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Currency evaluation using a big mac index for Thailand – lessons for Vietnam

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Abstract

The study is conducted to evaluate Thailand's currency using both Consumer Price Index (CPI) and Big Mac Index (BMI) over the period of 1980-2013. The measurement of long-run equilibrium exchange rate is based on the purchasing power parity (PPP) using panel unit root test, panel co-integration test, and the fully modified ordinary least squares method. Empirical results from this study confirm a solid validity of PPP for CPI-based exchange rate and a weak evidence for BMI-based exchange rate. As for Thailand's currency evaluation, the result illustrates that (i) the CPI-based exchange rate provides a relatively consistent result with BMI-based exchange rate, with the exception of the 1997 Asian financial crisis and that (ii) the BMI-based exchange rate is more superior when bilaterally being evaluated between Thai Baht and US Dollar. Some lessons can be drawn for policy for both Thailand and Vietnam.

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1. Introduction

In the early year of 2014, with the opening of the first ever branch of McDonald's, a giant US fast-food company in Ho Chi Minh City, Viet Nam, the Economics Magazine added the Vietnam Dong into its collection of the Big Mac Index (BMI). This index provides a McDonald's burger price in different parts of the world in terms of local and foreign currencies. It is considered as a lighthearted guide for an evaluation of whether a currency of a particular country is at its correct level. The index has been increasingly well-recognized as a global standard throughout its presence in several international economics books and many academic studies. According to a world-recognized Economics Magazine, the Vietnam Dong is undervalued approximately 40% compared to the US dollar, Euro, or British pound and around 5% against Japanese Yen, but it is overvalued by almost 5% against Chinese Yuan. From this context, a variety of questions emerge such as: (i) how much the Vietnam Dong actually is under- or overvalued, on average, in comparison with other currencies in the world?, and (ii) how the Big Mac index is used in research?. Seeking answers for such these questions represents a starting point for this paper. However, it appears to be difficult to conduct the study for Vietnam owing to data limitation. As a result, Thailand is selected as a case study for the following reasons. First, data for the BMI in Thailand are available as this index has been regularly published by the Economics magazine since 1993. Second, Vietnam and Thailand seems to be similar in many aspects and it is argued that Vietnam is catching up with Thailand in terms of economic growth and development. As a result, empirical findings achieved from this study can be used to draw policy implications for Vietnam.

Table 1 presents typical social and economic data for both countries over a decade from 2000 to 2010. Although Thailand's GDP was over two times larger as compared to that of Vietnam, the growth of GDP as well as growth of per capita GDP in Vietnam was slightly higher than that of Thailand. The ratio of trade to GDP in Vietnam was lower than in Thailand, accounting for around 115 per cent in the 2001-2005 period, but this ratio rose significantly in the following period, exceeding by 17 per cent than the same ratio of Thailand. In addition, the given periods experienced a surplus in its current account in Thailand whereas reversed patterns were observed in Vietnam. The total reserves over GDP for both countries increased considerably over the selected period. A striking note is that while the official exchange rate in Thailand appreciated, Vietnam currency experienced a depreciation.

Table I: Social and economic breakthrough in Thailand and Vietnam

Country	Year	GDP	GDP growth	GDP per capita growth	Trade over GDP	Current account balance	Total reserves over GDP	Exchange rate
Thailand	2001-2005	153.82	5.45	4.42	123.44	1.68	0.28	41.86
	2006-2010	279.72	3.78	3.52	130.01	3.71	0.40	34.34
Vietnam	2001-2005	44.60	6.90	5.63	115.92	-1.42	0.13	15,423
	2006-2010	92.97	6.32	5.18	147.15	-6.01	0.20	16,815

Source: Authors' calculation from World Bank data

The objective of this study is to evaluate the real value of Thailand Baht over the 1980-2013 period. The topic of currency evaluation is very interesting in the current economic context, especially for the Asian countries, as the understanding of the valuation of currencies is a significant intellectual challenge and of great importance for economic policy, the smooth functioning of financial markets, and the financial management of many international companies. The paper provides key advantages compared to previous studies. *First,* it widens empirical studies of evaluating Thailand's currency during the 1997 Asia financial crisis (Chinn 2000). It is essential that an evaluation of Thai Bath should be considered in different periods of time in other that policy-makers, investors, importers as well exporters grasp a whole picture of the tendency in exchange rate changes. *Second,* it is the first ever study of this kind, using the BMI for an evaluation of Thailand's currency. It is widely believed that the Big Mac index offers a sense of simplicity and brings a surprisingly accurate result (see also Clements and Lan 2010, and Ong 1997). Meanwhile, the common-used index, the Consumer Price Index (CPI), is adopted for the purpose of clarifying the effectiveness of BMI. *Third,* instead of ordinary least squares estimation, the study uses the fully modified ordinary least squares (FMOLS) method, which permits data with heterogeneous across individuals, for an estimation of the equilibrium exchange rate, and thus obtaining better results. As there are many acronyms used, they are summarized at the end of this paper.[1]

The paper is constructed as follows. Following this Introduction, literature review provides theory and empirical evidence related to exchange rate evaluation. Section 3 presents the overview of the BMI. Research methodology including econometric techniques and empirical model is presented in Section 4. Research findings are presented in section 5, following with conclusions and policy implications for Vietnam in section 6.

2. Literature review

The theory of purchasing power parity (PPP) includes two separate versions: the absolute PPP and the relative PPP. The absolute PPP relates to the relationship between nominal exchange rate and the corresponding relative price level. Meanwhile, the relative PPP expresses this relationship as the first difference form, meaning that percentage change in the exchange rate between two currencies over any period approximately equals the difference between the percentage changes in the national price levels (Krugman *et al.* 2012: 387).

There have recently been two emerging schools using panel data for the test of PPP: (i) panel unit root tests and (ii) panel co-integration test*s*. On the first school, Oh (1996) explicitly finds evidence in favor with PPP for the group of G-6 and OECD nations during the period of flexible exchange rate and argues that unit root tests using panel data were more powerful than that of conventional univariate time series. Wu (1996) and Connell (1998) offer further support for Oh's (1996) findings. Papell (1997) examines the long-run PPP for industrial nations over the period of floating exchange rate regimes. The finding indicates that the null hypothesis of unit roots had a stronger tendency to be rejected for large than small panels, for monthly than quarterly data, and for using German mark as a base currency than the US dollar. Another school of examining long run PPP has been employed the panel cointegration test, with some typical researchers including Cazoneri *et al.* (1999) and Pedroni (2004). These researchers find valid evidence to reject the null

hypothesis of no cointegration, thus reinforcing the weaker version of PPP with heterogeneous slope coefficients.

With the development of panel econometrics technique, a number of empirical papers make a supportive confirmation that the PPP holds in the long run. A common explanation for the support of PPP is the power of panel tests (see also Oh 1996, Wu 1996, and Connell 1998). Papell (2002) offers a different reason why PPP holds with panel data; the great appreciation and depreciation of currencies adhere to typical patterns of the dollar's fall and rise. However, it should be noted other issues which destabilize the validity of PPP tests. Benergiee *et al.* (2005) put an emphasis on an important underlining of cross-unit cointegrating relationship with panel-based unit root tests so that the use of panel methods for testing unit roots should be cautious. Papell and Theodoridis (2001) point out that the choice of a currency in panel methods significantly influenced results of PPP testing, together with distances between nations and the volatility of exchange rate. Taylor and Taylor (2004) present a summary of debates associated with PPP that have been challenged academic researchers for recent decades.

Chinn (2000) implements three different models including (i) long-run PPP, (ii) a productivity-based model, and (iii) a monetary model to estimate the equilibrium exchange rate of the East Asian currencies. The results indicate that most selected currencies had been overvalued before the 1997 financial crisis happened. The PPP and productivity-based approaches indicate closely conclusions in which currency of Hong Kong, Thailand, Malaysia, Indonesia, and Taiwan are overvalued and the Korea's Won is undervalued. The overvaluation of Malaysia's Ringgit and Thailand's Bath are negligible. In other study, Jonwanich (2008) shows consistent findings with that of Chinn (2000). Zhang (2001) indicate that China's currency, the Renminbi, is overvalued during central planning periods and converge to the equilibrium level after China's economic reforms. Using BMI, Yang (2004) makes an analysis of China's currency and shows her undervaluation. However, Cheung *et al.* (2007) cast doubt on the conventional wisdom of undervaluation of Renmibi, asserting that when the uncertainty and serial correlation in data accounted for, there is little evidence that China's currency is undervalued.

Rajan *et al.* (2004) identify misalignments of Thailand's currency in terms of economic fundamental model and examine effects of exchange rate misalignments on trade performance during the 1980s and 1990s. The findings indicate that the real exchange rate and bilateral exchange rate against the US dollar experience moderate misalignments while as for bilateral exchange rate against Japanese Yen, the degree of misalignments is significant.

3. An Overview of a Big Mac Index

BMI is the reflection of McDonald hamburger's prices all over the globe. The world-wide magazine, the Economists, has published regularly since 1986. The index has been increasingly well-recognized as a global standard with its presence in several international economics books and many academic studies. The advantage of BMI is its virtually exact composition. In other words, with few exceptions, ingredients of a burger seem to be the same in everywhere it is sold. Thus, the standard of BMI satisfies at least a requirement of testing the PPP, so its contribution to real exchange rate estimation could be relatively precise. However, the BMI cannot totally overcome other strict conditions for testing PPP theory. Pakko and Polard (2003) provide explanations of the failure to test the PPP. The first factor can possibly be trade barriers such as

transaction costs, trade restrictions, and taxes. The second element comes from the non-traded composition of goods, which allows to reflect productivity bias, government spending, and current account deficits among interest nations. The final determinant of PPP ineffectiveness is related to the pricing to market.

The BMI has been generally applied in the research community, where it has been utilized to evaluate a nation's currency, to test PPP hypothesis, and to forecast the exchange rate (see also Caetano *et al.* 2004, Clements and Lan 2010, Click 1996, Cumby 1996, Ong 1997, and Yang 2004). Clements *et al.* (2012) strongly believes that Bugernomics has become an increasingly growing trend on the prediction of exchange rates thanks to its simplicity (Clements and Lan 2010) and a surprisingly accurate result (Ong 1997). Parsley and Wei (2007) employ the Big Mac price as well as costs of different compositions with aims at studying real exchange rate and the speed of convergence of the real exchange rate adjusted by Big Mac index. Chen and Wang (2007) apply the panel co-integration approach on the purpose of comparing the validity of PPP using CPI and BMI. Amazingly, a Big Mac index-based price was more supportive to the validity of PPP than a CPI-based price.

Yang (2004) makes an analysis of China's currency, Renminbi, with the application of the BMI as a guide. The findings supported the view that the Renminbi was undervalued in comparison with the US dollar over the surveyed period. The author argued that the undervaluation of Renminbi resulted from two natural elements: (i) the non-traded ingredients of the products, and (ii) the wage differences between in China and in the US. A policy recommendation was that the Renminbi should revalue when the gaps in productivity and labor compensation between two nations narrow.

4. Research Methodology

4.1 Panel Unit Root Test

To avoid spurious regressions associated with time series data, the panel data is checked whether it is stationary or not with the use of Breitung's (2001) panel-based unit root test. It is argued that this test's performance is more powerful than unit root tests employed in individual time series data. Unlike other panel-based unit root tests (see also Im *et al.* 2003, and Maddala and Wu 1999), Breitung (2001) approach allows individual process to have a common unit root. This approach is similar to that of Levin *et al.* (2002). A common unit root assumes that the tests have a common autoregressive structure for all the series. The prime function form of Breitung's (2001) test could be expressed in regressions:

$$\Delta y_{it} = \alpha_i + \beta y_{it-1} + \sum_{j=1}^{p_i} \theta_{ij} \Delta y_{i,t-j} + \varepsilon_{it} \; ; i = 1,2, \dots, n; t = 1,2, \dots, T \qquad (1)$$

where Δ represents the first difference variable, i=1,2,.., n individuals in the panel, and t=1,2,…,T time periods. The error term, ε_{it}, is independently distributed normal for all *i* and *t*, and has heterogeneous variances across individuals. Under Breitung's (2001) panel-based unit root test, the null hypothesis is that all panels contain a unit root, meaning that H_0: $\beta=0$. The alternative hypothesis is that not all of the individual series have a unit root; that is H_A: $\beta < 0$.

4.2 Panel Cointegration Test

Kao's Cointegration Test

Kao (1999) constructed the residual-based cointegration test on the basis of Dickey-Fuller (DF) and Augmented Dickey-Fuller (ADF) test. The estimation model is as follows:

$$y_{it} = \alpha_i + \beta_i x_{it} + e_{it};\ i = 1, \dots, N; t = 1, \dots, T \quad (2)$$

where error term e_{it} is I(1).

The DF test could be applied to the residuals with a function $\widehat{e_{it}} = p\widehat{e_{it-1}} + v_{it}$ (3)

The ADF test uses an extension of above equation with an added lag changes in the regression to correct serial correlation. $\widehat{e_{it}} = p\widehat{e_{it-1}} + \sum_{j=1}^{k} \varphi_j \Delta\hat{e}_{it-j} + v_{itp}$ (4)

The null hypothesis of no co-integration is tested with p=1, and the alternative hypothesis is cointegrated with p<1. The function of the t-statistic calculation is presented in Kao (1999).

Pedroni's Cointegration Test

The general estimation for Pedroni's cointegration test is specified as follow:

$$y_{it} = \alpha_i + \sum_{m=1}^{M} \beta_{mi}\, x_{m\,i\,t} + \varepsilon_{it}\,; i = 1,2, \dots, N; t = 1,2, \dots, T \quad (5)$$

where M, N, and T respectively represent the number of independent variables, the number of individuals, and the time period. The parameter α_i denotes the unit-specific fixed effects. Pedroni (1999, 2001) proposed seven test statistics[2] for cointegration, which could be classified into two categories. These test statistics are calculated as follows.

Panel v-statistic: $\left(\sum_{i=1}^{N}\sum_{t=1}^{T} \hat{L}_{11i}^{-2}\, \hat{\varepsilon}_{i,t-1}^{2}\right)^{-1}$ (6)

Panel rho statistic: $\left(\sum_{i=1}^{N}\sum_{t=1}^{T} \hat{L}_{11i}^{-2}\, \hat{\varepsilon}_{i,t-1}^{2}\right)^{-1} \sum_{i=1}^{N}\sum_{t=1}^{T} \hat{L}_{11i}^{-2}\, (\hat{\varepsilon}_{i,t-1}^{2}\, \Delta\hat{\varepsilon}_{it} - \hat{\lambda}_i)$ (7)

Panel PP statistic: $\left(\tilde{\sigma}_{NT}^{2}\ \sum_{i=1}^{N}\sum_{t=1}^{T} \hat{L}_{11i}^{-2}\, \hat{\varepsilon}_{i,t-1}^{2}\right)^{\frac{-1}{2}} \sum_{i=1}^{N}\sum_{t=1}^{T} \hat{L}_{11i}^{-2}\, (\hat{\varepsilon}_{i,t-1}^{2}\, \Delta\hat{\varepsilon}_{it} - \hat{\lambda}_i)$ (8)

Panel ADF statistic: $\left(\tilde{s}_{NT}^{*2}\ \sum_{i=1}^{N}\sum_{t=1}^{T} \hat{L}_{11i}^{-2}\, \hat{\varepsilon}_{i,t-1}^{*2}\right)^{\frac{-1}{2}} \sum_{i=1}^{N}\sum_{t=1}^{T} \hat{L}_{11i}^{-2}\, \hat{\varepsilon}_{i,t-1}^{*}\, \Delta\hat{\varepsilon}_{i,t-1}^{*}$ (9)

Group rho statistic: $\sum_{i=1}^{N}\left(\sum_{t=1}^{T}\ \hat{\varepsilon}_{i,t-1}^{2}\right)^{-1} \sum_{t=1}^{T}\ (\hat{\varepsilon}_{i,t-1}^{2}\Delta\hat{\varepsilon}_{it} - \hat{\lambda}_i)$ (10)

Group PP statistic: $\sum_{i=1}^{N}\left(\sum_{t=1}^{T} \hat{\sigma}_i^{2}\ \hat{\varepsilon}_{i,t-1}^{2}\right)^{\frac{-1}{2}} \sum_{t=1}^{T}\ (\hat{\varepsilon}_{i,t-1}^{2}\Delta\hat{\varepsilon}_{it} - \hat{\lambda}_i)$ (11)

Group ADF statistic: $\sum_{i=1}^{N}\left(\sum_{t=1}^{T} \hat{s}_i^{*2}\ \hat{\varepsilon}_{i,t-1}^{*2}\right)^{\frac{-1}{2}} \sum_{t=1}^{T} \hat{\varepsilon}_{i,t-1}^{*}\Delta\,\hat{\varepsilon}_{it}^{*}$ (12)

The null hypothesis of the above-mentioned seven tests is that there is no cointegration amongst variables. If the null hypothesis is rejected, a conclusion of the existence of long-run relationship amongst variables could be drawn. In contrast, when the null hypothesis cannot be rejected, it means that there is no long run relationship amongst variables.

4.3 Fully Modified Ordinary Least Squares (FMOLS)

This paper applies the FMOLS technique proposed initially by Phillips and Hansen (1990) and extended by Pedroni (2000). The following co-integrated system of equations is considered as follows.

$$y_{it} = \alpha_i + \beta x_{it} + \mu_{it}\,; i = 1, \dots, N\,; t = 1, \dots, T \tag{13}$$

and $x_{it} = x_{it-1} + \varepsilon_{it}$ (14)

where the variables y_{it} and x_{it} are non-stationary and the vector error terms

The group-mean FMOLS estimator for the coefficient β is given by:

$$\hat{\beta}^*_{NT} = \frac{1}{N}\sum_{i=1}^{N}(\sum_{t=1}^{T}(x_{it} - \bar{x}_i)^2)^{-1}(\sum_{t=1}^{T}(x_{it} - \bar{x}_i)\, y^*_{it} - T\hat{\gamma}_i) \tag{15}$$

where $y^*_{it} = (y_{it} - \bar{y}_i) - \frac{\hat{L}_{21i}}{\hat{L}_{22i}}\Delta x_{it}$

and $\hat{\gamma}_i = \hat{\Gamma}_{21i} + \hat{\Omega}^0_{21i} - \frac{\hat{L}_{21i}}{\hat{L}_{22i}}\left(\hat{\Gamma}_{22i} + \hat{\Omega}^0_{22i}\right)$

$L_{11i} = (\Omega_{11i} - \Omega^2_{21i}/\Omega_{22i})^{1/2}\,; L_{12i} = 0;\; L_{21i} = \frac{\Omega_{21i}}{\Omega_{22i}^{\frac{1}{2}}};\; L_{22i} = \Omega_{22i}^{\frac{1}{2}}$

The t-statistic for $\hat{\beta}^*_{NT}$ is defined as follows:

$$\bar{t}_{\hat{\beta}^*_{NT}} = \frac{1}{\sqrt{N}}\sum_{i=1}^{N}\hat{L}^{-1}_{11i}(\sum_{t=1}^{T}(x_{it} - \bar{x}_i)^2)^{-1/2}(\sum_{t=1}^{T}(x_{it} - \bar{x}_i)\, y^*_{it} - T\hat{\gamma}_i) \tag{16}$$

As N-> ∞ and T-> ∞, the t-statistic converges to the standard normal distribution.

4.4 Empirical Models

Two methods of testing the PPP hypothesis for panel data are adopted in the paper including (i) panel co-integration test and (ii) panel unit root test. We use the estimation equations to test the validity of PPP, the approach adopted in Pedroni (2004).

$$ER_{it} = \beta_i . pcpi_{it} + qcpi_{it} \tag{17}$$

and $pbmi_{it} = \alpha_i . ER_{it} + qbmi_{it}$ (18)

where ER_{it} denotes a bilateral nominal exchange rate between Thailand and her trading partners i at time t in terms of natural logarithms. The $qcpi_{it}$ and $qbmi_{it}$ are the error terms of the equation respectively. The $pcpi_{it}$ is the natural logarithms of the ratio of consumer price index of country i to Thailand consumer price index, and $pbmi_{it}$ is the natural logarithms of the fraction of Thailand's BMI to that of country i. In contrast to CPI, the BMI was substituted on the left as a dependent variable like other studies in the Big Mac context (see also Click 1996, and Chen and Wang 2007).

An alternative method testing the PPP hypothesis is to consider the stationary characteristic of bilateral real exchange rate, RER_{it}, defined as the nominal exchange rate multiplying the ratio of the price indices of two countries. Following Oh (1996), Wu (1996), Connell (1998), Clements and Lan (2010), we express the equation for calculating the bilateral real exchange rate as follows:

$$RER\_cpi_{it} = log\, ER_{it} \frac{CPI_{it}}{CPI_t^{Thai}} \; ; \; RER\_bmi_{it} = log \frac{.BMI_t^{Thai}}{ER_{it}.BMI_{it}} \tag{19}$$

Where RER_cpi_{it} and RER_bmi_{it} are respectively bilateral real exchange rate based on CPI and BMI.

If the PPP holds or variables are co-integrated, the FMOLS is used to gain the equilibrium level of exchange rate. The misalignments are defined as the difference of exchange rate between equilibrium level and the actual level.

$$\widehat{ER}_{it} - ER_{it} = -qcpi_{it} \tag{20}$$

$$\widehat{pbmi}_{it} - pbmi_{it} = -qbmi_{it}\ ^{3} \tag{21}$$

The currency is called overvaluation if the equilibrium levels exceed its actual values ($q_{it} < 0$) and undervaluation if the equilibrium levels are less than actual values ($q_{it} > 0$). The $qcpi_{it}$ and $qcpi_{it}$ using to evaluating Thailand currency are based on consumer price and Big Mac indices.

5. Research Findings

This study has used annual panel-unbalanced data over the period from 1980 to 2013 between Thailand and her 62 trading partners. The nominal exchange rate and the CPI are collected from International Financial Statistics while data for the BMI are taken from the Economics magazine and from the paper of Pakko and Pollar (2003).[4] Shown in the table II is the descriptive statistics of all concerned variables. The mean value of bilateral exchange rate is over 94 thousands. The average level of CPI in Thailand is slightly less than that of the remained countries as the figures are 70 and 76, respectively. As for BMI, there is the almost similar pattern, which the Thailand's BMI is significantly less than that of other nations.

Table II: Descriptive Statistics

	Mean	Median	Std. Dev.	Skewness	Kurtosis	P-value	No. of Obs
ER	94418.9	4.81	2154919	27.30	797.61	0.00	1944
CPI	76.54	70.89	352.25	30.54	941.04	0.00	1916
CPI_Thailand	70.01	75.91	22.88	0.03	1.76	0.00	1950
BMI	19713.33	13.00	263979.10	14.56	214.52	0.00	658
BMI_Thailand	59.17	59.00	10.59	1.10	3.79	0.00	1300

Notes: P-value is the probability of variables following normal distribution. No represents for numbers of observations

Table III presents panel-based unit root tests using Breitung's (2001) test for variables including bilateral nominal exchange rate (ER), CPI, BMI, and real bilateral exchange rate based on CPI and BMI (RER_cpi and RER_bmi, respectively). The panel-based unit root test shows that the variables, including ER, CPI, BMI and RER_bmi are statistically insignificant, meaning that these variables contain unit roots or they are non-stationary. In contrast, as for the first difference

levels, the result indicates that all variables strongly reject the null hypothesis of unit root at the significance level of 1%. This finding confirms that all variables are integrated of I(1). Meanwhile, the CPI-base real exchange rate strongly rejects the null hypothesis of unit root at both the level and first difference at 5% level of significance, providing that it is I(0).

Table III: Unit root test for PPP testing

Breitung's panel-based unit root test		
Variable	*Level*	*First Difference*
ER	0.96	17.15***
CPI	0.31	3.04***
BMI	0.00	3.11***
RER_cpi	2.61**	8.31***
RER_bmi	0.00	-4.45***

*Notes: *, **, *** indicate the 10%, 5%, 1% significant levels, respectively*

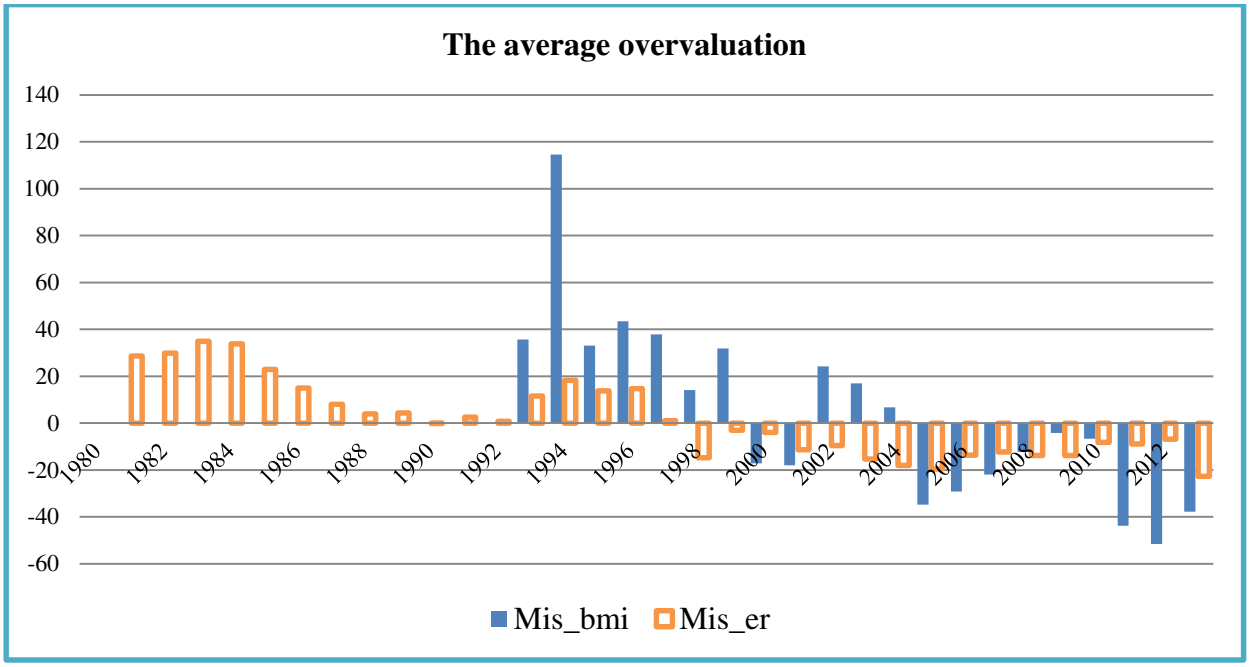
Table IV presents two types of cointegration test for two sets of variables including (i) ER CPI, and (ii) BMI and ER. Generally, two types of tests reject the null hypothesis of no cointegration. It could be seen that the Group rho statistics of both cases are strongly insignificant whereas the Panel v statistics are insignificant for the latter case. Additionally, other test statistics are significant at least at the significance level of 10%. It is concluded that Pedroni's (1999, 2001) tests present evidence to support the long run relationship amongst variables, while Kao (1999) cointegration test strongly rejects the null hypothesis of no cointegration. Hence, both cointegration tests offer a valid evidence of PPP.

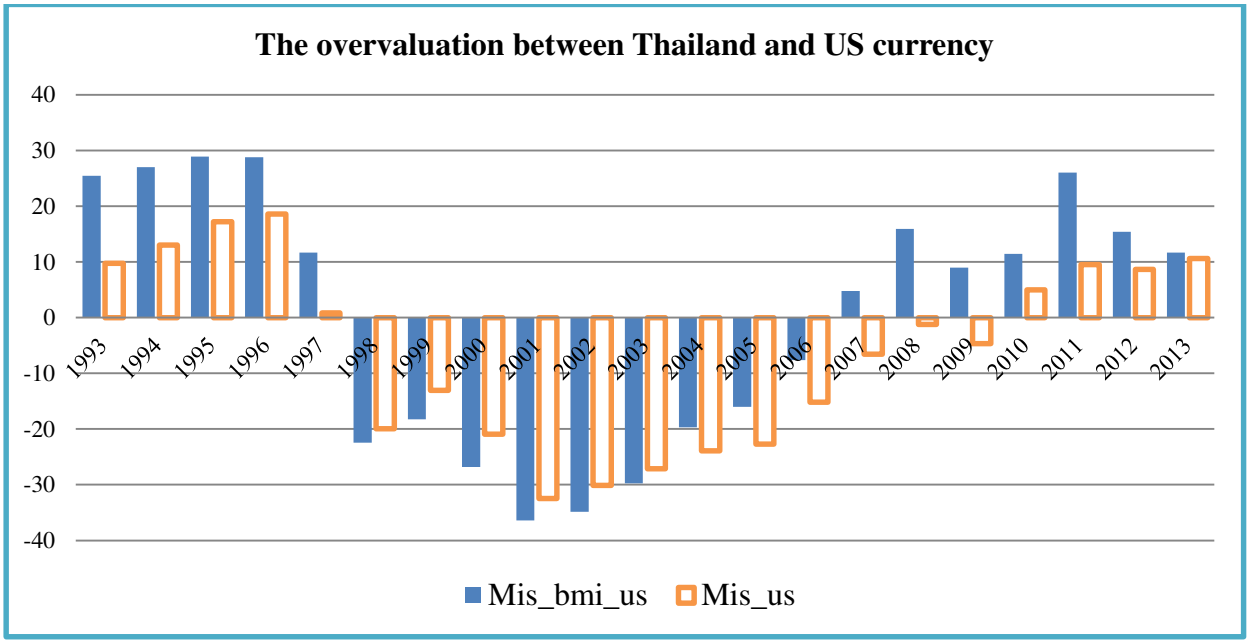
Table IV: Panel cointegration test for PPP

	Pedroni							**Kao**
	Panel v	*Panel rho*	*Panel PP*	*Panel ADF*	*Group rho*	*Group PP*	*Group ADF*	*t-statistic*
ER-CPI	6.25***	5.80***	5.73***	6.19***	1.01	3.91*	5.58***	3.73***
BMI-ER	3.42	-3.75***	-6.16***	-3.95***	1.57	-7.45***	-7.72***	3.76***

*Notes: *, **, *** indicate the 10%, 5%, 1% significant levels, respectively*

Figure 1: Misalignments of nominal exchange rate based on CPI and BMI





From Figure 1, Thailand's currency had clearly experienced two periods of overvaluation and undervaluation. The first period from 1980 to 1997 had experienced the tendency of overvaluation in Thailand currency, and the reserved pattern of undervaluation had taken place in the second period since 1997 - the year marked the Asian financial crisis. The pattern for 1980-2000 periods in this study appears to be similar to the study by Jonwanich (2008),[5] although the magnitudes of overvaluation or undervaluation in this study are more significant in comparison

with those in Jonwanich's (2008) findings. According to Jonwanich's (2008), in the early 1980s, the overvaluation of Thailand Baht was rather short-lived and converged to the equilibrium level due to the fact that the Thailand's government devalued the nominal exchange rate in 1984. The overvaluation reached a peak of approximately 37% before steadily reducing to its initial level three years after that. However, the actual RER had started to diverge from its equilibrium to be overvalued again from 1992 because the Thailand government opened the door wide for short-term capital inflows (Jonwanich 2008). In 1997, the Thailand's currency was overvalued slightly and that result is consistent to Chinn's (2000) conclusions.

In the second period after the 1997 Asian financial crisis, Thailand's currency had witnessed the pattern of undervaluation. The drastic depreciation of nominal exchange rate in the middle of the year 1997 and massive capital outflows in 1998 resulted in a significant devaluation of Thailand Baht by around 16% in 1998 before gradually returning to its equilibrium level (Jonwanich 2008). After that, Thailand Baht had been continuously devalued until 2013. It was argued that, after Asian currency crisis, Thailand was considered one of the most suffering countries in comparison with other nations in the Asian region. Consequently, it lost market shares to China and other ASEAN counterparts and suffered a severe deficit in its trade balance. Rajan *et al.* (2004) considered the large trade deficit between Thailand against her trading partners is caused by significant misalignments of bilateral exchange rate. Therefore, the strategy of currency devaluation would allow Thailand to increase her regional competitiveness, to recovery her lost market shares, and to improve the trade balance (Bahmani-Oskooee and Kantipong 2001). A recent study by Vo and Vo (2016) proved this claim by providing evidence that exchange rate devaluation stimulates trade performance with a third of all Thailand's trading partners as well as with trading groups of high income levels.

When it comes to BMI–based exchange rate, the estimated exchange rate, on average, diverges significantly its equilibrium level for an extended period of time. Additionally, the trend of overvaluation (undervaluation) seems to be similar between CPI-based exchange rate and BMI-based exchange rate with an exception of a 2002-2004 period, although the magnitudes of BMI-based exchange rate are more significant than those of CPI-based exchange rate. Therefore, the use of BMI-based exchange rate to evaluate whether the currency is under- or over-valued, on average, should be carefully examined, especially for developing countries.

When the BMI-based exchange rate and CPI-based exchange rate are used to evaluate the bilateral direction with the US dollar, an interesting finding is found. Before the Asian financial crisis in 1997 and after global financial crisis in 2008, the BMI-based exchange rate is far overvalued as compared to CPI-based exchange rate. However, during the period of 1998-2007, the valuation patterns of CPI-based exchange rate and BMI-based exchange rate are entirely consistent. During the global financial crisis, the Thailand valuation based on CPI-based exchange rate is undervalued while the valuation by BMI-based exchange rate provides opposite trend.

6. Conclusions and policy implications for Vietnam

The study is conducted to evaluate Thailand's currency value in terms of CPI as well as BMI. The starting point is to test the validity of the PPP theory for Thailand currency using panel-based unit root test and cointegration test. If the PPP theory is satisfied in terms of panel cointegration test, FMOLS is adopted for valuation process. The empirical results confirm a solid validity of

PPP for the case of CPI-based exchange rate and a weak evidence for BMI-based exchange rate. In relation to an evaluation of Thailand's currency, the findings illustrate that (i) the valuation of Thailand currency using CPI-based exchange rate is relatively consistent to that of BMI-based exchange rate with an exception during the 1997 Asian financial crisis; and (ii) the use of a BMI-based exchange rate is superior when bilaterally evaluating Thailand's Baht and the US dollar, where BMI was first estimated.

Thailand and Vietnam are very similar in many aspects including both social and economic characteristics. This study is not directly conducted for Vietnam because of the data limitation. Given similarities between Thailand and Vietnam, we are of the view that implications from the findings of this empirical study can be drawn for the Government of Vietnam and also for the Government of Thailand. An implication has emerged that while this new area of study using the BMI is further being tested and enhanced, the use of the BMI in lieu of the traditional CPI in empirical studies requires a caution in interpreting research findings. As stated by Yang (2004), valuations on such measurements should not be taken as the basis for exchange rate policy recommendations. It is recommended that BMI could be used as a guide for a prediction of exchange rate trend over the non-crisis period.

Notes

1 Abbreviation list

BMI	Big Mac Index
CPI	Consumer Price Index
ER	Exchange Rate
FMOLS	Fully Modified Ordinary Least Square
PPP	Purchasing Power Parity
RER	Real Exchange Rate

2 Of these seven statistics, four are based on the within-dimension approach and three referred to group-mean panel or between-dimension approach.

3 This fundamental model was also applied by such researchers as Ong (1997), Clements and Lan (2010) to evaluate the real exchange rate using Big Mac index.

4 Pakko and Pollar (2003) provided a summary of Big mac index over 1986-2003 periods at *http://research.stlouisfed.org/publications/review*.

5 Jonwanich (2008) examined the real exchange rate valuation for the case of Thailand with the use of model approach, which estimated the long-run equilibrium RER based on internal and external fundamentals.

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