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## A “TIME SERIES” APPROACH ON THE CHINESE EXCHANGE RATE REGIME

### *Abstract*

*This paper deals with the issue of the exchange rate regime that China has established since 2005, when it announced a move away from the US dollar peg. In fact, from that date, the RMB was managed with reference to a basket of currencies rather than being pegged to the dollar; the exchange rate, therefore, became more flexible.*

*But, though in the presence of basket peg, early econometric analysis (Shan-2005, Frankel & Wei-2006, Ogawa-2006, Yamazaky-2006) found that the assigned basket gave overwhelming weight to the dollar, and that the degree of flexibility had hardly increased at all.*

*Almost all those studies used a technique introduced by Frankel in 1994 to estimate the weights in a currency basket: on one side regressed changes in the value of the local currency, in this case the RMB, while on the other one changes in the values of the dollar, the euro, the yen and other currencies that may be in the basket.*

*Though there are numerous econometric techniques for estimating the exchange rate system, the technique proposed by Frankel is still the most widely used. However, in our opinion, this model has an error of autocorrelation among the variables, a factor that could lead the analysis to different results.*

*Therefore, this work proposes a study on the Chinese exchange rate regime through an alternative econometric technique.*

**JEL Classification:** C22, E42, E44;

**Keywords:** Exchange Rate, China, Econometric ARMA model.

## 1 INTRODUCTION

The dollar for more than sixty years has taken on the role of being an international reference, not to mention the value for many countries which have anchored their foreign exchange rate to the dollar.

Nevertheless, the presence of many inequalities in the present time at a global level, the return to an expansive monetary policy by the Federal Reserve that from the end of the 1990's has sought to ensure a trend of growth, characterized by an internal support of the question and

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even finally this expansion as an answer to the financial crisis, together have all been factors that have destabilized the role of the dollar as a value of international reference.

In fact, according to declarations of the International Monetary Fund, at least forty countries of the fifty five belonging to the organization have diversified their reserves to the advantage of a more stable currency, that being the Euro.

In the past few years, at the end of checking these actual exchange regimes, many studies have been conducted using different techniques of estimation, notably, those that concern countries that use the anchor for currency regime peg (the Central European Bank, for example, uses models based on brownian motion geometry). Among these studies Frankel and Wei (1994) proposed an original technical regressive.

Taking a logarithmic equation of the type:

$$\ln \text{homecurrency}_{t+1} - \ln \text{homecurrency}_t = a + \sum w(j) \ln x(j,t,s) - \ln x(j,t) \quad (1)$$

If the national value (home) dependent variable of the model is linked to a series of values  $x_1, x_2, \dots, x_n$  for the corresponding weight  $w_1, w_2, \dots, w_n$  it would be possible to estimate through a general OLS, the weight of each value of the considered basket peg.

Nevertheless, the impossibility of defining the effective value of each currency, especially in the absence of a rigid basket peg induces the model of consideration of a chart of numbers in presence of which it will present itself regressively:

$$\Delta \ln y_{\text{home}/k} = \alpha + \beta_1 \Delta \ln e_{\text{USD}/k} + \beta_2 \Delta \ln e_{\text{JPY}/k} + \beta_3 \Delta \ln e_{\text{Euro}/k} + \mu_t \quad (2)$$

Returning to the method of ordinary minimal quadratic equations, it is possible to estimate the weight of each single value (measured by coefficients) that multiply the logarithmic variations of the corresponding exchange rates using a numeraire  $k$  respecting two simple criteria of analysis: error standard next to zero and R squared near to one.

The simple application of such an econometric model means that it was used for numerous studies by various authors<sup>ii</sup>. Nevertheless, in the presence of data distributed in historic series, the return to simple logarithmic differences between the variables-whether they are dependent or independent, would seem in our view a rather basic method of estimation. Nothing excludes the self correlation of such a regression to skew the results towards inaccuracy.

On that account, in face of a possible depreciation of the dollar: the consequences of the actual lack of equilibrium and American financial affairs, would impel the principal holder of reserves based in dollars, that is China, to review their exclusive link to the American currency and in the following basket peg we will attempt to prove through an econometric model based on that of Frankel and Wei (1996) modified according to the ARMA approach- the actual weight of three currencies in the Chinese basket peg.

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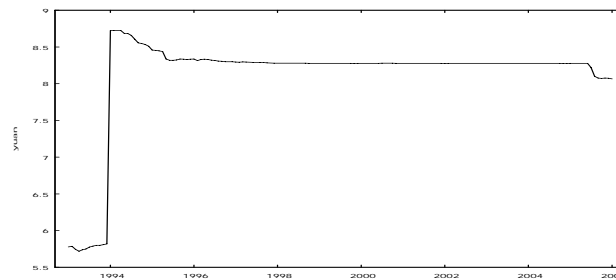
<sup>ii</sup> Ogawa (2006), Eichengreen (2006), Yamazaky (2006) e Yoshimi (2008).

## 2 THE APPLICATION OF ECONOMETRIC MODELS FOR THE STUDY OF THE CHINESE EXCHANGE RATE REGIME.

The renminbi (RMB) legal tender for the People's Republic of China has been tightly linked to the American dollar with a reference value to the fixed exchange rate of 8.28 renminbi to the dollar. (fig.1)

**Fig 1.**

**Progress of the Chinese renminbi relative to the American dollar 1993-2006**



Source: our econometric processing with Gretl. Ver. 1.8.4 software on RBA data

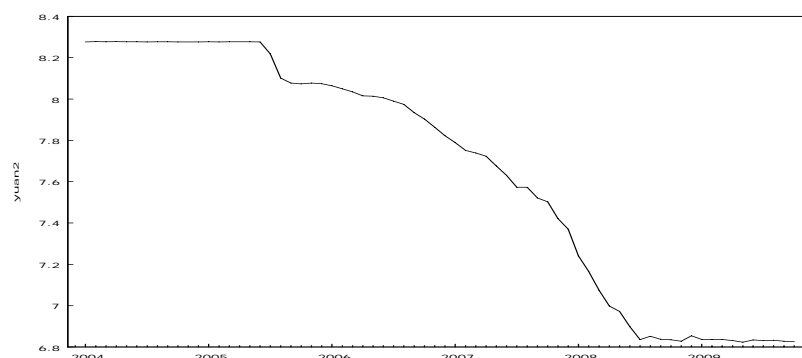
On the 21st of July, 2005 as a response to the international debate on the fact that the Chinese currency was excessively undervalued (therefore favouring national exports) the Chinese Central Money Authority declared the re-evaluation of the renminbi to an exchange of 8.11 renminbi to the American dollar, not to mention the adoption of a new exchange rate regime focussed on the abandonment of the dollar, preferring instead an exchange rate based on a basket of international currencies.

The abandonment of an exchange rate system, such as the dollar peg, although this had permitted a type of inflation control over the years in a country with low income- that is China, could be interpreted as the first step towards a fluctuating exchange rate regime. A situation of this type, in fact would permit the Chinese authorities to pursue the objective of external equilibrium and monetary sovereignty, impossible with a de facto link to a foreign currency.

Therefore, from 2006 the Chinese, started to register rises in the value of the RMB with respect to the dollar, this consequence deriving from the reduction of the weight of the American dollar in favour of the currencies present in the Chinese basket peg. (fig.2)

**Fig 2.**

**Progress of the Chinese renminbi relative to the American dollar 2004-2009**



Source: our econometric processing with Gretl. Ver. 1.8.4 software on RBA data

With reference to the Asian area, and particularly the Chinese exchange rate regime, various empirical analyses have been conducted from the nineties to today, aimed to check if the Chinese governing authorities and other Asian countries had adopted a regime of the type basket peg.

Between these, Shan (2005), Frankel&Wei (2006), Ogawa (2006), Eichengreen (2006), Yamazaky (2006), Yoshimi (2008) and Zeleis (2009) have proposed interesting results based on econometric model (2), therefore preferring this ultimate model to the approach of equilibrium models with systems of partial equations which are those used by CEPII or BIS.

The majority of these studies also differentiate themselves in the number of observations and the characters used, presenting as dependent variable, the renminbi, while as regressors, the summary of the exchange rate of the three or more currencies in the basket with a dummy currency ( the Swiss franc), at the end to check the presence of variations in the weight of the currencies used in the basket. The model used is therefore shown below with the expression:

$$\Delta \ln y_{RBM/k} = \alpha + \beta_1 \Delta \ln e_{USD/FRsv} + \beta_2 \Delta \ln e_{JPY/FRsv} + \beta_3 \Delta \ln e_{EURO/FRsv} + \mu_t \quad (3)$$

Taking a time series from the month of December 2006 to the month of March 2008, almost all of the works they have chosen share the method of estimation used in technique 2, this final result, being the fact that though officially unlinked, the Chinese currency is still linked significantly with the American currency.

It is relevant to point out the fact, that even if they are formally present in the basket, the other currencies do not emerge as significant from the p-values (figs 3,4,5).

**Fig.3**

**Chinese Evolution Basket peg 2006-2008-Frankel-**

	2006	2007	2008
dollar	1,005***	0,973***	0,972***
euro	0,006	0,01	0,003
yen	-0,023	-0,019	0,026
const.	0,00**	0,000***	0,001**
obs.	61	63	64
R <sup>2</sup>	0,95	0,94	0,97

**Fig.4**

**Chinese Evolution Basket peg 2005-2006 -Ogawa (p.47)-**

	2005	2006
dollar	0,9998***	1,004***
euro	0,0001	0,0166
yen	0,0002	-0,004
won	-0,0003	0,0220*
const.	0**	0**
R <sup>2</sup>	1	0,9982

**Fig.5**

**Chinese Basket peg 2005-Zeileis (p.9)-**

	2009
dollar	0,9809***
euro	0,008
yen	-0,007
pound	0,0085
const.	0,001
R <sup>2</sup>	0,9979

Nevertheless, these results are at odds with economic reality. More precisely in the case of the European currency, the countries belonging to the European Monetary Union (EMU) for short, have intensified their commercial exchange with China in the last ten years. Whether it is imports or exports from or to China, the European trade volume has almost tripled, the Chinese being the second trading partner only to Japan for the European market. (Eurostat 2009).

Therefore, the results of the econometric studies show a heavy growth of the presence of the Euro in the exchange system of China. In addition, a relevant role of the European currency in the Chinese basket peg would find justification even from an appreciation of the yuan with respect to the dollar, conditioned by the absence of the dollar peg, or if we consider an exchange rate intersected to three currencies (euro, dollar, yuan) an appreciation of the euro on the dollar registered in real terms from 2002-2008.

### **3 AN ALTERNATIVE APPROACH**

The results obtained through Frankel's econometric methodology, would skew the results in real terms towards one explanation only: although in the presence of a basket-peg, the Chinese currency is still tightly linked to the American dollar. Nevertheless, as we have stressed previously, the euro's role has grown in the course of these last few years as an intermediary in exchanges both as a medium in the real market, as for capital markets, placing the euro as the second most important currency in the exchange markets.

Basing ourselves on such results, one may ask why the econometric model proposed in these last few years is today widely used, on the contrary to limit the role of the euro. An explanation could be hidden itself in the same model: not in its formulation-genuinely original and economically plausible- but in the method of estimation used.

In particular, each variable -even the dummy variable itself- could be subject to non stationary trends, not to mention self correlations between the explicatives. Therefore, pushed by necessity to analyze the effective weights of the currencies considered in the Chinese basket, we will try to estimate (2) with a regressive technique in a time series.

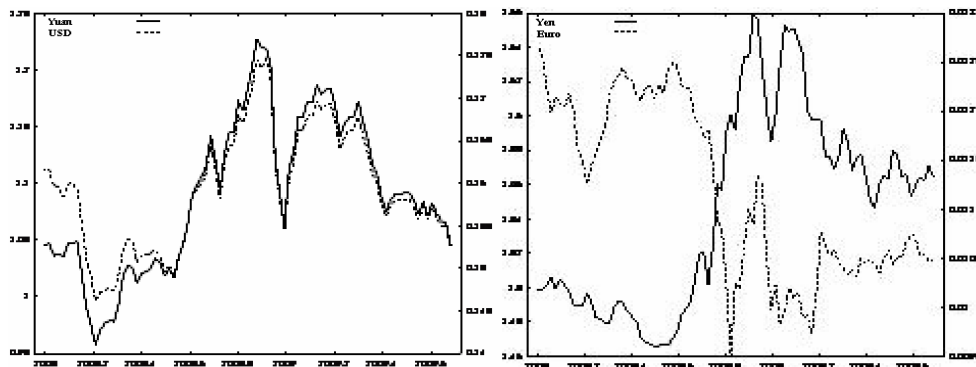
### 3.1 ECONOMETRIC METHODOLOGY

Moving ourselves from Frankel-Wei's basic analyses and assuming that the econometric model (2) could present distortions owing to estimations of the type 'time series', we will try to test the importance and the value of three currency coefficients –the dollar, the euro and the yen -present in the Chinese basket peg, with respect to the dependent variable- the Chinese yuan. If a time series is considered, from 01/01/2008 to 20/09/2009, with weekly data provided by the "Pacific Exchange Rate Service, 2009" and consequently estimated through the model "Auto-Regressive Moving Average" reinforced through Kalman's filter.

Before estimating (2), it is preferred to carry out the Dickey-Fuller test prefixed to seven delays necessary to test if the historic series relative to the three currency explicatives, to the dependent currency (Renminbi), and the Swiss franc being proposed as dummy variable being little present or less stationary.

**Fig. 6**

**Graph of the historic series relative to two currencies (yuan/dollar)/(yen/euro)**

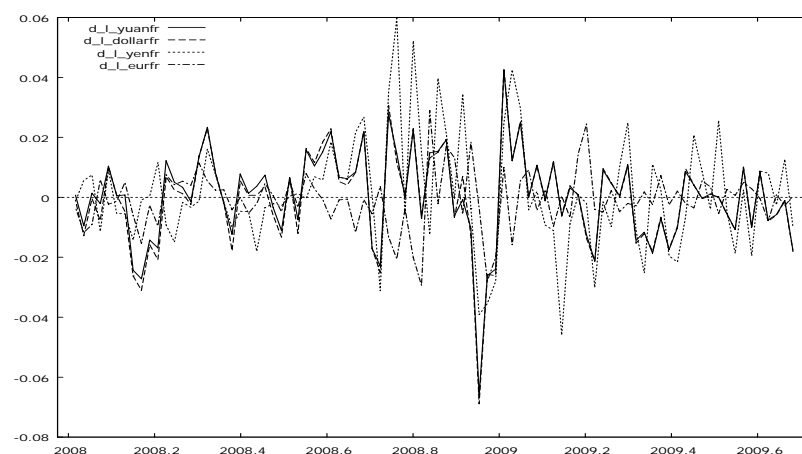


Source: our econometric processing with Gretl. Ver. 1.8.4 software.

The results obtained confirm the necessity of a logarithmic differentiation of the variables, like that suggested by Frankel (1996).

**Fig. 7**

**Analyses of the stationary movements in prime logarithmic difference**



Source: our econometric processing with Gretl. Ver. 1.8.4 software.

Nevertheless, although stationary, the outcome of the correlogram provides proof, instead, of the presence of self-correlation between the three explicatives.

A result of this type requires the application of a model different from the generic OLS (instead, it is used by various works which regard it), and more precisely, of an estimation in historic series of the type AR-MA with the object of eliminating for each value, the influence of the one preceding it.

Therefore, from our analyses that we have carried out, though still widely used, fig 2 presents a methodology of regression spoiled by the error of self correlation.

The regression with Kalman's filter for our purposes will therefore be:

$$\Delta d.\ln y_{RBM/FRsv} = \alpha + \beta_1 \Delta d.\ln e_{USD/FRsv} + \beta_2 \Delta d.\ln e_{JPY/FRsv} + \beta_3 \Delta d.\ln e_{EURO/FRsv} + \mu_t$$

whose decomposition in time series for each explanatory is:

$$\begin{aligned}\alpha_{0,t} &= \alpha_{0,t-1} + \eta_{0,t} \\ \beta_{1,t} &= \beta_{1,t-1} + \eta_{1,t} \\ \beta_{2,t} &= \beta_{2,t-1} + \eta_{2,t} \\ \beta_{3,t} &= \beta_{3,t-1} + \eta_{3,t}\end{aligned}$$



## 4 THE RESULTS

*Model: ARMAX, using the observations*

*01/01/2008 to 20/09/2009 (T = 88)*

*Estimated using Kalman's filter (exact MV)*

*Dependent variable: d\_l\_yuan*

*Standard errors based on Hessian*

	<i>coefficient</i>	<i>std.err.</i>	<i>t</i>	<i>p-value</i>	
<i>Const</i>	0,00087	0,00085	1,093	0,2742	
<i>phi_l</i>	0,7806	0,02626	37,33	5,50E-305	***
<i>theta_l</i>	-0,8729	0,0581	-15,02	5,80E-51	***
<i>d_l_dollar</i>	0,81317	0,0148	63,37	0,000	***
<i>d_l_yen</i>	0,00062	0,0012	0,4969	0,6193	
<i>d_l_euro</i>	0,3991	0,0192	1,91	0,0501	**

\*\*\* Levels of significance 1%; \*\* significance level 5%

Average dependent var. -0,000012; SQM dependent var. 0,015133

Average innovations -0,000160; SQM innovations 0,001605

Log-verisimilitude 440,9779; Akaike's criterion -867,9558

Schwarz's criterion -850,6145; Hannan-Quinn -860,9694

R-square 0,986089.

From the results of the informative criteria, it is shown that the ARMA-"Kalman" model (1,1) present for its similar values, therefore, doesn't differentiate itself. The model, moreover, doesn't demonstrate common factors, confirming the reliability of the data obtained: an estimation of the robust initial type, it has permitted moreover to limit the effect of the heteroschedasticity of the model, therefore avoiding an ARCH analysis.

From tests on the residues, though some disperse themselves according to a Gaussian normal curve, an anomalous value (outlier) has shown itself on the date of the 17th of September, 2008 with such results as to influence the progress of the same results, consequently requiring the analyses of the "dummy stabilizer" application to data for historic series.

Such a phenomenon can find economic explanations in the failure of "Lehman Brothers" on that date, an event that caused instability to the world financial system and the sudden fall of the indexes of the principal international stock exchanges. In conclusion, from the residues correlogram graph, one derives the absence of self-correlations.

If we move the observation, to the value of the co-efficients of each regressor, one concludes straight away, comparing the output results of the research on page 6, that the European currency emerges significantly, with an error standard roughly equivalent to 0.019 and a co-efficient value of approximately 0.40.

The dollar, even if it is significant has a co-efficient value equal to 0.81, the yen, instead doesn't change the significance of its currency position in the Chinese basket peg.

Therefore, one can deduce, that with respect to the considerable weight of the dollar, the euro is acquiring relevance in the Chinese basket peg, in comparison with other currencies officially declared part of the basket but especially in comparison with the American dollar.

## **5 CONCLUDING CONSIDERATIONS**

The continual current trade balance disadvantages of the United States of America, the uninterrupted growth of Southeast Asian countries pushed by commercial surpluses, the financial crisis explosion that has persuaded the monetary authority to effect a policy of expansive monetarism, have all created an atmosphere of global distrust towards the US dollar as an international currency. In particular, the great fear of a sudden collapse of the American currency is ever present, so much as to precipitate the world economy into a great new crisis. For this reason, it is not surprising that already many countries such as Brazil, Russia and even those who are stronger like Kuwait have abandoned their current regime of exchange rate dependence on the American dollar.

Therefore, pushed by necessity to demonstrate their currencies' strength as countries strongly linked to the dollar, the first among all being China; these countries are gradually substituting the dollar with other international reserve currencies, we proposed an econometric study that succeeded in harmonizing through a time series approach, the data of economic sources (Eurostat, ICE) with the resulting quantitative statistics.

China has emerged as fearing a sharp fall of the dollar with an immediate effect being the loss of value of its currency reserve (approximately 2 thousand billion US dollars); in light of the vulnerable drama of the US trade balance, China is diversifying its reserve in favour of an international currency- the euro- that despite its youth- seems to assume the role of international currency.

Such a phenomenon finds ample evidence in our results. In fact, before a regression in historic series, in which only two independent variables are significant results- the percentages of the dependent explained (using partial quadratic co-efficients) that result respectively-redefining the values in partial percentages- 71 percent the dollar, 28 percent the euro and around 1 percent for the remaining currencies hypothetically present in the basket and not considered in our model.

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## PRISTUP «VREMENSKE SERIJE» REŽIMU KINESKOG VALUTNOG TEČAJA

### *Sažetak*

*Ovaj se rad bavi pitanjem režima valutnog tečaja kojeg je Kina uvela 2005. kad je najavila odmak od veze s američkim dolarom. Doista, otada se RMB (CNY) veže za košaricu valuta osim za dolar te je tako tečaj postao fleksibilniji.*

*No usprkos tome, prve ekonometrijske analize (Shan-2005, Frankel & Wei-2006, Ogawa-2006, Yamazaky-2006) pokazale su da je odlučujuća valuta u košarici još uvijek dolar i da je stupanj fleksibilnosti jedva povećan.*

*Gotovo su sve te analize koristile tehniku koju je uveo Frankel 1994. kako bi procijenio važnost pojedinih valuta u košarici: s jedne strane RMB a s druge promjene u vrijednosti dolara, eura, jena i ostalih valuta koje se mogu naći u košarici valuta.*

*Iako postoje brojne ekonometrijske tehnike za procjenu sustava valutnog tečaja, još uvijek je najraširenija Frankelova tehnika. Ipak, po našem mišljenju taj model ima grešku u autokorelaciji varijabli što je faktor koji bi analizu mogao odvesti do drugačijih rezultata.*

*Stoga ovaj rad predlaže proučavanje režima kineskog valutnog tečaja pomoću alternativne ekonometrijske tehnike.*

**JEL klasifikacija:** C22, E42, E44;

**Ključne riječi:** Valutni tečaj, Kina, ekonometrijski ARMA model