Euro Appreciation and Chinese Fear of Floating: *Pressures from the NDF Market*

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Abstract

This paper examines financial market data to assess the likelihood of renminbi appreciation and its implications for Chinese financial markets, given the continuing strength of the Euro against the U.S. dollar. Using VAR and Bayesian VAR estimation, we find that the 3-month non-deliverable forward premia are key series linking the Euro to financial market movements in China. By contrast, the NDF market for the Korean Won, based on a more flexible spot exchange rate and open access to domestic banks, plays little or no role linking the Euro to domestic currency or financial markets.

Key Words: Prediction, Bayesian forecasting, Granger tests of causality, Nested models, VAR, Bayesian VAR

JEL Codes: G14, G15, G18

1 Introduction

This paper takes up one question: what can we learn about prospects for further Renminbi (RMB) appreciation as well as Chinese financial market developments from offshore Non-Deliveral Forward market data, since the RMB band was widened in July 2005? How does the continuing appreciation of the Euro against the US dollar affect these developments? To contrast the effects of Euro appreciation on Chinese RMB pressures, we apply the same model to Korea, whose currency and financial markets are more open and flexible. We find that the Euro has little effect on the NDF market for the Won, but has direct effects on the on-shore Korean currency and financial markets. The NDF market for the RMB plays a key role in transmitting pressures from Euro appreciation to the Chinese spot and financial markets.

Of course, many studies have attempted to measure pressures for appreciation and thus the degree of RMB misalignment, based on purchasing power

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partiy [see, for example, Frankel (2006), and Coudert and Couharde (2005)]. More recently, Cheung,Chinn and Fujii (2008) attempted to measure the misalignment of the RMB using relative price and relative output levels. They found that once sampling uncertainty and serial correlation are taken into account, there is little statistical evidence that the RMB is undervalued, even though many point estimates usually indicate significant misalignment.

However, as noted by Niehans (1981), there is no reason to expect that purchasing power parity to hold exactly as an empirical proposition, even in the long run, much less in the short run, and that the choice of appropriate price indices for empirical measures of misalignment is beside the point.

Given the limited and fragile nature of empirical estimates of misalignment based on purchasing power parity, this study makes use of direct market information to measure pressues on the RMB for appreciation, from the offshore Non-Deliverable Forward market. The NDF market for the RMB is smaller and more restricted than the NDF market for the Korean Won, to be sure, but it is a market with traders taking positions for or against RMB appreciation. There is no reason not to evaluate signals from this source.

The appreciation of the Euro (or decline of the US dollar), of course, reflects differences in the United States and Euro Area macroeconomic fundamentals. While the RMB is linked to the US dollar, the fundamentals of the Chinese economy are very different from the fundamentals of the United States. Thus we may expect that the effects of Euro appreciation will have different consequences in China than in the United States. Given these differences, there are strong pressures for the Chinese to appreciate further their currency. Prior to July 2005, Fred Bergsten, for example, noted that China continued to "strengthen its competitiveness" by "riding the dollar down", which in turn "severely truncated the adjustment process" because "other Asian countries fear losing competitiveness against China and thus block their appreciations against the dollar" [Bergsten (2004), p. 13]. Bergsten argued at the time that further RMB revaluation would "help China cool its overheated economy" and help stop the inflow of speculative capital.

Prior to July 2005, the RMB was pegged to the US dollar at 8.2777. After July 2005, a new exchange rate regime was implemented. In the new system, the RMB was pegged to a basket of currencies of the main trading partners.[1] To be sure, there was some appreciation against the US dollar, but, as Corden (2009) notes, US critics have not considered the RMB appreciation sufficient. The presumption of these criticis, Cordon suggests, is that Chinese exchange rate intervention played an important role in causing the US current account deficit.

Of course, there are other views on this matter coming from the Pacific region. Before the July 2005 regime change, Lau, Mo and Li (2004) of the Hong Kong Monetary Authority argue that a further RMB revaluation would not necessarily dampen speculative capital flows, but rather invite renewed speculative

[1] The curruncies are the US dollar, the Japanese Yen, the Euro, South Korean Won, Australian Dollar, Canadian Dollar, Great Britain Pound, the Malayisan Ringgit, Russian Rubel, Singapore Dollar and Thai Baht. The weights attached to each currency were not revealed.

inflows on the expectation of further strengthening of the currency. They point out that job creation and financial stability are the key priorities and RMB revaluation may in fact do more harm than good. They also note that a reduction in Chinese competitiveness with the United States, through increased RMB revaluation, would actually reduce exports of many Asian countries, since China imports many of its raw materials from these countries as inputs for industrial exports to the United States and other developed countries [Lau, Mo and Li, (2004), p. 4].

More recently, Corden (2009) argued that in addition to an "exchange rate protection" motive for maintaining profitability in the export sector, the Chinese aim is to maintain a stable exchange rate, "avoiding both a floating rate and sharp changes in a fixed-but-adjustable rate", [Corden (2009), p. F435]. The Chinese exchange rate policy is a clear example of fear of floating, first studied by Calvo and Reinhart (2002). This fear takes the form in many emerging markets as a preference for a managed float with much less flexibility rather than a Taylor-rule inflation targeting mechanism.

China's mid course is not unlike that of the Monetary Authority of Singapore, which uses a basket band crawl (BBC) system with a trade-weighted index (TWI) for its exchange rate target [see Khor, Robinson and Lee (2004)]. Much like China, the exchange rate in Singapore is used as an intermediate monetary policy instrument to achieve the primary objective of growth with price stability.

We do not, of course, assess the merits of these arguments for or against further RMB flexiblity. Given these strong differences of opinion, reflecting not only economic logic but also political factors, it is safe to say that further RMB flexibility is considered by financial markets to be a "plausible event", and as Neftçi (2004) points out, there will be positions taken in favor or against its occurrence. These positions, in turn, may create significant exposures, with the result that balance sheets may have new currency and maturity mismatches [Neftçi (2004): p.2]. Furthermore, understanding the way these exposures are put together (the instruments used and the way they are structured) is crucial for correct measurement and monitoring of the risks involved in the event or non-event of RMB revaluation.

The main results, based on in-sample and out-of-sample Granger causality tests, show that the Euro/dollar exchange rate has strong direct effects on the NDF premia, which in turn affect the RMB exchange rate, and interest differentials between the US and China. These interest differentials significantly affect the share markets. These results are robust to the use of Vector Autoregressive (VAR) or Bayesian VAR specification. Furthermore, bootstrapped generalized impulse response paths, based on 95% confidence bands, are consistent with the appreciating Euro leading to discounts in the NDF market.

By contrast, Euro appreciation has little effect on the relatively large highly liquid offshore Korean Won NDF market, where the Korean Won is mainly traded, and where domestic banks are permitted to operate [see Kang (2009)]. Unlike China, the Euro directly and significantly affects on-shore Won spot markets, and the on-shore spot markets significantly affect the offshore Korean

Won NDF market. Thus, the offshore Korean Won NFD markets appear to reflect, rather than transmit, appreciating Euro effects on the on-shore Korean sport markets. The link between the on-shore and off-shore Korean markets is consistent with earlier work by Park (2001), who suggested that there are important information flows between these two markets. [2]

The next section describes the data we use for our estimation, while the third section describes recent developments in Chinese foreign exchange (FX) markets, and Section 4 puts forward the central hypothesis of this paper, with a simple model. Section 5 describes the benchmark linear and Bayesian VAR specifications, while Section 6 examines the results of the estimation of the two models on the basis of in-sample diagnostics, in-sample Granger tests of causality, and the impulse-response paths generated by a change in the Euro/U.S. Dollar exchange rate. Section 7 takes up forecasting performance of the two competing models, as well as Granger out-of-sample tests of causality with the BVAR model.

2 Data

Although the Remimbi/US dollar exchange rate we officially fixed until July 2005, there were small daily movements before that. Afterwards, we see enhanced volatility, as Figure 1 and 2 show. Before July 2005, the maximum weekly rate of change was approximately .06%; after July 2005, the maximum weekly change reached .5%.

Figure 1
Rate of Change of RMB/USD, 2003-2009

[2] Empirical work on RMB NDF markets by Colaveccio and Funke (2008) examined the volatility links between the Chinese NDF markets and other Asian on-shore and off-shore NDF dollar contracts.

Figure 2
Rate of Change of RMB/USD, 2006-2009

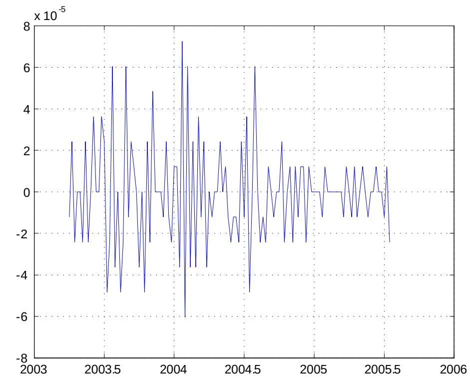
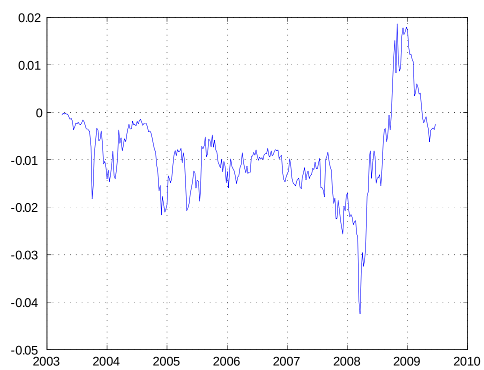


Figure 3 pictures the 3-month Non-deliverable forward primia for the same period, 2003-2009. What is interesting about Figure 3, relative to Figures 1 and 2, is that the non-deliverable forward markets show expectations of a weekly appreciation of the RMBI, with little or no variation from .1%, from the beginning of 2003 through the beginning of 2008. In early 2008, we see expectations of a sharp appreciation, and later in 2008, at the time of the global financial crisis, a sharp depreciation.

Figure 3:
Weekly NDF Premia/Discounts, 2003-2009



The question we ask in this paper: with the wider band for the RMB, do NDF premia provide information for further developments in the RMB and other financial markets in China?

3 Foreign Exchange Market in China

It is often not realized that China had already introduced significant flexibility in foreign exchange operations prior to 2005, when compared with the early days of reform (1979-93). In many ways, RMB convertibility for current account transactions is similar to those that exist in OECD countries. RMB is not convertible for capital account transactions, but a significant amount of flexibility has been introduced here as well.

Early reforms have eliminated the existence of multiple or dual exchange rates, and have unified the settlement and sale of foreign exchange (FX). A unified inter-bank market in FX was established. [3]

The China Foreign Exchange Trade Center (CFETC) in Shanghai is a PBoC directed non-profit entity. It is based upon membership, and it has more than 1000 members as of 2004. These members are made up of Chinese banks, foreign banks and other non-bank financial institutions. The CFETC deals only with cash trades and members cannot take proprietary positions. It plays the role of a unified, nationwide spot FX market in China. PBoC directly runs the operations and controls the RMB exchange rate movements in the Center. (See Zhang(2004)).

NDF operations can be conducted on the RMB, and this is known. [4] Less well known is the existence of forward RMB contracts. The Bank of China has been allowed for the last 8 years to trade RMB forwards. Local Chinese banks were given the right to trade such contracts as well, but after December 2006 this practice was stopped. However, the Bank of China's dominating position in this market persists. [5]

It is relatively easy, given these markets and the related reforms, to take speculative positions of the Chinese RMB. In fact, the high transactions costs, lower transparency and limited liquidity of RMB NDFs make these instruments and the Yuan forwards a less than economical way of taking such positions. Asset swaps, equity swaps and currency swaps may be much more economical in this respect. It is quite likely that such instruments are being used more and more in these speculative positions. However, it is quite difficult to obtain such data on these over-the-counter (OTC) deals. The Yuan NDFs, on the other hand, are quoted in Reuters and weekly data are available. Although these may not be the most cost effective instruments, the NDF quotes are still an excellent

[3] The FX market is administered by the State Administration of Foreign Exchange (SAFE), which is part of the People's Bank of China (PBoC) structure. SAFE has 294 center branch offices and 487 smaller branch offices in China. For details of this and related issues see Zhang(2004).

[4] Chinese NDF market started in Hong Kong during mid 1990's. During most of the 1990's market players felt that there was a risk of a Renmimbi devaluation and they wanted to hedge their operations in China. Expectations of a revaluation appeared after 2002 and the RMB NDF market started to be better known. The RMB NDF's settle according to the 4:00pm value of the State Administration of Exchange Control(SAEC) rate as announced in Reuters page CNY.

[5] The traded forward contract has 14 tenors. There is an initial margin and the positions are marked to market. Yet, the market has been rather thin, mainly due to limits and restrictions on the participation of financial institutions.

proxy for the speculative sentiment that exists in the NDF market. For this reason, we make use of this for investigating the dynamics of the RMB exchange rate and the underlying speculative sentiment.

4 A Model and Hypothesis

For simplicity we formulate the hypothesis in terms of China, USA and Europe. We abstract from most of the reality and consider a simple macro model that describes the macroeconomic conditions for the US economy.

The U. S Federal Reserve (FED) is assumed to target interest rates r_t, so that

$$r_t = r_o$$

We omit the time subscripts and write,

$$r_o = f(\frac{M}{p}),\ \ f' < 0$$

where M is money supply and the p is the price level. The demand side, where y^d is the real demand, is given by

$$y^d = g(r, W)$$

where W is real wealth. The growth of real wealth is assumed to be exogenous.

The interesting part of the argument relates to aggregate supply y^s and to imports im. We assume that Chinese economy can provide unlimited amount of imports at a near constant price to the US economy. The USD-RMB rate denoted by e_t and the Chinese price level p^c are assumed to be nearly constant.[6] Thus we have:

$$y^d = y^s + (p^c/e_t) \cdot im$$

Here im should be considered as a residual and y^s as a constant.

The main point of this model is that the Chinese economy sets the exchange rate e_t within tight bands, so as to provide unlimited imports to the US economy at a near constant price, p^c/e_t. As the FED maintains an environment of low interest rates, the real demand in US is met by higher or lower imports from China, as United States wealth changes.

The implications of such a (temporary) equilibrium are,

1. continuing, and growing United States current account deficits tied to changes in W,

2. the appearance that such deficits are more sustainable than previously imagined–this is know as Bretton Woods II;

[6] This ignores the recent worries about an increased Chinese inflation. However, we think that this is of secondary importance within the present context.

3. absence of any significant United States inflationary pressure, since we need to have

$$p = \frac{p^c}{e_t}$$

The continuing sustainability of the U.S. current account deficit with respect to China has also been argued by Dooley, Folkerts-Landau, and Garber (2004). In fact, they call this deficit not only sustainable but an *integral feature* of a sustainable international monetary system. Through the deficit, the United States supplies international collateral to China, which in turn supports two-way trade in financial assets, which liberates capital formation in China from inefficient domestic markets.

A major feature of this paradigm is its effect on Europe. We do not model this component, but under the paradigm described here the US Dollar will continue to depreciate against the Euro due to larger and larger current account deficits. This will force the RMB to depreciate against Euro by the same amount and will make Chinese exports more and more competitive against European export sectors.

We claim that as the US Dollar depreciates against the Euro, Chinese goods would become *increasingly* more competitive in Europe. As the European economy suffers there will be increasingly further pressures on the RMB for further appreciation, which, we assume, is captured by the NDF discounts.

According to this hypothesis, the time series data should show the Euro/U.S. Dollar as the main determinant of the NDF discount observed in the RMB NDF market. Pressures from this market are reflected in the movements in the RMB and in other on-shore Chinese financial markets as these markets liberalize.

5 VAR and Bayesian VAR Methodology

We use two models: the benchmark linear vector autoregressive (VAR) model, and the alternative Bayesian vector autoregressive model (BVAR).

For the VAR, we use the familiar specification

$$\begin{aligned} Y_t &= X_t\beta + \epsilon_t \\ \epsilon_t &\sim N(0, \Sigma) \\ \Sigma &= diag(\sigma_1^2, \sigma_2^2, ...\sigma_G^2) \end{aligned} \tag{1}$$

where the matrix X includes lagged values of the matrix Y_t ,which is dimension 1 by G, while X is dimension 1 by K and β is dimension K by G, ϵ is 1 by G, while the time-invariant variance-covariance matrix Σ is a diagonal matrix.

As noted years ago by Litterman (1986), estimation of such VAR models suffer from overparameterization, leading to multicollinearity problems as well as reduced out-of-sample performance. If we are interested in Granger tests of causality based on F statistics, we need a large number of lags to remove serial dependence.

The Bayesian approach is to specify "fuzzy" restrictions on the coefficients of the VAR model, rather than zero exclusion restrictions, or assumptions about the shape of the lag coefficients, as in geometrically declining weights. This is an alternative to the "all or nothing" approach of dropping lags completely, in order to save on degrees of freedom. The idea is that coefficients on longer lags are more likely to be closer to zero than coefficients on short lags. However, in Bayesian estimation, the data are permitted to override this prior if the empirical evidence to the contrary about a coefficient is strong. The idea is to impose on the longer lags prior normal distributions with means of zero and progressively smaller standard deviations. We use the mixed estimation technique of Theil (1963) for obtaining $\widehat{\beta}$ in equation g :

$$\begin{aligned}
Y_{g,t} &= X_t \beta^g + \epsilon_{g,t} & (2)\\
R\beta^g &= r + \upsilon & (3)\\
\epsilon_{g,t} &\sim N(0, \sigma_g^2) & (4)\\
\upsilon &\sim N(0, \lambda^2 I) & (5)\\
\widehat{\beta}^g &= inv(X'X + kR'R) \cdot (X'Y_g + kR'r) & (6)\\
k &= \lambda^2 / \sigma_g^2 & (7)
\end{aligned}$$

The estimation involves the choice of hyperparameters governing the estimation of $\widehat{\beta}^g$. The vector r, for the priors of the coefficients for each of the g dependent variables, is assumed to be a vector set at γ for the first lag and zero for all of the others, for the lags of Y_g

$$r = \begin{bmatrix} \gamma \\ 0 \\ . \\ . \\ 0 \end{bmatrix} \tag{8}$$

For the lags of the other dependent variable, we set the mean at zero. We call this specification a Monte Carlo Markov Chain (MCMC) prior, since only the first lag of the dependent variable enters with a unitary coefficient while all other lags are zero.

Similarly, the matrix R is normalized so that λ is the standard deviation of the coefficient of the first lag of the dependent variable. Given this specification, the standard deviations (around a zero mean) in the lag distributions decrease in a harmonic manner. Thus the coefficients on lags $\ell = 2, ...\ell^*$ are given prior normal distributions with standard deviations $\lambda/\ell^{-\delta}$, where δ represents a decay hyperparameter. Furthermore, the standard deviations on the lags of variables other than the dependent variable are tightened around zero, at all lags, by a factor θ, called the "shrinkage parameter".

The matrix R has the following specification:

$$
\begin{aligned}
R &= \frac{\lambda}{\delta_{ij}^{\ell}} && (9)\\
\delta_{ij}^{\ell} &= \frac{\lambda}{\ell^{-\delta}}, \text{for } i=j && (10)\\
&= \frac{\theta\lambda\widehat{\sigma}_i}{\ell^{-\delta}\cdot\widehat{\sigma}_j}, \text{for } i\neq j && (11)
\end{aligned}
$$

Following Litterman (1986), the parameters $\widehat{\sigma}_i$ and $\widehat{\sigma}_j$ are obtained for dependent variables Y_i and Y_j by univariate regressions of each variable on a liberal number of lags and a constant term.[7]

Hamilton (1994) points out that for many series, such as first-differences, the natural prior might be a white noise, with $\gamma = 0$, rather than a unit root autoregression, with $\gamma = 1$, as Litterman suggests. Hamilton also points out that there is need for seasonal adjustment in order to use these priors[Hamilton (1994): p. 362]. In our transformation of the daily data, to remove "calendar effects", we take weekly differences, so that we regress $\ln(Y_{t+5}) - \ln(Y_t)$ on the variable $\ln(Y_t) - \ln(Y_{t-5})$ and further lags. However, instead of setting the prior at simply a white noise process or a unit root, we set the prior for the first lag to be .2, thus allowing some predictability in the first differences, but not a unit root process.

We note, as Hansen (2000) reminds us, that when our forecasting horizon is greater than the sampling interval, so we are building in a moving average process in the error term. Rather than correct the VAR with MA processes, however, we use longer lags to correct for the moving average effects.

6 In-Sample Results

The in-sample regression diagnostics for the VAR and BVAR models appear in Table 1. We estimate the model initially for the data set starting in July 2005, when China introduced greater flexibility in the RMI.

We use the following diagnostics: the multiple correlation coefficient $[R^2]$, the marginal significance of the Ljung-Box (1978) $[LB]$ Q-statistic for serial dependence in the residuals, as well as that marginal significance of the MacLeod-Li (1983) $[ML]$ Q-statistic for serial dependence in the squared residuals, the marginal significance of the Jarque-Bera (1980) $[JB]$ test of normality of residuals and the marginal significance of the Brock-Deckert-Scheinkman (1987) $[BDS]$ test of nonlinear serial dependence in the residuals Finally, the Lee-White-Granger (1992) $[LWG]$ test gives the number of significant regressions of the residuals for 1000 randomly generated nonlinear combinations of regressors.[8] We present these statistics for the four dependent variables, the weekly

[7] Litterman also notes that a gain in efficiency can be obtained by estimating all equations together, in a Regression of Semmingly Unrelated Equations (RESURE) method. He does not recommend this, because of the increased computational burden.

[8] All of these statistical tests are clearly summarized in Franses and van Dijk (2000).

logarithmic change in the RMB, Δrmb, the weekly change in the non-deliverable forward premia, Δndf,the weekly change in the interest-rate differentials, Δi^d, and the weekly change in the logarithm of the Series A share price index, Δspi. In both systems, these variables are functions of their own lags as well as the lags of the weekly change in the Euro exchange rate, $\Delta euro$.

We selected a liberal lag length of twelve weeks for all of the variables in order to ensure serial independence in the regression residuals. The interest differential variable was also used in levels at a one-week forecasting horizon, but the results appeared to be quite robust to the use of levels or first differences.

Table 1

In-Sample Regression Diagnostics: July 2005-Aug. 2009

	Method:							
	VAR				BVAR			
	Dependent Variables							
	Δrmb	Δndf	Δi^d	Δspi	Δrmb	Δndf	Δi^d	Δspi
R^2	0.470	0.959	0.995	0.417	0.480	0.959	0.995	0.417
LB	0.968	0.995	0.864	0.914	0.950	0.998	0.948	0.919
ML	0.436	0.002	0.000	0.112	0.351	0.001	0.000	0.134
$JB]$	0.714	0.000	0.000	0.020	0.788	0.000	0.000	0.017
BDS	0.039	0.289	0.062	0.003	0.053	0.251	0.040	0.005
LWG	0	0	0	0	0	0	0	0

Table 1 tells us that the overall in sample explanatory power, given by the R^2 statistics, is pretty much the same for the VAR and BVAR methods. The liberal lag length has allowed us to accept the null hypothesis of serial independence for both methods, as shown by the LB statistics. However, the VAR still shows traces of serial dependence in the squared residuals for the RMB, while the BVAR does not, as shown by the ML statistics, while both do not allow us to reject normality in the regression, as indicated by the JB tests. Finally the BDS tests show traces of nonlinear forms of serial dependence for both the VAR and BVAR for the regressions for the Δndf and Δi^d variables, while the LWG tests show little evidence of neglected nonlinearities in all of the equations.

Since the underlying data come from markets undergoing structural change, it is not surprising that the in-sample diagnostics fail to pass some of the specification tests, such as the BDS test, which can be viewed alternatively as a test for model misspecification or a test for nonlinearity [Belaire-Franch and Contreras-Bayarri (2001): p.1] . The overall explanatory power of both models is about the same, but the diagnostics give the edge to the BVAR approach on the basis of the McLeod-Li tests.

Table 2 pictures the in-sample Granger tests of causality. We see that the change in the $\Delta euro$ is a Granger cause of the Δndf in both methods. In turn,the Δndf is a significant determinant of Δrmb and the Δi^d. The interest rate differential also responds to Δrmb, and Granger causes Δspi. The Granger method suggests that the Euro puts pressure on the RMB through the NDF market, while the RMB affects the interest differential, which in turn significantly affects the share market.

Table 2

Granger Tests of Causality

P-Value of F-Statistics

	Method:							
	VAR				BVAR			
	Dependent Variables							
	Δrmb	Δndf	Δi^d	Δspi	Δrmb	Δndf	Δi^d	Δspi
Argument:								
Δrmb	0.571	0.353	0.002	0.400	0.167	0.356	0.000	0.075
Δndf	0.042	0.000	0.026	0.461	0.010	0.000	0.000	0.131
Δi^d	0.001	0.209	0.000	0.003	0.001	0.212	0.000	0.003
Δspi	0.144	0.870	0.161	0.262	0.147	0.872	0.163	0.264
$\Delta euro$	0.226	0.033	0.419	0.099	0.230	0.034	0.421	0.100

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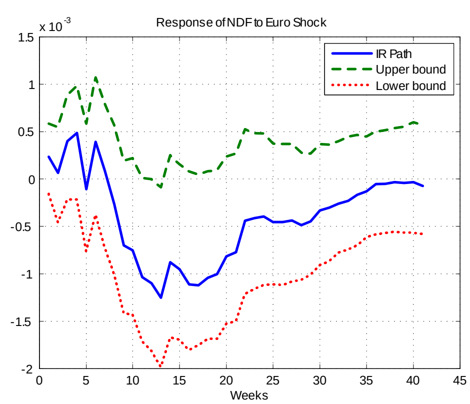
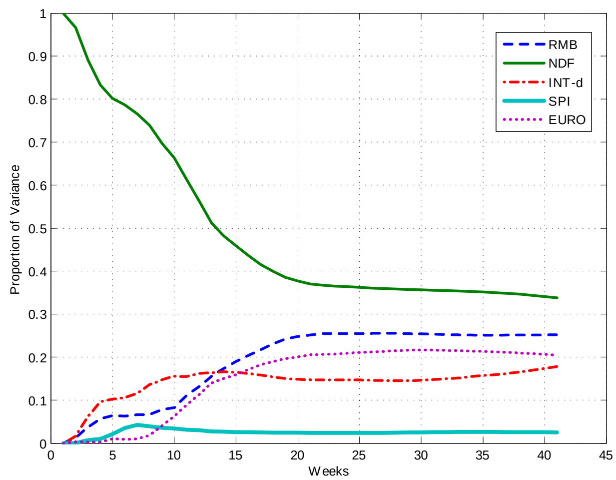
Of course the Granger tests of causality give no hint about the effects being positive or negative. We picture in Figure 4 the generalized impulse response paths as well as the upper and lower bounds from bootstrapped simulations, for a one standard deviation shock to the Euro, on the NDF. The generalized impulse response analysis, developed by Pesaran and Shin (1998), does not require orthogonalization of shocks and is invariant to the ordering of the variables in the VAR. We see that the response is signficantly negative after 8 weeks.

Figure 4:
Generalized Impulse Response Paths
95% Boostraped Confidence Intervals



To understand the relative importance of the Euro for the total variance of the NDF market, we picutre in Figure 5 the variance decomposition of the NDF weekly rate of change at horizons from 0 to 40 weeks. This table shows that after 10 weeks, movements in the Euro are almost equal in importance as movements in the underlying on-shore RMB for overall NDF volatility. Talbe 3 shows, of coure, that idiosyncratic shocks in the NDF market have center stage in this market, but after this variable, the on-short RMB and the offshore Euro movements are the key sources of volatlity.

Figure 5:
Variance Decomposition of NDF Movments



7 Out-of-Sample Performance

7.1 Competing Models

We first take up the out-of-sample performance of the two competing methods, the VAR and BVAR approaches. Then we evaluate the performance of the better BVAR model for the out-of-sample Granger test of causality. Table 3 shows the out-of-sample statistics, the root mean squared error measure ($RMSQ$), the success ratio of correct sign predictions (SR), as well as the P-values of the Diebold-Mariano test (DM), the Giamomini-White test (GM), and Clark-West test (CW) for out-of-sample predictive ability of two competing models.

We follow the real time forecasting approach of Stock and Watson (1999) for evaluating out-of-sample performance: we split the sample in half, forecast the dependent variables for one period, and obtain the first forecast error of our sample. Then we incorporate this period into our sample, re-estimate the model, and forecast for the next period. We continue this period of one-period sequential forecasting until we exhaust our sample.

Table 3 shows that the $RMSQ$ and SR statistics slightly favor the BVAR model. However, these statistics did not tell us if one model significantly outperforms another model in terms of out-of-sample forecasting performance.

The Diebold-Mariano (1995) was the first test for model comparison for out-of-sample forecasting performance. This test takes the out-of-sample forecasting errors of two models, applies a loss function to these errors, such as the absolute value of the errors, and compares the differences in the loss functions of these errors. After correcting for serial dependence in the differences in the loss functions, the test is a standard-normal distribution. Table 3 tells us that the BVAR is a significant improvement over the VAR model for all of the dependent variables.

The Giacomini-White (2004) test is an adaptation of the Diebold-Mariano test, in that it is a test of conditional predictive accuracy. What model does better, conditional on the previous period losses? This test reduces to the Diebold-Mariano test if we are only interested in unconditional predictive accuracy. We see that the conditional GW test shows that the BVAR is significantly better for all of the variables. Finally the Clark-West (2004) takes up out-of-sample performance of two competing nested model. This test is appropriate to the extent that the VAR and BVAR models are nested, since the BVAR reduces to a VAR model in the absence of the Bayesian priors. Table 3 shows that the BVAR model outperforms the VAR models at the 5 percent level for all of the variables in the Clark-West approach.

The statistics and tests in Table 4 favor strongly the BVAR approach over the VAR approach in terms of out-of-sample performance. We will use the BVAR approach for assessing out-of-sample tests of causality.

Table 3

Out-of-Sample Forecasting Performance

VAR vs. BVAR Models

	Method:							
	VAR				BVAR			
	Dependent Variables							
	Δrmb	Δndf	Δi^d	Δspi	Δrmb	Δndf	Δi^d	Δspi
Test:								
$RMSQ$	0.003	0.005	0.001	0.026	0.003	0.004	0.001	0.021
SR	0.545	0.960	0.931	0.416	0.624	0.970	0.941	0.505
DM	—	—	—		0.000	0.002	0.000	0.000
GW	—	—	—		0.000	0.012	0.020	0.000
CW	—	—	—		0.000	0.000	0.000	0.000

7.2 Out-of-Sample Granger Tests of Causality

Chao, Corradi, and Swanson (2001) note that in-sample tests of Granger causality, usually done with F-tests, are the common practice. However, they develop an out-of-sample approach based on the one-period predictive ability of competing models, one a restricted model and the other an unrestricted model. In this case, the two competing models are nested models.

We are interested in the causal influence of the $\Delta euro$ on the endogenous variables. We see in Table 4 that the out-of-sample tests show even stronger effects: at the five percent level of significance the $\Delta euro$ is a Granger cause of all of the variables. Table 4 also shows that Δndf is a Granger cause of Δrmb,Δi^d, and Δspi, unlike the in-sample boostrap results.

Thus, the basic message of the out-of-sample tests of Granger causality are broadly the same as the in-sample Granger tests of causality, suggesting that changes in the euro affect Chinese markets..

Table 4

Out-of-Sample Granger Causality Tests

BVAR Models

Test:	$H_0 : \Delta euro$ does not predict...			
	Δrmb	Δndf	Δi^d	Δspi
CW	0.003	0.000	0.005	0.000
Test:	$H_0 : \Delta ndf$ does not predict...			
	Δrmb	—	Δi^d	Δspi
CW	0.000		0.000	0.000

8 Contrast with Korea

To sharpen our understanding of the adjustment of the Chinese RMB and Chinese domestic markets to appreciation of the Euro, we apply the same model to Korean data for the same period. The Korean market, relative to China, is far more open and flexible, Our hypothesis is that NDF markets are less relevant for transmitting the effects of Euro appreciation.

Table 5 gives the VAR regression diagnostics of the VAR and VAR models. We see that all of the equations are free of serial correlation. In contrast with the RMB, the equation for the weekly rate of change in the Korean WON, given by Δkrw, does not exhibit any trace of serial correlation in squared residuals, nor traces of non-normality nor neglected nonlinearity. All of the residuals are free of serial dependence.

Table 5

In-Sample Regression Diagnostics: Korea, July 2005-Aug. 2009

	Method:							
	VAR				BVAR			
	Dependent Variables							
	Δkrw	Δndf	Δi^d	Δspi	Δkrw	Δndf	Δi^d	Δspi
R^2	0.698	0.579	0.995	0.564	0.697	0.577	0.995	0.561
LB	0.106	0.830	0.851	0.274	0.256	0.866	0.891	0.258
ML	0.552	0.000	0.006	0.026	0.288	0.000	0.004	0.012
$JB]$	0.655	0.000	0.158	0.741	0.629	0.000	0.077	0.604
BDS	0.488	0.007	0.008	0.074	0.582	0.003	0.001	0.014
LWG	0	0	0	0	0	0	0	0

Table 6 shows the in-sample Granger tests of causality. In contrast to China, we see that the appreciating Euro has no significant effect on the NDF markets.

We also see that the appreciating Euro has direct effects on the Won as well as on interest-rate differentials and the domestic share market. The offshore NDF markets for the Won appear to have a very small role for transmitting pressures from the appreciating Euro on Korean financial markets, although these markets do have direct effects on the on-shore markets.

Table 6

Granger Tests of Causality for Korea
P-Value of F-Statistics

	Method:							
	VAR				BVAR			
	Dependent Variables							
	Δkrw	Δndf	Δi^d	Δspi	Δkrw	Δndf	Δi^d	Δspi
Argument:								
Δkrw	0.000	0.029	0.520	0.274	0.000	0.029	0.000	0.002
Δndf	0.001	0.016	0.010	0.066	0.000	0.017	0.000	0.000
$\Delta idiff$	0.000	0.296	0.000	0.002	0.000	0.320	0.000	0.003
Δspi	0.014	0.002	0.597	0.194	0.020	0.002	0.612	0.228
$\Delta euro$	0.036	0.192	0.018	0.020	0.036	0.196	0.018	0.022

Figure 6 gives the generalized impulse response path of the Korean Won NDF to a one standard-deviation shock in the Euro. As in Figure 3, we also present upper and lower 95% confidence bounds based on bootstrap simulations. Unlike the case of the NDF market for the Chinese RMB, there is no clear cut positive or negative response of this NDF market following a Euro shock.

Figure 6: Korean Won
Generalized Impulse Response Paths
95% Boostraped Confidence Intervals

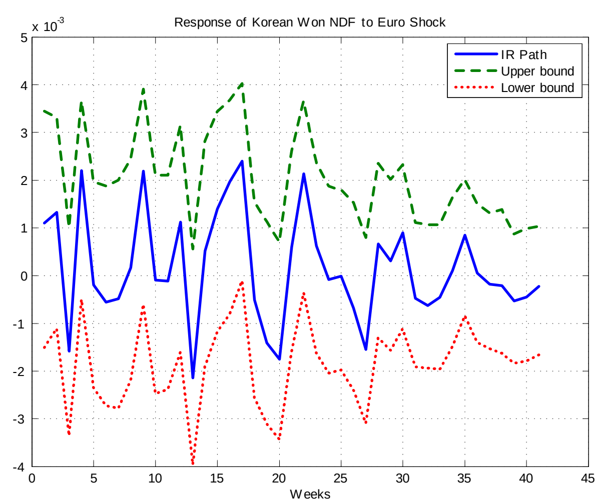


Table 7 pictures the out-of-sample tests. These results are consistent with the results of Table 6. The Euro does not have a significant effect on the off-shore NDF markets for the Won, but directly affects the currency and financial markets. The NDF, though not response to Euro pressures, also have direct effects on the currency and financial markets.

Table 7

Out-of-Sample Granger Causality Tests for Korea

BVAR Models

Test:	$H_0 : \Delta euro$ does not predict...			
	Δkrw	Δndf	Δi^d	Δspi
CW	0.008	0.060	0.006	0.009
Test:	$H_0 : \Delta ndf$ does not predict...			
	Δkrw	Δndf	Δi^d	Δspi
CW	0.003	—	0.004	0.001

9 Conclusion

We have run the Bayesian autoregressive system under several alternative specifications as well as those discussed above. The results are very robust and very clear. In fact, even the simplest, non-bayesian Vector Autoregression gives a very clear and highly significant evidence for the hypothesis formulated in this paper.

We summarize our results:

1. The Renmimbi NDF is driven by its own dynamics and by the Euro-Dollar exchange rate. Neither interest rate differentials nor the spot exchange rate RMB-US Dollar movements influence the offshore Renmimbi NDFs. This is in stark contrast to Korea, where on-shore financial market developments affect the Won NDF market.

2. The effect of Euro-US Dollar exchange rate is very clear. As Euro appreciates, the Renmimbi discount in the NDF market becomes more negative. This result is significant even at 5% level within one quarter.

3. As we argued in this paper, the US Dollar-RMB has some predictability, through information from the NDF markets.

The results become richer when we consider the smoothing effect of the Bayesian priors. In this paper we outlined a hypothesis that maintained that the Chinese Renmimbi NDF movements were driven by speculative psychology generated by the Euro-dollar exchange rate. According to this hypothesis, as Euro appreciates, market players bet on further RMB appreciation and the NDF discount deepens. The evidence for the hypothesis outlined in this paper is overwhelming, in spite of the short sample of weekly data that are available since July 2005.

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Appendix

Appendix Table A-1 gives the indices from Bloomberg for the data used in this paper.

Table A-1:
Data Sources with Bloomberg Index

Variable	*Frequency*	*Code*
US T bill	3 month	USGG3M Index
Euro/Dollar Spot		
China Interest	3 month	CNDR3M Index
China Spot Rate		USDCNY Curncy
China Equity Index		SHCOMP Index
China NDF	3 month	CCN3M BGN Curncy
Korea Interest	3 month	CTKRW3M Govt
Korea Spot Rate		USDKRW Curncy
Korea Equity Index		KOSPI Index
Korea NDF	3 month	KWN3M BGN Curncy