rate between two currencies should be equal to the ratio of the two relevant national price levels.

The exchange rate between two currencies and their prices level can be written as equation (6). There, p_t is the domestic price level at time t, p^*_t denotes the price level of some foreign countries at time t. s_t is the nominal exchange rate of these two countries' currencies at the same time.

$$p_t = s_t p_t^* \quad t = 1,2,\dots,N \qquad (6)$$

The real exchange rate is the ratio of the real purchasing power between these two countries through the official exchange rate. The real exchange rate q_t function is shown in equation (7).

$$q_t \equiv s_t p_t^* / p_t \qquad (7)$$

We can measure the price levels in the two countries by their respective national consumer price index (CPI) series. Hence, the real exchange rate between China and United States is identically equal to the official exchange rate of RMB/USD s_t (counted by the amount of RMB required to buy one unit of USD) multiplied by the ratio of the Chinese CPI[1] p_t to the U.S. CPI[2] p^*_t. The real exchange rate series is also monthly, running from January 1971 to December 2002.

This model also includes two intervention dummies to represent policy differences over the period. This relates to phases where the authorities effectively unified the official market and black market rates[3]. This occurred twice, phase one running from 1970:1 to 1985:8, and phase two from 1985:9 to 2002:12. Therefore, the dummy variable D1 is set equal to one from January 1970 to August 1985, and zero otherwise. The dummy variable D2 is zero from 1970:1 to 1985:8 and one in the second phase.

Incorporating these dummies and the real exchange rate into the ARIMA(1,1,1) model for the black market premium yields the following estimated equation:

$$\Delta b_t = \underset{(0.0000)}{0.08796 AR_{t-1}} - \underset{(0.0000)}{0.08146 MA_{t-1}} - \underset{(0.0000)}{0.08556 q_t} + \underset{(0.0001)}{0.308 D_1} + \underset{(0.0000)}{0.6552 D_2}$$

The figures in brackets show the probability value of the t-test. The result confirms our a priori assumptions about the affects of changes in the real exchange rate. When the RMB nominal price increases, the black market premium will scale down. We see that government action, as represented by the dummy variables, can also influence the black market premium significantly.

5 Conclusion and discussion

The main aim of this paper has been to test whether or not the black market exchange rate can replace the official market rate in a particular period when the official rate was fixed by the

[1] Chinese CPI source: National Bureau of Statistics, China. Price index set 2000=100.

[2] US CPI source: US Department of Labor, Bureau of Labor Statistics. Price index set 2000=100.

[3] See before the timeline D in 2 the review of the Chinese parallel market.

authorities. Analysing the data we see that these two market rates show similar trends. However the black market rate showed itself to be more sensitive than the official rate in responding to changes in market conditions. In confirming the requirements of this hypothesis, two different methodological approaches have been used; (i) to examine the relationship of the official rate and the black rate, and (ii) to examine movements in the black market premium. The data used in this paper cover 32 years of monthly values of the USD/RMB rate from 1971M1 to 2002M12.

First, the Granger causality test confirmed the short-run causal relationship between these two variables, and the Johansen test showed that the official exchange rate and the black market rate are cointegrated. As Agéno and Taylor (1993) found when cointegration exists in the official-parallel market bivariate model, at least one market rate can help to forecast the other. However, there are two limitations to the standard Granger causality test: the data structure problem and the absence of a test for a long-run relationship. An ECM from the cointegration equation is used to patch into the original Granger model. The evidence for the Chinese market showed that the black market rate is able to be used for forecasting the official rate but not vice versa.

Second, the reaction of the black market rate to major events in China confirmed its free market credentials. An ARIMA model that also included a real exchange rate term and intervention dummies indicated a significant linear relationship between the black market premium and the real exchange rate and the authorities' unification policy. The negative relationship with the real exchange rate confirms the view that a tight economic policy or a higher inflation rate will stimulate the development of the black market and increase the black market premium. The significant positive reaction to the government unification policy supports enables us to acceptation the view that the black market was sensitive to market information and policies.

Application of these two approaches to the black market rate confirmed the linkage between the controlled official market and the free market rate. We are able to conclude that, in the historic period when the official exchange market in China was under tight control, the black market had the essential free-market characteristics and also was causally connected with the official rate. Therefore it can be used in any analysis which requires free market data.

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