RELATIVITY OF ECONOMIC FUNDAMENTALS AND FLUCTUATION OF THAI CURRENCY: SPECTRA ANALYSIS OF THAI BAHT REER (REAL EFFECTIVE EXCHANGE RATE)

Thanapon Sathitwitayakul[1] and Kriengsin Prasongsukarn[2]

บทคัดย่อ

บทความทางวิชาการนี้มีวัตถุประสงค์เพื่อศึกษาฟังก์ชั่ นคลื่นที่ส่ งผลกระทบต่ออัตราการแลกเปลี่ยนที่แท้จริงใดใช้หลักการพื้นฐานของอนุกรมฟูเรียร์ในการแยกองค์ประกอบของกราฟดัชนีค่ าเงินบาทให้อยู่ในรูปของผลรวมของฟังก์ชั่ นคลื่นรูปไซน์ท่ ีความถี่และแอบพลิจูดที่แตกต่างกัน
ซึ่งผลที่ได้จะทำให้เราสามารถสร้างแบบจำลองทางคณิตศาสตร์ เพื่อทำนายมูลค่าอัตราการแลกเปลี่ยนซึ่งจะทำให้การตัดสินใจเกี่ยวกับธุรกิจที่ต้องทำการแลกเปลี่ยนเงินตราเป็นไปอย่างมีประสิทธิภาพยิ่งขึ้น นอกจากนี้ยังสามารถแสดงการเปรียบเทียบหลักการพื้นฐานทางเศรษฐกิจกับการผันแปรของเงินบาทซึ่งแสดงนัยว่าหน่วยพื้นฐานของหลักการพื้นฐานทางเศรษฐกิจมีอยู่จริงและมีลักษณะในเชิงมิติเวลาเป็นคลื่นรูปไซน์

Abstract

This paper examines the major wave functions that influence the real effective exchange rate of Thai baht. In this paper, Fourier transform technique is used to extract the hidden sinusoidal wave function in the main graph. Consequently, the wave function will lead to development of a better mathematical model which can be used to predict the future value of exchange rate. An exchange rate prediction is one of the most important tools to develop better strategic decisions. In accordance with the results gained, we can show the relativity of economic fundamentals and currency fluctuation, which implies that the basis unit of economic fundamentals exists and its characteristic of time-value (price quantity) function is shown in sinusoidal waveform.

---

[1]Thanapon Sathitwitayakul holds a Bachelor degree in Engineering from Assumption Univer-sity, Thailand. Currently he is studying for the Master of Business Administration degree in the Graduate School of Business at Assumption University.

[2]Assist. Prof. Dr. Kriengsin Prasongsukarn holds a Ph.D. in Marketing from the University of New South Wales Sydney, Australia. Currently he is working as a Lecture at Graduate School of Business at Assumption University. He also serves as Managing Director at Inspire Research Co., Ltd.

Background

The exchange rate nowadays has become one of the critical factors in international trading. The weak currency usually enhances the competitive advantage of the exporters in that particular country due to the illustrative decreasing in the cost and vice versa (Moosa, 2008). For instance, recently, even though china did well in world trading and gained tremendous inflow currency, Chinese government still tries to peg the Chinese Yuan to be weaker than it is supposed to be so that the exporting section of the country can gain competitive edge over the competitors around the world (Berthelsen, 2010). As a result, with the intention of gaining edges in international competition, many people try to investigate the hidden factors, creating models to explicate the phenomena of exchange rate deviation. In order to launch a right strategic management decision and monetary policy for the country, the accurate prediction of exchange rate deviation is very crucial.

Earlier Work on Exchange Rate Model

There are a lot of arguments on the factors effecting predictability of exchange rate. There are, at least, three concepts that have been issued:

1. Exchange rate is simply the standard deviation of the error term. The concept mentions that the prediction of exchange rate model, which is macroeconomic fundamentals basis, is not better than random model (Meese & Rogoff, 1983).
2. Purchasing power parity (PPP) mentions that the change in exchange rate should occur when there is an offset in inflation rate with the following relationship (Simonoff, 2008):

   Average annual change in the exchange rate = Average annual difference in inflation rates + random error

   There are several ideas analysing the factors affecting Thai baht exchange rate. Back to the PPP hypothesis, it states that the fluctuation depends heavily upon the price level of the countries. Though we fail to reject PPP and there are a lot of studies reporting applicability of PPP in the long run, the short run validity of PPP is still divisive (Cheung & Lai, 1993). Moreover, according to the theory of supply and demand, the value of currency relies greatly on the demand of that particular currency (Stonebraker, 2010). In other words, when the demand of particular currency is substantially increased; then, consequently, that currency value will be appreciated.
3. Macroeconomic fundamentals influence the deviation of exchange rate value. Especially in long-term fluctuation, 85% of exchange rate of commodity currency can be predicted accurately with the data from four major cycles of commodity price (Sanidas, 2005). The four cycles, sometime, are called four cycles harmonic.

Fourier transform is the technique used to extract the hidden sinusoidal component

of any graph. The original graph is in time domain; however, after transformation, the result is usually shown in frequency domain for ease of understanding the fundamental frequency and other components. The coefficient will tell the amplitude of the wave function. Fourier transform can also show its components in term of series, so call Fourier series. The Fourier series are normally shown in the following format:

$$f(x) - \frac{a_0}{2} + \sum_{n=1}^{\infty} \left[a_n \cos\left(\frac{2\pi nx}{T}\right) + b_n \sin\left(\frac{2\pi nx}{T}\right) \right]$$

Where

$$a_n = \frac{2}{T} \int_0^T f(x) \cos\left(\frac{2\pi nx}{T}\right) dx \; ; \; n \geq 0$$

And

$$b_n = \frac{2}{T} \int_0^T f(x) \sin\left(\frac{2\pi nx}{T}\right) dx \; ; \; n \geq 1$$

The frequency that gives the largest coefficient indicates that its change provides greater effects on the f(x) which is the exchange rate. By exploiting Fourier series, the hidden nature of major influence factors will show up in term of cycle period.

However, in case, the function f(x) is not the repetitive function then the period (T) will go approaching infinity (α). Then, we can use another tool called "Fourier Transform":

$$F(f) = \int_{\infty}^{\infty} f(x) e^{-2\pi i x f} \, dx$$

The result is shown in frequency domain as F (f) means the function "F" containing frequency (f) as the domain (Brown & Churchill, 1993).

Very few studies concern about nominal effective exchange rate (NEER), which is the measurement of weighted average of that particular currency to the major trading partners (Canales-Kriljenko & Habermeier, 2004). In this paper, the analysis uses real effective exchange rate (REER) basis instead of NEER. REER refers to the product of NEER and the price ratio of two countries (Catã, 2007). The studies dealing with two currencies cannot easily differentiate the change in exchange rate whether the change is caused by the target currency or the reference currency. If the study bases on one reference currency, there will be problem on the instability of that currency. With this reason, this paper will be REER basis and there is no particular currency used as reference. The following equation is used to calculate the NEER:

$$Index_t^{NEER} = \sum_{i=1}^{n} w_i \left(\frac{E_{it}}{E_{ib}}\right) = w_1 \left(\frac{E_{1t}}{E_{1b}}\right) + w_2 \left(\frac{E_{2t}}{E_{2b}}\right) + w_3 \left(\frac{E_{3t}}{E_{3b}}\right) \ldots + w_n \left(\frac{E_{nt}}{E_{nb}}\right)$$

Where

w_i = Weighted or ration of export and import value

E_{it} = Exchange rate between trading partner country *i* and our country at time t

E_{ib} = Basis of exchange rate between trading partner country *i* and our country

About REER, the equation is:

$$REER = \sum_{i=1}^{n} w_i \times \left(\frac{FC_i}{HC_{ib}}\right) \times \left(\frac{P}{P_i}\right)$$

Where

n = Number of trading partner countries

FC_i/HC = Exchange rate between trading partner country *i* and our country

P_i = Price level in trading partner country *i*

P = Price level in our country

There are several ways to calculate REER. The above equation is one of the all types. The concept bases on PPP, using the

arithmetic mean to finalize the result. In reality, geometric mean or using macroeconomics balance approach is also acceptable; however, arithmetic mean with PPP basis is the most popular due to its ease (Supasawatkul, 1999).

Limitation and Design of Study

In order to do Fourier analysis, the plot of historical data of Thai baht REER, derived from Bank of Thailand (BOT), in 249 months period, started from January 1990 to October 2010. It is exploited as the foundation of study. Fourier analysis of historical data will be processed in order to extract all components with hypothesis implied by earlier works, ***the basis unit of economic fundamentals exists and its characteristic of time- value (price ✕ quantity) function is sinusoidal wave form***. The analytical procedure can be divided into five steps as demonstrated below:

1. The beginning of procedure is to examine the raw REER data (see Appendix1) which is published by BOT.
2. All data is converted into the line graph whose horizontal axis regards the dimension of time and the vertical axis regards the value of REER through the method of linear interpolation as shown in figure 1. This plot will be very beneficial when we compare the raw data and analytical results.
3. The implementation of Fourier analysis can be executed through the fundamental equations of Fourier series in order to extract the hidden harmonics out of the traditional sketch. In this process, linear interpolation is applied before hand for an ease of mathematical integration when doing Fourier series transformation.

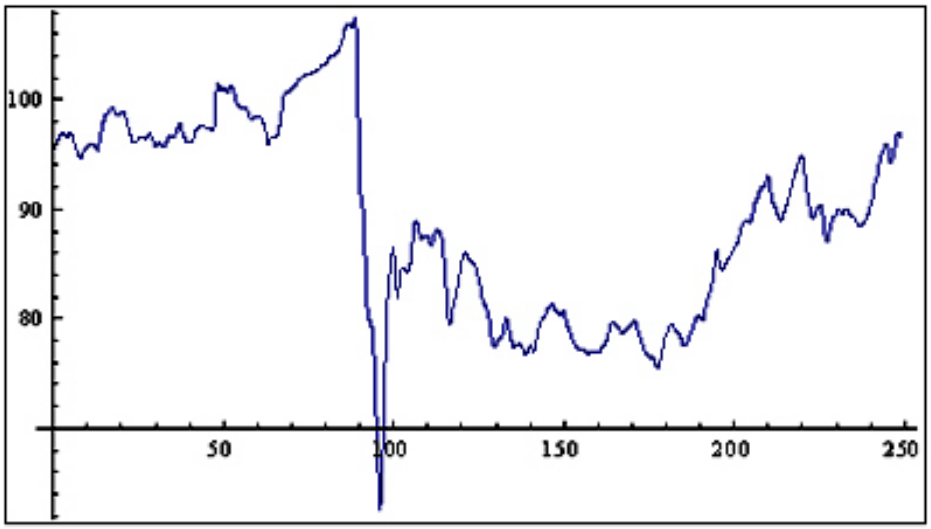

Figure 1: Real effective exchange rate of Thai baht
Source: graph constructed by the author, based on data from BOT website.

The Fourier series transformation is done accordingly to the equation below:

$$f(x) = \frac{a_0}{2} + \sum_{n=1}^{\infty} \left[a_n \cos\left(\frac{2\pi nx}{T}\right) + b_n \sin\left(\frac{2\pi nx}{T}\right) \right]$$

Where

$$a_n = \frac{2}{T} \int_0^T f(x) \cos\left(\frac{2\pi nx}{T}\right) dx \; ; \; n \geq 0$$

And

$$b_n = \frac{2}{T} \int_0^T f(x) \sin\left(\frac{2\pi nx}{T}\right) dx \; ; \; n \geq 1$$

4. After Fourier series transformation is finished, the derived relationship between amplitude and frequency of each harmonic will be shown up in terms of an and bn coefficients. The plots can be differentiated into two graphs. The first graph is amplitude plot in which the relationship between amplitude and frequency is demonstrated. The second graph expresses the relationship between frequency and polar.
5. In spectral plot, all of dominant harmonics are selected so as to compare its life cycle to several existing business cycles; subsequently, the comparison of harmonic frequencies and business cycles will imply the outstanding factors for further analysis.

Result of Fourier Analysis

Corresponding to the background, the exchange rate depends upon the demand of the currency from all over the world. As a result, we use indirect method to examine the hidden influence frequency spectra to REER of Thai baht.

The results of Fourier series transformation are shown below:

a_n = {30.4241Sin[2nπ/249]}/n + {30.5737(-Sin[2nπ/249] + Sin [4nπ/249])}/n + {30.8251 (-Sin [4nπ/249] + Sin[2nπ/83])}/n + {30.8538(-Sin[2nπ/83] + Sin[8nπ/ 249])}/n + {30.7424(-Sin[8nπ/ 249] + Sin [10nπ/249])}/n + {30.8761(-Sin[10nπ/249] + Sin [4nπ/83])}/n + {30.6437(-Sin [4nπ/83] + Sin[14nπ/249])}/n + {30.3031(-Sin[14nπ/249] + Sin [16nπ/249])}/n + {30.1981(-Sin [16nπ/249] + Sin[6nπ/83])}/n + ….

b_n = {30.8251(Cos[4nπ/249]-Cos [2nπ/83])}/n + {30.8538 (Cos [2nπ/83] - Cos[8nπ/249])}/n + {30.7424(Cos[8nπ/249] - Cos [10nπ/249])}/n + {30.8761(Cos [10nπ/249] - Cos[4nπ/83])}/n + {30.6437(Cos[4nπ/83] - Cos [14nπ)/249])}/n + {30.3031(Cos [14nπ/249] - Cos[16nπ/249])}/n + {30.1981 (Cos[16nπ/249] - Cos[6nπ/83])}/n + {30.3636(Cos [6nπ/83] - Cos[20nπ/249])}/n + {30.4718(Cos[20nπ/249] - Cos [22nπ/249])}/n + ….

Then, substitution of n by positive integers is done in order to ascertain the value of coefficients. The derivatives of substitution are:

a_1 = 6.46358, a_2 = -1.67527,
a_3 = 0.286379, a_4 = 0.0775947,
a_5 = -1.06439, a_6 = 2.01154,
a_7 = -0.0452464, a_8 = -1.10845,
a_9 = 1.65238, a_{10} = -0.219299, etc.
b_1 = 8.59625, b_2 = -1.70544,
b_3 = -1.37579, b_4 = 2.25575,
b_5 = 0.984286, b_6 = -0.730876,
b_7 = 1.83633, b_8 = -1.62614,
b_9 = 0.0119177, b_{10} = 0.564926, etc.

The combination of coefficient a_n and b_n forms two significant parameters; they are amplitude and polar. The plots of both parameters versus frequency, so-called frequency spectra or spectral plot, are shown in figure 2 and figure 3.

After performing Fourier series transformation and getting coefficients, it is observable that there are four major frequencies dominating the characteristic of the original plot. As shown in figure 2 and figure 3, it is obvious that the first harmonic has the greatest effect on overall value. In addition, the 2nd, 4th, and 6th harmonics also have the relatively great affect on the plot. By taking consideration of four harmonics, we derive the following equation.

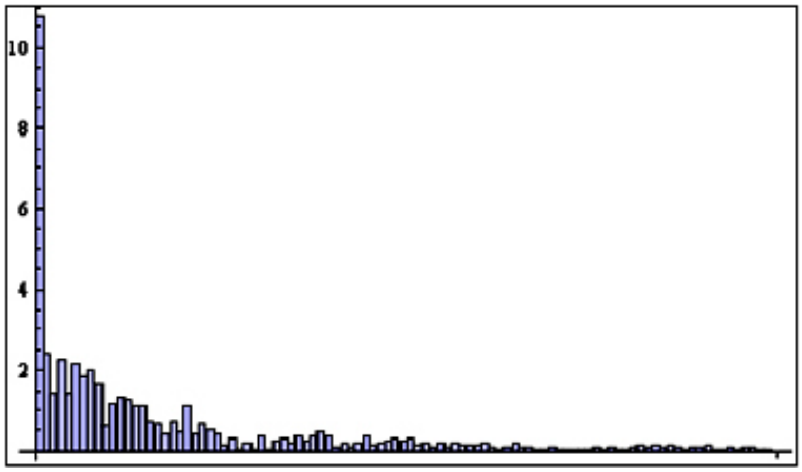

Figure 2: Frequency Spectra of Thai Baht Real Effective Exchange Rate (1)

Source: amplitude |F (ϖ)| plot constructed by the author, based on data from Fourier analysis of original plot

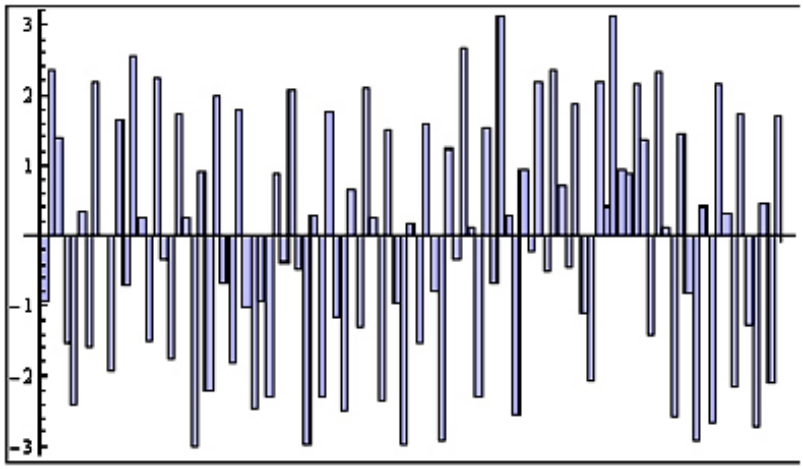

Figure 3: Frequency Spectra of Thai Baht Real Effective Exchange Rate (2)

Source: polar plot graph constructed by the author, based on data from Fourier analysis of original plot

REER =

$$89.2373 + 6.46358\cos\left[\frac{2\pi x}{249}\right] + 8.59625\sin\left[\frac{2\pi x}{249}\right] - 1.67527\cos\left[\frac{4\pi x}{249}\right] - 1.70544\sin\left[\frac{4\pi x}{249}\right] + 0.0775947\cos\left[\frac{6\pi x}{249}\right] + 2.25575\sin\left[\frac{6\pi x}{249}\right] + 2.01154\cos\left[\frac{12\pi x}{249}\right] - 0.730876\sin\left[\frac{12\pi x}{249}\right]$$

*NOTE: x is time domain (month)

The sum of harmonics shows correspondence in tendency between resultant analysis and the original sketch. Moreover, according to the series, factors that may influence the exchange rate need to have the life cycle of three, five, ten, or twenty years. The harmonics obtained from the Fourier analysis, basically, coincide with three interesting cycles; they are Kuznet Cycle (Inventory cycle), Juglar Cycle (fixed investment cycle), and Kitchin cycle (infrastructure investment cycle) (Pancrazi, 2007). The major influencing overall value is Kuznet Cycle as shown in first harmonic of twenty years period.

Moreover, the collection of all important factors will result in the function that is able to predict the REER accurately. The comparison between taking 4 dominating harmonics and 43 harmonics is shown below.

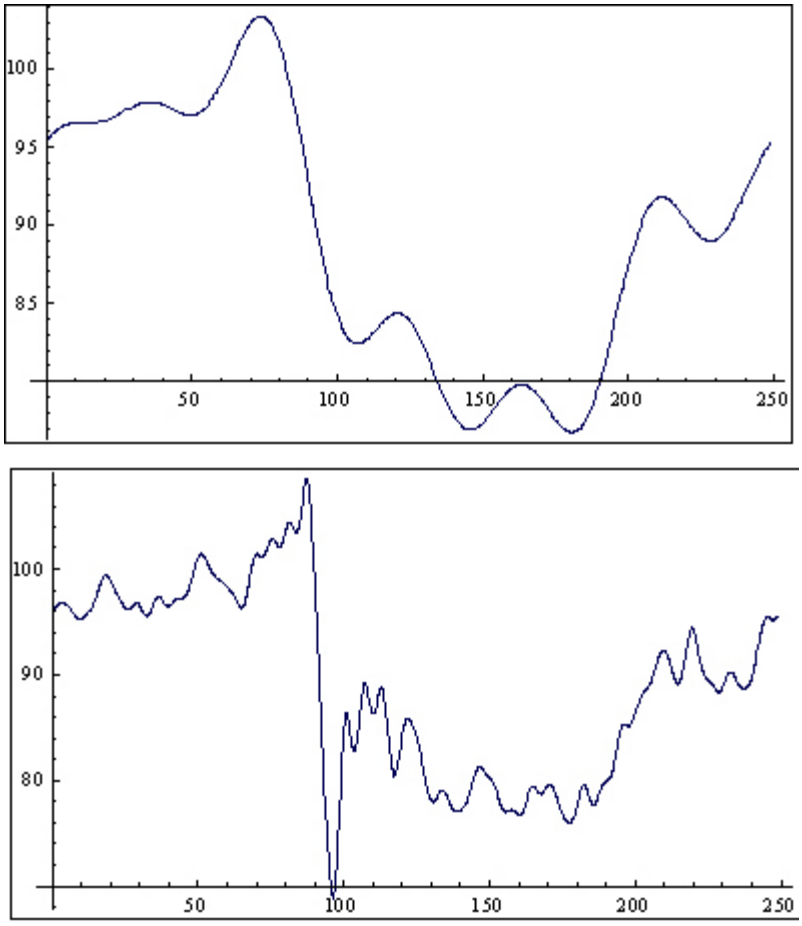

Figure 4: Comparison of Calculated REER Based on 4 Dominating Harmonics and 43 Harmonics of Fourier Series Components

Source: graph constructed by the author, based on data from Fourier analysis of original plot

Conclusion & Recommendation

According to earlier studies and the results found in this paper, it clearly indicates that macroeconomic fundamentals overwhelm REER of currency. The fluctuation of currency can be demonstrated in term of Fourier series which refers to the sum of sinusoidal waveform with different frequencies. Moreover -- based on analysis -- it shows that the resultant harmonics are corresponding to the existence of Kitchin cycle (1923), Juglar cycle (1862), and Kuznet cycle (1930). As a result, corresponding to those cycles, keeping eyes on fixed capital investment, employment level, and infrastructure investment situation lead to better strategic decision whose basis needs currency exchange rate.

However, the affirmation of relativity between economic fundamentals and harmonic components of real effective exchange rate needs further research in order to create accurate mathematical model explicate time-demand value function of currency. In addition, if the applicability is confirmed, it will prove that direct usage of traditional regression analysis is not applicable to demonstrate relativity of economic fundamental factors and fluctuation of currency; instead, Fourier analysis has become necessary to extract harmonics and, afterward, regression analysis between economic fundamentals and harmonics will be doable.

ReEFERENCES

Arghyrou, M. (2000). *EXCHANGE RATE PEGGING: CREDIBILITY AND FUNDAMENTALS* Evidence from Greece. Retrieved December 4, 2010, from http://bura.brunel.ac.uk/bitstream/2438/883/1/00-02.pdf

Baye, M.R. (2010). *Managerial Economics and Business Strategy* (7th ed.). Singapore: McGraw-Hill/Irwin

Berthelsen, J. (2010, October 5). China and the Weak Yuan. *Asia Sentinel*. Retrieved December 9, 2010, from http://www.asiasentinel.com/index.php?option=com_content &task=view&id=2737&Itemid=422

Brown, J.W., & Churchill, R.V. (1993). *Fourier Series and Boundary Value Problems* (5th ed.). Singapore: McGraw-Hill Book

Canales-kriljenko, J., & Habermeier, K. (2004). *Structural Factors Affecting Exchange Rate Volatility: A Cross-Section Study*. Retrieved December 4, 2010, from http://www.imf.org/external/pubs/ft/wp/2004/wp04147.pdf

Cheung, Y. W. and Lai, K.(1993). Long-Run Purchasing Power Parity during the RecentFloat, *Journal of International Economics*, 34,181-192.

Darby, M. R. (1980). *Does Purchasing Power Parity Work?* Retrieved December 8, 2010, from http://www.nber.org/papers/w0607.pdf

Finney, R.L., Weir, M.D., & Giordano, F.R. (2001). *Thomas' Calculus* (10th ed.). Boston: Addison Wesley Longman.

Hopper, G. P. (1997). *What Determines the Exchange Rate: Economic Factors or Market Sentiment?*. Retrieved December 9, 2010, from http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.116.6702&rep=rep1&type=pdf

Isard, P. (1980). *Factors Determining Ex-*

change Rates: The Roles of Relative Price Level, Balances of Payments, Interest Rates and Risk. Retrieved December 8, 2010, from http://www.bis.org/publ/work4.pdf.

Meese, R. A., & Rogoff, K. (1983). Empirical Exchange Rate Models of the Seventies. *Journal of International Economics*, 3-24.

Moore, N. (2006). *How to do research: a practical guide to designing and managing research projects* (3rd ed.). Great Britain: Facet Publishing

Moosa, I. A. (2008). Forecasting the Chinese Yuan-US Dollar Exchange Rate under the New Chinese Exchange Rate Regime. *Journal of Business*, 7(1), 23-35.

Phillips, C.L., Parr, J.M., & Riskin, E.A. (2003). *Signals, systems, and transforms* (3rd ed.). New Jercy: Prentice Hall

Rogoff, K. (1992). Traded Good Consumption Smoothing and the Random Walk Behavior of the Real Exchange Rate. *BOJ MONETARY AND ECONOMIC STUDIES*, 10(2), 1-29.

Sanidas, E. (2005). *The Australian Dollar's Long-term Fluctuations and Trend: The Commodity Prices-cum-Economic Cycles Hypothesis*. Retrieved December 3, 2010, from http://ro.uow.edu.au/commwkpapers/135/

Simonoff, J.S. (2008). *Purchasing power parity: is it true?*. Retrieved December 5, 2010, from http://pages.stern.nyu.edu/~jsimonof/classes/2301/pdf/ppp.pdf

Stonebraker, R.J. (2010). *Demand and Supply Applied: Exchange Rate*. Retrieved December 10, 2010, from http://faculty.winthrop.edu/stonebrakerr/book/exchangerates.htm

Supasawatkul, M. (1994). ดัชนีค่าเงินที่แท้จริง แนวคิด การคำนวณ และการประยุกต์ใช้กรณีประเทศไทย [Real Effective Exchange Rate Index and its application in Thailand]. *Exchange Organizational Behaviour Teaching Journal*, p.1-17.

Appendix 1 (Real Effective Exchange Rate)

	2010/10	**2010/09**	**2010/08**	**2010/07**	**2010/06**	**2010/05**	**2010/04**	**2010/03**
REER	96.34	96.78	94.92	94.28	95.97	95.61	94.36	93.06
	249	248	247	246	245	244	243	242
	2010/02	**2010/01**	**2009/12**	**2009/11**	**2009/10**	**2009/9**	**2009/8**	**2009/7**
	91.40	90.38	89.32	88.73	88.48	88.94	89.27	89.59
	241	240	239	238	237	236	235	234
	2009/6	**2009/5**	**2009/4**	**2009/3**	**2009/2**	**2009/1**	**2008/12**	**2008/11**
	90.10	89.52	90.11	89.46	89.30	87.71	87.16	89.90
	233	232	231	230	229	228	227	226
	2008/10	**2008/9**	**2008/8**	**2008/7**	**2008/6**	**2008/5**	**2008/4**	**2008/3**
	90.27	89.77	89.14	90.80	92.47	94.90	94.35	93.44
	225	224	223	222	221	220	219	218
	2008/2	**2008/1**	**2007/12**	**2007/11**	**2007/10**	**2007/9**	**2007/8**	**2007/7**
	92.00	90.76	90.01	88.99	89.44	90.52	91.00	93.08
	217	216	215	214	213	212	211	210
	2007/6	**2007/5**	**2007/4**	**2007/3**	**2007/2**	**2007/1**	**2006/12**	**2006/11**
	92.05	92.01	91.04	90.47	88.97	88.97	88.90	88.16
	209	208	207	206	205	204	203	202
	2006/10	**2006/9**	**2006/8**	**2006/7**	**2006/6**	**2006/5**	**2006/4**	**2006/3**
	87.01	86.38	85.80	85.35	84.64	84.68	86.23	84.01
	201	200	199	198	197	196	195	194
	2006/2	**2006/1**	**2005/12**	**2005/11**	**2005/10**	**2005/9**	**2005/8**	**2005/7**
	82.50	81.40	79.91	80.26	80.05	79.22	78.45	77.81
	193	192	191	190	189	188	187	186
	2005/6	**2005/5**	**2005/4**	**2005/3**	**2005/2**	**2005/1**	**2004/12**	**2004/11**
	77.65	78.66	78.76	79.40	79.41	78.40	77.22	75.76
	185	184	183	182	181	180	179	178
	2004/10	**2004/9**	**2004/8**	**2004/7**	**2004/6**	**2004/5**	**2004/4**	**2004/3**
	75.76	76.62	76.50	76.97	77.81	78.81	79.80	79.45
	177	176	175	174	173	172	171	170
	2004/2	**2004/1**	**2003/12**	**2003/11**	**2003/10**	**2003/9**	**2003/8**	**2003/7**
	79.29	78.85	78.57	79.17	79.42	79.77	78.48	77.65
	169	168	167	166	165	164	163	162
	2003/6	**2003/5**	**2003/4**	**2003/3**	**2003/2**	**2003/1**	**2002/12**	**2002/11**
	77.40	76.93	76.97	76.94	76.82	77.29	77.28	77.38
	161	160	159	158	157	156	155	154
	2002/10	**2002/9**	**2002/8**	**2002/7**	**2002/6**	**2002/5**	**2002/4**	**2002/3**
	77.87	78.69	79.32	80.65	80.35	80.76	81.08	81.25
	153	152	151	150	149	148	147	146
	2002/2	**2002/1**	**2001/12**	**2001/11**	**2001/10**	**2001/9**	**2001/8**	**2001/7**
	80.78	80.09	79.63	78.14	77.12	77.61	76.76	77.28
	145	144	143	142	141	140	139	138
	2001/6	**2001/5**	**2001/4**	**2001/3**	**2001/2**	**2001/1**	**2000/12**	**2000/11**
	77.77	77.62	77.56	78.92	80.03	78.39	78.36	77.52
	137	136	135	134	133	132	131	130
	2000/10	**2000/9**	**2000/8**	**2000/7**	**2000/6**	**2000/5**	**2000/4**	**2000/3**
	77.87	80.04	81.23	81.75	83.56	84.78	85.25	85.55
	129	128	127	126	125	124	123	122

	2000/2	**2000/1**	**1999/12**	**1999/11**	**1999/10**	**1999/9**	**1999/8**	**1999/7**
	85.99	85.27	83.32	81.90	79.96	80.02	84.57	87.45
	121	120	119	118	117	116	115	114
	1999/6	**1999/5**	**1999/4**	**1999/3**	**1999/2**	**1999/1**	**1998/12**	**1998/11**
	88.02	87.86	86.68	87.57	87.55	87.39	88.52	88.84
	113	112	111	110	109	108	107	106
	1998/10	**1998/9**	**1998/8**	**1998/7**	**1998/6**	**1998/5**	**1998/4**	**1998/3**
	85.43	84.28	84.55	84.49	81.93	86.40	84.36	80.37
	105	104	103	102	101	100	99	98
	1998/2	**1998/1**	**1997/12**	**1997/11**	**1997/10**	**1997/9**	**1997/8**	**1997/7**
	71.20	62.46	70.88	78.10	79.80	81.26	89.80	92.29
	97	96	95	94	93	92	91	90
	1997/6	**1997/5**	**1997/4**	**1997/3**	**1997/2**	**1997/1**	**1996/12**	**1996/11**
	106.38	106.68	106.84	106.81	105.83	104.59	104.18	104.07
	89	88	87	86	85	84	83	82
	1996/10	**1996/9**	**1996/8**	**1996/7**	**1996/6**	**1996/5**	**1996/4**	**1996/3**
	103.83	103.31	103.21	102.75	102.64	102.48	102.42	102.26
	81	80	79	78	77	76	75	74
	1996/2	**1996/1**	**1995/12**	**1995/11**	**1995/10**	**1995/9**	**1995/8**	**1995/7**
	102.07	101.89	101.36	101.09	100.73	100.68	99.04	97.11
	73	72	71	70	69	68	67	66
	1995/6	**1995/5**	**1995/4**	**1995/3**	**1995/2**	**1995/1**	**1994/12**	**1994/11**
	96.63	96.65	96.01	97.39	98.33	98.36	98.36	98.23
	65	64	63	62	61	60	59	58
	1994/10	**1994/9**	**1994/8**	**1994/7**	**1994/6**	**1994/5**	**1994/4**	**1994/3**
	99.00	99.35	99.33	99.64	100.87	101.24	100.66	101.11
	57	56	55	54	53	52	51	50
	1994/2	**1994/1**	**1993/12**	**1993/11**	**1993/10**	**1993/9**	**1993/8**	**1993/7**
	100.88	101.32	97.46	97.45	97.40	97.68	97.50	97.43
	49	48	47	46	45	44	43	42
	1993/6	**1993/5**	**1993/4**	**1993/3**	**1993/2**	**1993/1**	**1992/12**	**1992/11**
	96.36	96.25	96.31	97.09	97.81	96.99	96.55	96.77
	41	40	39	38	37	36	35	34
	1992/10	**1992/9**	**1992/8**	**1992/7**	**1992/6**	**1992/5**	**1992/4**	**1992/3**
	95.99	95.72	96.12	95.80	96.51	96.91	96.35	96.70
	33	32	31	30	29	28	27	26
	1992/2	**1992/1**	**1991/12**	**1991/11**	**1991/10**	**1991/9**	**1991/8**	**1991/7**
	96.47	96.10	96.44	97.36	98.67	98.87	98.69	98.81
	25	24	23	22	21	20	19	18
	1991/6	**1991/5**	**1991/4**	**1991/3**	**1991/2**	**1991/1**	**1990/12**	**1990/11**
	99.37	98.74	98.49	96.85	95.49	95.77	95.93	95.73
	17	16	15	14	13	12	11	10
	1990/10	**1990/9**	**1990/8**	**1990/7**	**1990/6**	**1990/5**	**1990/4**	**1990/3**
	95.39	94.87	95.20	96.27	97.00	96.58	96.93	96.84
	9	8	7	6	5	4	3	2
	1990/2	**1990/1**						
	96.05	95.58						
	1	0						

Source: http://www2.bot.or.th/statistics/BOTWEBSTAT.aspx?reportID=407&language=TH

Appendix 2 (Fourier Transform Code in Mathematica)

```
(*data is derived from appendix 1*)
f = Interpolation[data];

(*find An coefficient*)
atemp = 0;
For [j = 0, j < 249, j = j + 1,
atemp = atemp + Refine[Integrate[2/249*f[j]*Cos[2*Pi*n*x/249], {x, j, j + 1}],
Assumptions -> n ? Intergers]];
Print[atemp];

(*find Bn coefficient*)
btemp = 0;
For [j = 0, j < 249, j = j + 1,
btemp = btemp + Refine[Integrate[2/249*f[j]*Sin[2*Pi*n*x/249], {x, j, j + 1}],
Assumptions -> n ? Intergers]];
Print[btemp];
```