

## Constructing Modified-ULC-based RMB Index and Its Derivative Products<sup>\*</sup>

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### Abstract:

This paper develops and empirically tests a model of Modified-ULC-based Chinese Yuan Index (CNYX), and constructs its futures contract. In particular, it highlights improvements to the CNYX over 1979-2007, including modifications to the computational methodology, use of updated data, and extension of samples. We should regularly show RMB indices and its derivative products in publicity, imitate trade of RMB indices and its derivative products, and send signals of what RMB would appreciate or depreciate according to market mechanics. We would make model-transfer upgrading of economic structure, clean production, and low-carbon economy.

**Key Words:** RMB indices; Modified-ULC; Futures Contract.

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## 1. INTRODUCTION

This paper describes the methodology to calculate Chinese Yuan Index (CNYX). It is principally intended to help users of CNYX and other interested parties gain a better understanding of the nature of CNYX and its derivative products and thus help them form a judgment of their diagnostic power in specific circumstances. The paper is very much focused on describing the derivation and computation of CNYX.

The paper is organised as follows. Following this introduction, literature is presented in Section II. Section III discusses methodology of computation of Modified-ULC-based RMB indices. Section IV prices CNYX FUTURES. Section V concludes the paper with an agenda for future work.

## 2. LITERATURE

### 2.1. The Literature of Currency Index Research

#### 2.1.1 What Are Currency Indices?

As Mico Loretan (2005) pointed out, Currency indices aggregate and summarise information contained in a collection of multilateral foreign exchange (FX) rates. Choices concerning the exchange rates to include, the formula to use in combining the component exchange rates into a single number, and the weights to assign the exchange rates in an index all depend importantly on the objectives of the index. The main objective of the currency indices is to summarise the effects of currency appreciation and depreciation against foreign currencies on the competitiveness of the domestic economy products relative to goods produced by important trading partners of the domestic economy. In fact, currency indices are just effective exchange rates (W. Erwin Diewert, 1987; David Hargreaves and Bruce White, 1999; Birone Lynch and Simon Whitaker, 2004; Mico Loretan, 2005; Zhang Hejie, 2005; Han Liyan and Wang Yungui, 2009; Lu Qianjin, 2009; Zhang Hejie and Yuwen, 2009). Generally speaking, we can build currency indices derivative products based on normal effective exchange rates, and forecast the trends of currency indices based on real effective exchange rates.

#### 2.1.2 It Should Be Changed With the Mechanics Change of Forming FX (foreign exchange) Rates for the Currencies and Weights to Be Entered into Currency Indices

At the end of 1998, the staff, Mico Loretan, of the Federal Reserve Board introduced a new set of indices of the FX value of the U.S. dollar. The staff made the changeover, from indices that had been used since the late 1970s, for two reasons. First, five of the ten currencies in the staff's previous main index of the dollar's FX value were about to be replaced by a single new currency, the euro. Second, developments in international trade since the late 1970s called for a broadening of the scope of the staff's dollar indices and a closer alignment of the currency weights with U.S. trade patterns (Mico Loretan, 2005). Effective exchange rates are revised

every five years in principle. The next revision is scheduled in 2011 when 2010 trade data become available (Research and Statistics Department, Bank of Japan, 2009).

## **2.2 The Literature of ULC-Based Currency Indices**

### **2.2.1 The practicalities of ULC-based currency indices**

The Balassa-Samuelson hypothesis considers the effect on unit labor costs as the most core supply force to appreciation of equilibrium exchange rate during medium-long-term. It has been widely used in the world for the simple idea of appreciation or depreciation of exchange rate just to depend on unit labor costs although the economists in the world have not known whether or not the hypothesis is true or not with empirical tests until now. IMF has been offering real effective exchange rate indices –based on unit labor costs (ULC) for 21 industrial countries according to the simple idea (Alessandro Zanello and Dominique Desruelle, 1997; *International Financial Statistics Yearbook*, IMF various years)

### **2.2.2 Properties of ULC-Based REER Indices**

Real effective exchange rate (REER) indices based on unit labor costs in the manufacturing sector have been found by many authors to be useful indices of international competitiveness for a variety of reasons (Turner and Van't dack, 1993). They capture cost developments in an important sector exposed to international competition. They offer a reliable gauge of the relative profitability of traded goods. They are convenient from a statistical viewpoint, since fairly comparable data on the manufacturing sector exist for a number of countries. And, finally, by construction, they bring into focus the largest component of nontraded costs and of value added, thus proxying for significant developments in total variable costs. Since capital goods are traded internationally and financial market integration tends to equalise real long-term interest rates, the emphasis on labor costs to assess international competitiveness seems warranted (Alessandro Zanello and Dominique Desruelle, 1997).

Given these characteristics, ULC-based REER indices are often judged preferable to alternative, economy-wide measures, such as REER indices based on consumer price indices or value added deflators. This does not mean, of course, that ULC-based REER indices are a uniformly superior index of competitiveness. In fact, as argued in a number of articles on exchange rate indices, no single available measure can claim such a status because the informational content of each index is necessarily limited (Alessandro Zanello and Dominique Desruelle, 1997).

### **2.2.3 The Pitfalls of ULC-Based Currency Indices**

The use of intermediate inputs in the production of manufactured goods whose prices can differ across countries; the possibility of different intensities of capital use across countries; and cyclical movements in labor productivity, even though remedies can be used to attempt to filter out volatility at business-cycle frequencies (These factors can distort the interpretation of ULC-based REER indices in the following way: differential increases in nonlabor costs will

affect the relative competitive position of a country but will not be recorded in the index; a higher capital-labor ratio, which entails higher capital costs and lower unit labor costs, lead to a ULC-based index that overestimates competitiveness; the procyclical changes in productivity add statistical noise to the indices). In addition, the incomplete coverage of the tradable sector in ULC-based REER indices can be a serious restriction in countries where trade in raw materials, semi-finished products and services is a large proportion of total trade (Alessandro Zanello and Dominique Desruelle, 1997) .

In practice, the choice of the preferred real effective exchange rate index is also in part dictated by data constraints. For many countries, a lack of data makes it impossible to compute ULC-based REER indices and may limit the choice of indices to CPI-based ones. This last factor largely explains why, in the INS (the IMF's Information Notice System), ULC-based REER indices are computed only for a subset of industrialised countries, where generally comparable information on unit labor costs and necessary data on production and trade of manufactured goods are available (Alessandro Zanello and Dominique Desruelle, 1997) .

### 2.2.4 The weighting scheme is all important

The weighting scheme is all important because it determines how developments in exchange rates and unit costs in different foreign countries have an impact on the measured competitive position of the home country (Alessandro Zanello and Dominique Desruelle, 1997) . There are many different measures of an effective exchange rate. Different measures emphasis different aspects of the effect of the exchange rate on the economy, and it is generally necessary to consider a range of measures to obtain an overall view (David Hargreaves, Bruce White, 1999). Various kinds of weighted value of trade (such as export or import value, or the total value of exports and imports) are commonly used according to the purpose of calculating the effective exchange rate (e.g., whether the impacts on Japan's exports, or imports, or balance of trade, are of interest). Here, for the purpose of measuring the "competitiveness of Japan's exports," Bank of Japan uses the weighted value of Japan's exports to the individual countries and regions (Research and Statistics Department, Bank of Japan, 2009) . Mico Loretan (2005) selected currencies for inclusion in three indices: the broad index, the major currencies index, and the other important trading partners (OITP) index.

## 3. METHODOLOGY OF COMPUTATION OF MODIFIED-ULC-BASED RMB INDICES

### 3.1. Model

The index of nominal effective exchange rate based IMF is as follows.

$$I_t = I_0 \prod_{j=1}^n \left( \frac{S_{j,t}}{S_{j,0}} \right)^{w_{j,t}} \quad (1)$$

Where

$I_t$  is the nominal exchange rate index value of the domestic economy at time  $t$ ,  $S_{j,t}$  is the nominal exchange rate ( $j$  currencies per the domestic economy currency unit) of the domestic economy at time  $t$  relative to  $j$  currency.  $S_{j,0}$  is the nominal exchange rate of the domestic economy in the base period to  $j$  currency.  $I_0$  is the nominal exchange rate index value of the domestic economy in the base period, and defined as 100,  $n$  is the number of trading partners of the domestic economy,  $W_{j,t}$  is the appropriate trade weight for each of the trading partners  $j$  ( $j=1, 2, \dots, n$ ) with the domestic economy. It can be simply understood for us to express that the nominal exchange rate index is nominal exchange rate of the domestic economy relative to other economies. If the index value is higher than ever, it expresses that the exchange rate of the domestic economy is appreciation to the currencies of other economies.

We can get  $RI_t$ , real effective exchange rate index value of the domestic economy, if putting  $q_{j,t}$ , the real exchange rate of the domestic economy relative to the  $j$  currency, into (1) instead of  $S_{j,t}$ ,

$$RI_t = RI_0 \prod_{j=1}^n \left( \frac{q_{j,t}}{q_{j,0}} \right)^{w_{j,t}} \quad (2)$$

In (2),  $q_{j,t} = S_{j,t} p_t / p_{j,t}$ , where  $p_t$  and  $p_{j,t}$  are consumer price indices for the domestic economy  $i$  and foreign economy  $j$  in year  $t$ .  $RI_0$  is the real effective exchange rate index of the domestic economy in the base period, and is considered as 100. As the same as above, it can be simply understood for us to express that the real exchange rate index of the domestic economy is real exchange rate of the domestic economy relative to the currencies of other economies. If the index is higher than ever, it expresses that the currency of the domestic economy is appreciation relative to the other currencies. It expresses that the competitiveness of export price is lower than ever.

### 3.2. Renew weight

The main innovation in the paper is that we renew the weight in (1)

#### 3.2.1 Weighting scheme

The definition of our weight is as follows:

$$W_{j,t} = A_{j,i,t} \times B_{j,i,t} \quad (3)$$

Where,  $w_{j,t}$  Can be decomposed into two sub-weights,  $A_{j,i,t}$  based unit labor costs which accounts for the labor productivity of  $i$  economy relative to  $j$  economy, and  $B_{j,i,t}$  which accounts for competition of the exports and imports between local market  $i$  and foreign market  $j$ . Under this decomposition,  $A_{j,i,t}$  and  $B_{j,i,t}$  can be written, respectively, as follows:

$$A_{j,i,t} = \frac{m_{j,t}}{m_{i,t}} \quad (4)$$

Where

$$m_{j,t} = \frac{\text{GDP of } j \text{ economy in year } t}{\text{employee of } j \text{ economy in year } t} \quad (5)$$

Where:

$$m_{i,t} = \frac{\text{GDP of } i \text{ economy in year } t}{\text{employee of } i \text{ economy in year } t} \quad (6)$$

Let  $B_{j,i,t}$  be economy  $j$ 's share of economy  $i$ 's exports and imports in  $t$  year in the world, which is to say:

$$B_{j,i,t} = \frac{\text{sum of exports and imports value between local } i \text{ and foreign } j \text{ economy in } t \text{ year}}{\text{sum of exports and imports value of local } i \text{ economy in } t \text{ year in the world}} \quad (7)$$

Thus, for each pair of countries or regions  $(i,j)$ , the weight  $w_{j,t}$  expresses two components, one  $(A_{j,i,t})$  reflecting competition of unit labor costs between the home market (i.e., country  $i$ ) and the other foreign market (i.e., country  $j$ ); one  $(B_{j,i,t})$  representing economy  $j$ 's share of economy  $i$ 's exports and imports in  $t$  year in the world, and accounting for competition of the exports and imports between local market  $i$  and foreign market  $j$ . The coefficient on the  $A_{i,j,t}$ ,  $B_{j,i,t}$  as the ratio of a measure of the intensity of competition between economy  $i$  and  $j$  in the world, measures the relative importance of competition in the world market. The more local economy  $i$  depends on foreign economy  $j$ , the stronger the changer of share impacting on the effective exchange rate of  $i$  economy. Thus, the influence, economy  $j$  in the weight of effective exchange rate impacting on economy  $i$ , is more important than the others.

For each economy,  $B_{j,i,t}$  attached to by any other economy to economy  $i$  should reflect the importance of economy  $j$  as either a seller or a buyer in the world market.

The weighting scheme is all important because it determines how developments in exchange rates and unit costs in different economies have an impact on the measured competitive position of the home economy.

This weight can be interpreted as a gauge of the degree of competition between economy  $i$  and  $j$  with the view of unit labor costs times a gauge of the degree of competition between economy  $i$  and  $j$  with the view of economy  $j$ 's share of economy  $i$ 's exports and imports in  $t$  year in the world.

### 3.2.2 The Modified-ULC-Based Weights of the Trading Partners Sum to 1

The Modified-ULC-based weights of the trading partners sum to 1 as indicated in equation (8) below.

$$\sum_{j=1}^n W_{jt} = 1 \quad (8)$$

### 3.2.3 Research China

Putting China into equation (3) instead of  $i$  economy, we have:

$$W_{jt} = A_{j,China,t} \times B_{China,j,t} \quad (9)$$

Where

$$A_{j,China,t} = \frac{m_{j,t}}{m_{China,t}} \quad (10)$$

$$m_{j,t} = \frac{GDP \text{ of } j \text{ economy in year } t}{\text{employee of } j \text{ economy in year } t} \quad (11)$$

$$m_{China,t} = \frac{GDP \text{ of } China \text{ in year } t}{\text{employee of } China \text{ in year } t} \quad (12)$$

$$B_{j,China,t} = \frac{\text{the total exports and imports value between } China \text{ and foreign } j \text{ economy in } t \text{ year}}{\text{the total exports and imports value of } China \text{ in } t \text{ year in the world}} \quad (13)$$

### 3.3 The Criterion for Selecting the Currencies

To avoid the difficulty of choosing data and given  $B_{j,i,t}$  is very small, it was decided to truncate each share at a threshold of no less than or equal to and more than one percent. It is also taken into account to remove fluctuations in choosing sample currencies and to ensure consistency, if the average value of  $B_{j,i,t}$  in every 3 years is no less than or equal to and more than one percent, the currency should be chosen, such as Malaysia, the shares are 1.2%, 1.1%, 0.7% from 1979 to 1981, respectively, and Chinese Taiwan, the shares are 6.5%, 0.6%, 6.3% from 1996 to 1998, respectively, these currencies should also be chosen. The period covered by these data varied among countries according to data availability and reliability. The data vary by year.

Countries accounted for more than 70%, 71.9%-89.2%, of the shares of all exports and imports in Chinese trade in 1979-2007—the sum of 20 countries and regions, Australia, Brazil, Canada, France, Germany, Hong Kong, Korea, India, Indonesia, Italy, Japan, Malaysia, Netherland, Philippines, Russia, Singapore, Thailand, Taiwan (Province of China), United Kingdom, and United States, happened to meet this condition.

Because trade patterns generally move little over short periods of time, we chose to base the weights on annual rather than higher-frequency trade data to simplify the index calculations. Therefore, the weights are constant within a calendar year.

With the release of the newest figures of the effective exchange rate, the current year's weighted value is not available. Preliminary estimates are therefore calculated using the weighted values of the latest annual data available at the time of release. After the current year's data become available, the preliminary estimates are finalised.

### 3.4. Choice of Base Period

Generally speaking, The base period is the relative near year, such as the data given by IMF (International Financial Statistics Yearbook various years); Or the year of reforming exchange rate, as the base period is March 1973, just after Japan's adoption of the floating exchange rate system (Research and Statistics Department (Bank of Japan) , 2009) . The effective exchange rates are indexed by the base period = 100. We take account for 2005 year as the base period, due to reforming RMB exchange rate regime from fixed to floating exchange rate regime referring to a basket of currencies on the 21st July 2005.

## 4. PRICING CNYX FUTURES

### 4.1. Data Scheme

#### 4.1.1 Model

Let  $CNYX_t$  be Chinese (RMB) indices, let  $I_0 = 100$ . For the purpose of mathematical convenience, the CNYX can be rewritten as:

$$I_t = CNYX_t = 100 \prod_j \left( \frac{S_{j,t}}{S_{j,0}} \right)^{w_{j,t}} \quad (14)$$

Equation (14) can be rewritten as:

$$I_t = CNYX_t = A \times \prod_{j=1}^n s_{j,t}^{w_{j,t}} \quad (15)$$

Where  $A = 100 \prod_{j=1}^n \left( \frac{1}{S_{j,0}} \right)^{w_{j,t}}$  (16)

Where  $S_{j,0}$  is the nominal exchange rate of the domestic economy in the base period (21st July 2005) to  $j$  currency,  $w_{j,t}$  is in the base period (2005), refer to model (3). We can obtain:  $A=143.138$

Thus:

$$I_t = CNYX_t = 143.138 \prod_{j=1}^n s_{j,t}^{w_{j,t}}, \quad (17)$$

#### 4.1.2 Data scheme

Based on (17), when calculating  $w_{j,t}$ , use recent available data, such as 2007, because ULC and CPI are unavailable in spot year.

## 4.2. Test the Stability of CNYX

### 4.2.1 Idea

Make model of CNYX, using 200 data beforehand. Then test forecast, using other 40 data, and judge forecast errors.

### 4.2.2 Test the Stability of CNYX



We may find that the  $RI_t$  of 2009 is a non-stationary time series, refer to Table 1, but the first difference AR(1) of that is stationary.

### 4.2.3 Identifying and Estimating Model of ARIMA

Because there is only eminent in lag 6 of AR term in PACF, so can obtain the model as:

$$DI = C(1) + [AR(6)=C(2)] \quad (18)$$

Using the results of e-views, we can get:

$$DI = -0.03396903117 + [AR(6)=0.212142957] \quad (19)$$

### 4.2.4 Diagnosing the Model (19)

There are not any autocorrelation and partial autocorrelation being eminent in statistic meaning. It expressed that what estimated the error from model (19) is pure random.

### 4.2.5 Forecast

Model (19) can be rewritten as below:

$$I_t - I_{t-1} = c(1) + c(2)(I_{t-6} - I_{t-7}) + u_t \quad (20)$$

Put the data of (19) into (20), rearrange it, we have:

$$I_t = -0.03396903117 + I_{t-1} + 0.212142957I_{t-6} - 0.212142957I_{t-7} + u_t \quad (21)$$

We forecast CNYX, using other 40 data, root mean squared error is 0.350143, see Fig. 1 of Appendix.

## 4.3. PRICING CNYX FUTURES

### 4.3.1. Assumptions and Notation

Our analysis is based on continuous time stochastic calculus, assuming that FX rates are lognormally distributed and that the China and foreign risk free interest rates are constant. We easily could assume that interest rates change deterministically over time, but this would not change the final results. Assuming nonstochastic interest rates implies that forward prices and futures prices are the same (see Cox, *et al.* 1981; French, 1983). Therefore, throughout the paper, we will ignore the "marking-to-the-market" property of futures contracts, and use the words "forward" and "futures" interchangeably. The error introduced is that of ignoring the interest basis risk. It is a sufficiently small error to warrant this assumption (see Cornell and Reinganum, 1981). We also ignore transaction costs, margin requirements, and any potential role taxes may play in the determination of futures prices. Borrowing and lending rates are assumed to be equal. These perfect capital market assumptions are fairly standard in contingent claims analysis and are necessary for tractability and compactness (Eytan T, *et al.* 1988).

We denote by  $r_c$  and  $r_i$  the instantaneous risk free interest rates in the China and in country or

region  $i$ , respectively. The rate of change,  $\frac{dS_i}{S_i}$ , of spot exchange rate,  $S$ , in country  $i$ 's (Chinese

Yuan per foreign currency unit) FX rate over an infinitesimal time interval,  $d_t$ , is given by:

$$\frac{dS_i}{S_i} = (\mu_i - r_i)dt + \sigma_i dZ_i \quad (22)$$

where  $dZ_i$  is the standard Wiener process increment,  $\sigma_i$  is the constant instantaneous volatility of the FX rate of change, and  $\mu_i$  is the instantaneous expected rate of return on an investment involving the purchase of foreign or region currency  $i$  with Chinese yuan, investing it in foreign or region default free bonds for an infinitesimal time period, and then cashing out in Chinese yuan at the new FX rate. Such an investment is exposed to the FX risk of currency  $i$ , and  $\mu_i$ , is therefore a "risk-adjusted" rate of return. The rate of change in FX rate  $i$ , given by Equation (22), is equivalent to the instantaneous rate of return resulting from the holding of foreign currency momentarily without investing it in foreign bonds. Since such an investment forfeits the foreign interest rate, its instantaneous expected rate of return is  $(\mu_i - r_i)$ . Note that the FX dynamics in Equation (22) are analogous to the conventional dynamics of a stock price with continuous dividend yield equal to the foreign or region interest rate  $r$ , (Eytan T, *et al.*, 1988).

### 4.3.2 Pricing CNYX Futures

We write  $F(t, T)$  for the futures prices, as of period  $t$ , of the CNYX and foreign or region currency  $i$  contracts with expiration at time  $T(T > t)$ . With this in mind we can proceed to explore the CNYX dynamics. The equilibrium CNYX futures price can be stated in terms of the component forward prices (Eytan T, *et al.*, 1988), we obtain:

$$F(t, T) = I_t e^{(r - \delta)(T-t)} \quad (23)$$

Where  $I_t$  is spot value of CNYX, refer to equation (22),  $r_t$  is the weighted risk free interest rate,  $r_t = \sum_{j=1}^n w_j r_j$ ,  $r$  is the instantaneous risk free interest rates in the China, let us denote by  $\delta$  as the

CNYX drift factor, we have:  $\delta = \frac{1}{2} (\sum_{j=1}^n w_j \sigma_j^2 + \sigma_t^2)$ , the CNYX growth rate, denoted by  $\sigma_t^2$ ,

$\sigma_t$  is the CNYX volatility, satisfying:  $\sigma_t^2 = \sum_{i=1}^n \sum_{j=1}^n w_i w_j \sigma_i^2 \sigma_j^2 \rho_{ij}$ ,  $w_i$  and  $w_j$  refer to model (9),

$\sigma_i$  and  $\sigma_j$  are the component FX rate volatilities,  $\rho_{ij}$  is correlation coefficient among the underlying FX rates of change of various component currencies in CNYX,  $i \neq j; i, j = 1, 2, \dots, n$ ,

Put equation (17) into (23), we have:

$$F(t, T) = [143.138 \prod_{j=1}^n s_{j,t}^{w_{j,t}}] e^{(r-r-\delta)T} \tag{24}$$

Note that the term,  $w_{j,t}$ , in brackets should use the updated data (year) which are available.  $S_{j,t}$  should use spot value (day).

We also know that at expiration the CNYX futures price converges to the spot index value, See Table 1.

Table 1 Imitated CNYX Futures at Expiration of Dec. 2009

| date    | CNYX     | rc     | rI     | δ        | before expiration date | Validity of term | expiration of Dec. 2009 |
|---------|----------|--------|--------|----------|------------------------|------------------|-------------------------|
| 9 Oct.  | 111.0242 | 0.0225 | 0.0316 | 0.004418 | 59                     | 0.1639           | 111.2704                |
| 12 Oct. | 111.5044 | 0.0225 | 0.0316 | 0.002094 | 58                     | 0.1611           | 111.7057                |
| 13 Oct. | 111.2515 | 0.0225 | 0.0316 | 0.001323 | 57                     | 0.1583           | 111.4352                |
| 14 Oct. | 111.0886 | 0.0225 | 0.0316 | 0.001089 | 56                     | 0.1556           | 111.2648                |
| 15 Oct. | 110.7303 | 0.0225 | 0.0316 | 0.005632 | 55                     | 0.1528           | 110.9798                |
| 16 Oct. | 110.8511 | 0.0225 | 0.0316 | 0.001721 | 54                     | 0.1500           | 111.0312                |
| 19 Oct. | 111.2897 | 0.0225 | 0.0316 | 0.002820 | 53                     | 0.1472           | 111.4851                |
| 20 Oct. | 110.8516 | 0.0225 | 0.0316 | 0.001430 | 52                     | 0.1444           | 111.0204                |
| 21 Oct. | 111.1112 | 0.0225 | 0.0316 | 0.005230 | 51                     | 0.1417           | 111.3370                |
| 22 Oct. | 110.8885 | 0.0225 | 0.0316 | 0.001581 | 50                     | 0.1389           | 111.0531                |
| 23 Oct. | 111.0248 | 0.0225 | 0.0316 | 0.003325 | 49                     | 0.1361           | 111.2127                |
| 26 Oct. | 111.2368 | 0.0225 | 0.0316 | 0.003137 | 48                     | 0.1333           | 111.4185                |
| 27 Oct. | 111.5970 | 0.0225 | 0.0316 | 0.002174 | 47                     | 0.1306           | 111.7614                |
| 28 Oct. | 111.6966 | 0.0225 | 0.0316 | 0.001960 | 46                     | 0.1278           | 111.8545                |
| 29 Oct. | 111.7942 | 0.0225 | 0.0316 | 0.004865 | 45                     | 0.1250           | 111.9895                |
| 30 Oct. | 111.4515 | 0.0225 | 0.0316 | 0.003359 | 44                     | 0.1222           | 111.6214                |
| 2 Nov.  | 111.5919 | 0.0225 | 0.0316 | 0.002030 | 43                     | 0.1194           | 111.7404                |
| 3 Nov.  | 111.4169 | 0.0225 | 0.0316 | 0.004241 | 42                     | 0.1167           | 111.5904                |
| 4 Nov.  | 111.5104 | 0.0225 | 0.0316 | 0.004945 | 41                     | 0.1139           | 111.6889                |
| 5 Nov.  | 111.3161 | 0.0225 | 0.0316 | 0.001090 | 40                     | 0.1111           | 111.4422                |
| 6 Nov.  | 111.2251 | 0.0225 | 0.0316 | 0.000950 | 39                     | 0.1083           | 111.3463                |
| 9 Nov.  | 110.8416 | 0.0225 | 0.0316 | 0.003273 | 38                     | 0.1056           | 110.9865                |
| 10 Nov. | 110.5839 | 0.0225 | 0.0316 | 0.000758 | 37                     | 0.1028           | 110.6960                |
| 11 Nov. | 110.4706 | 0.0225 | 0.0316 | 0.001438 | 36                     | 0.1000           | 110.5871                |
| 12 Nov. | 110.5187 | 0.0225 | 0.0316 | 0.003160 | 35                     | 0.0972           | 110.6505                |

|         |          |        |        |          |    |        |          |
|---------|----------|--------|--------|----------|----|--------|----------|
| 13 Nov. | 110.9250 | 0.0225 | 0.0316 | 0.001059 | 34 | 0.0944 | 111.0314 |
| 16 Nov. | 110.4799 | 0.0225 | 0.0316 | 0.000935 | 33 | 0.0917 | 110.5816 |
| 17 Nov. | 110.2646 | 0.0225 | 0.0316 | 0.002296 | 32 | 0.0889 | 110.3764 |
| 18 Nov. | 110.5473 | 0.0225 | 0.0316 | 0.001636 | 31 | 0.0861 | 110.6495 |
| 19 Nov. | 110.5179 | 0.0225 | 0.0316 | 0.001384 | 30 | 0.0833 | 110.6145 |
| 20 Nov. | 110.6744 | 0.0225 | 0.0316 | 0.001743 | 29 | 0.0806 | 110.7711 |
| 23 Nov. | 110.6547 | 0.0225 | 0.0316 | 0.001108 | 28 | 0.0778 | 110.7426 |
| 24 Nov. | 110.5036 | 0.0225 | 0.0316 | 0.000684 | 27 | 0.0750 | 110.5847 |
| 25 Nov. | 110.3501 | 0.0225 | 0.0316 | 0.004346 | 26 | 0.0722 | 110.4573 |
| 26 Nov. | 109.8301 | 0.0225 | 0.0316 | 0.008988 | 25 | 0.0694 | 109.9682 |
| 27 Nov. | 110.1205 | 0.0225 | 0.0316 | 0.001880 | 24 | 0.0667 | 110.2012 |
| 30 Nov. | 110.0600 | 0.0225 | 0.0316 | 0.001142 | 23 | 0.0639 | 110.1320 |
| 1 Dec.  | 110.0027 | 0.0225 | 0.0316 | 0.002533 | 22 | 0.0611 | 110.0809 |
| 2 Dec.  | 109.7977 | 0.0225 | 0.0316 | 0.001606 | 21 | 0.0583 | 109.8663 |
| 3 Dec.  | 109.9830 | 0.0225 | 0.0316 | 0.001303 | 20 | 0.0556 | 110.0466 |
| 4 Dec.  | 110.1663 | 0.0225 | 0.0316 | 0.013553 | 19 | 0.0528 | 110.2981 |
| 7 Dec.  | 110.9093 | 0.0225 | 0.0316 | 0.002902 | 18 | 0.0500 | 110.9759 |
| 8 Dec.  | 110.7880 | 0.0225 | 0.0316 | 0.005003 | 17 | 0.0472 | 110.8618 |
| 9 Dec.  | 110.8267 | 0.0225 | 0.0316 | 0.001615 | 16 | 0.0444 | 110.8795 |
| 10 Dec. | 110.8267 | 0.0225 | 0.0316 | 0.000675 | 15 | 0.0417 | 110.8718 |
| 11 Dec. | 110.9307 | 0.0225 | 0.0316 | 0.002509 | 14 | 0.0389 | 110.9808 |
| 14 Dec. | 111.2302 | 0.0225 | 0.0316 | 0.000403 | 13 | 0.0361 | 111.2684 |
| 15 Dec. | 111.0992 | 0.0225 | 0.0316 | 0.004024 | 12 | 0.0333 | 111.1479 |
| 16 Dec. | 111.5996 | 0.0225 | 0.0316 | 0.000994 | 11 | 0.0306 | 111.6340 |
| 17 Dec. | 111.7456 | 0.0225 | 0.0316 | 0.005016 | 10 | 0.0278 | 111.7894 |
| 18 Dec. | 112.0622 | 0.0225 | 0.0316 | 0.003117 | 9  | 0.0250 | 112.0964 |
| 21 Dec. | 112.3329 | 0.0225 | 0.0316 | 0.000715 | 8  | 0.0222 | 112.3574 |
| 22 Dec. | 112.6072 | 0.0225 | 0.0316 | 0.001192 | 7  | 0.0194 | 112.6297 |
| 23 Dec. | 112.7720 | 0.0225 | 0.0316 | 0.000908 | 6  | 0.0167 | 112.7908 |
| 24 Dec. | 112.5160 | 0.0225 | 0.0316 | 0.000961 | 5  | 0.0139 | 112.5317 |
| 25 Dec. | 112.4201 | 0.0225 | 0.0316 | 0.000826 | 4  | 0.0111 | 112.4325 |
| 28 Dec. | 112.4127 | 0.0225 | 0.0316 | 0.001238 | 3  | 0.0083 | 112.4224 |
| 29 Dec. | 112.4067 | 0.0225 | 0.0316 | 0.002120 | 2  | 0.0056 | 112.4137 |
| 30 Dec. | 112.4808 | 0.0225 | 0.0316 | 0.002609 | 1  | 0.0028 | 112.4845 |
| 31 Dec. | 112.4560 | 0.0225 | 0.0316 | 0.001404 | 0  | 0.0000 | 112.4560 |

Note: Term is 9th Oct. 2009—31st Dec. 2009

Source: Table 1 of Appendix

## 5. AGENDA FOR FUTURE WORK

Three directions for future work naturally come to mind. The first is extension of the computation of Modified-ULC-based CNYX series to up-to-date data which are available. Improvements in the availability, reliability and timeliness of national statistics should make this possible over time. The second is computation of Modified-ULC-based CNYX series for “new” derivative products, such as option, according to the methodology used for other economies. Again, the passage of time and improvements in national statistics should allow this to happen in due course. Third is further comparative analysis of different methods for computing Modified-ULC-based weights and CNYX series at little or no cost to the series` accuracy.

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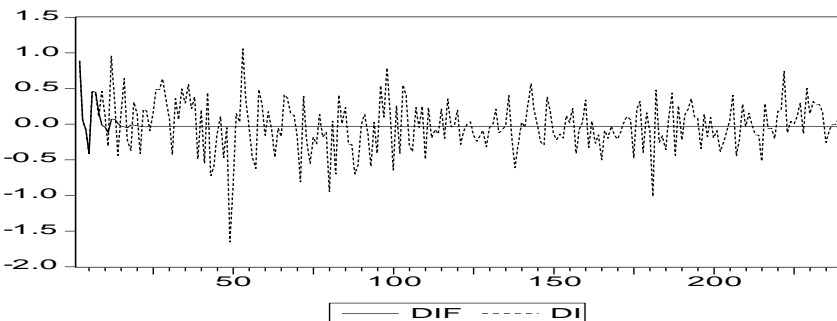


Fig. 1. Forecast

Note: DIF are values of forecast, DI are values of original time series.