Economics Bulletin

Volume 32, Issue 1

A structural VARX modelling of international parities between China and Japan in the liberalization era

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Abstract

This study systemically investigates the international parity conditions for China and Japan in the liberalization era (1990:Q1-2010:Q2). Advanced econometric procedures including the structural VARX and persistent profiles are utilized in the empirical analysis. The finding upholds support for both purchasing power (PPP) and uncovered interest parity (UIP) conditions, when structural breaks due to the Asian and subprime crises were taken into accounts. By comparing the persistent profiles, we find shocks to real sector are more likely to lead to the establishment of parity at faster rate than capital market. This seems to suggest sequencing problem in market integration is not an issue.

The authors would like to thank the reviewer for the valuable suggestion. This research was supported by a research university grant from Universiti Sains Malaysia [Grant no: 1001/PMGT/816150]. The usual disclaimer applies.
Citation: Tze-Haw Chan and Chee-Wooi Hooy and Ahmad Zubaidi Baharumshah, (2012) "A structural VARX modelling of international parities between China and Japan in the liberalization era", *Economics Bulletin*, Vol. 32 No. 1 pp. 730-736.
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Submitted: June 23, 2011. **Published:** February 24, 2012.

1. Introduction

China and Japan are presently the second- and third-largest economy in the world, respectively. Despite being the major engine of global growth, their economic link is also among the most important bilateral economic affairs. In 2009, China absorbed approximately 19% of Japanese exports, whereas Japan has appeared as China's second major trading partner (after the US) since 2008, with a total trade of $267 billion. Likewise, Japanese foreign investments in China have shown an upward trend since 1999. Although these investment and trade ties have accelerated economic development in both nations, the vulnerability to foreign price instability and financial risks is, in some ways, inevitable. It is thus crucial to scrutinise the links between the two nations so that the dynamics of the economic transmission mechanism can be better understood.

As theoretical propositions, purchasing power parity (PPP) and uncovered interest parity (UIP) provide clues of how price and monetary effects are transmitted globally. Both theories are also popular in the assessment of goods and capital market integration (Cheung *et al.*, 2003; Cavoli *et al.*, 2004; Kargbo, 2009). Nevertheless, the respective empirical evidence of PPP and UIP, which has hitherto been abundant, is still inconclusive (see Rogoff, 1996; Alper *et al.*, 2009; for recent surveys). Among China studies, Finke and Rahn (2005) and Coudert and Couharde (2007) revealed that Chinese yuan significantly deviates from PPP, whereas Gregory and Shelley (2011) found evidence of PPP – only for the real effective yuan but not for the real yuan/USD rates. Cheung *et al.* (2003), in addition, examined three parity conditions consecutively and concluded that parities hold among China-Taiwan-Hong Kong. Meanwhile, Cavoli *et al.* (2004) examined the parity conditions for ASEAN5, East Asia and China but failed to find clear indication of intensified regional financial integration. Other than the methodological concerns, a rather mixed and puzzling evidence that have accumulated on time series properties of UIP and PPP could be due to the failure account for the interdependence of adjustments in the international asset and commodity markets (Juselius, 1995; Özmen and Gökcan, 2004). The policy arguments recently extend from the validity of parity conditions to the exploration of connection and sequence between trade and financial integration among Asian members (Pomfret, 2005; Eichengreen, 2006).

To tackle the above mentioned issue, we set up a systemic framework that shows the interaction of prices, interest rates and exchange rates to jointly assess PPP and UIP for Sino-Japan during 1990:Q1-2010Q2. Our study contributes to the literature in several important aspects. First, a structural VARX model with the presence of I*(1)* weak exogenous (foreign) variables is constructed (see Pesaran *et al.*, 2000; Garratt *et al.*, 2006). Unlike conventional VAR, cointegrating VARX distinguishes between an $m_y \times 1$ vector of endogenous variables y_t and an $m_x \times 1$ vector of exogenous I*(1)* variables x_t among the core variables in $z_t = (y'_t, x'_t)$. In our case, Chinese price, interest and exchange rates are considered as y_t whereas the Japanese price and interest rates are x_t – long-run forcing variables[1]. Second, long-run PPP and UIP are further justified by the exact- and over-identification restrictions based on theoretical assumptions; this is supported by the persistent profile analysis, which shows how the cointegrating relations evolve with respect to system-wide shocks (Pesaran and Shin, 1996; Yazgan, 2003). Third, we provide consistent estimators and test statistics based on non-

[1] Despite the 'lost decade' since 1990s, Tokyo remains as one of the largest financial centres, after London and New York. Japanese financial market is healthy with more mature, efficient and sizable banking sector as compared to China. Although China has become the second largest economy, Chinese financial market has not yet posed significant impact in the global financial market over the last decade. In such consideration, it is reasonable to treat Japanese financial variables as weakly exogenous.

parametric bootstrapping to reduce size distortions in the finite sample bias. The empirical results are interpretable and provide new insight into the dynamics of the long-run adjustment processes of PPP and UIP. Lastly, our study covers the post-Bretton Wood era– a period of economic liberalization and trade expansion for Sino-Japan. It also includes the landmark events of the Asia and Subprime crises. Given the fact that most of the international trade settlements are in US dollar, the nominal effective Chinese yuan that adjusted for trade weightage is used in the empirical analysis. All data, including the Chinese and Japanese interest rates plus producer prices, are sourced from DataStream and cross-checked with the respective central banks.

2. Theory and Methodology

Following Juselius (1995) and Özmen and Gökcan (2004), a relation combining the PPP and UIP conditions can be represented by:

$$R_{Ct} - R_{Jt} = P_{Ct} - P_{Jt} - EX_{CJt+1} \tag{1}$$

with R_{Ct} and R_{Jt} being the respective nominal interest rates denominated in domestic (China) and foreign (Japan) currencies compounded over the time period t - $(t - 1)$; EX_{CJt} is the Chinese exchange rate at $t+1$; and P_{Ct} and P_{Jt} represent the respective domestic (China) and foreign (Japan) price levels.

Pesaran *et al*. (2000) modified and generalised the approach to the problem of estimation and hypothesis testing in an augmented vector error correction model. Garratt *et al*. (2006) extended the idea and developed the VARX and VECX* models along the same lines. Based on Eq. (1), a conditional VECX* model with five variables and two structural cointegration relations, which correspond to PPP and UIP, is given by:

$$\Delta \mathbf{z}_t = \mathbf{b} + \alpha\beta' \mathbf{z}_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \, \Delta z_{t-i} + \mathbf{u}_t \tag{2}$$

and $\mathbf{z}_t = (P_{Ct}, R_{Ct}, EX_{CJt}, P_{Jt}, R_{Jt})'$.

Economic theory predicts two structural long-run relations in Eq. (1):

$$PPP: \qquad (P_{Ct} - P_{Jt} - EX_{CJt}) \sim I(0) \tag{3}$$

$$UIP: \qquad (R_{Ct} - R_{Jt}) \sim I(0) \tag{4}$$

To verify (3) and (4), we can set the following (over)-identification restrictions on the cointegration matrix β in Eq. (2).

$$\beta' = \begin{pmatrix} 1 & 0 & -1 & -1 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & -1 & 0 & 0 & 0 \end{pmatrix} \tag{5}$$

where $\beta_1(PPP) = (\beta_{11} \quad \beta_{12} \quad \beta_{13} \quad \beta_{14} \quad \beta_{15} \quad \beta_{16} \quad \beta_{17} \quad \beta_{18})'$

$\beta_2(UIP) = (\beta_{21} \quad \beta_{22} \quad \beta_{23} \quad \beta_{24} \quad \beta_{25} \quad \beta_{26} \quad \beta_{27} \quad \beta_{28})'$

3. Empirical Discussion

The data properties are examined using Zivot-Andrew's unit root test that allows for an endogenous structural break. The series are overwhelmingly integrated of I*(1)*, where the unit roots are rejected at the first difference.[2] The breaks mostly fall on the periods of the Asian financial crisis and the subprime crisis. We therefore impose two dummy variables (D_{97}, D_{08}) on the structural VARX model prior to the examination of cointegrating rank in Eq. (2). The cointegration model contains three domestic variables, P_C, R_C, and EX_{CJ}, and two exogenous foreign variables, P_J and R_J. A cointegrating VARX (3, 2) is selected based on the Schwarz Bayesian Criterion (SBC). In Table 1, both the λ-Max and trace-statistics reject the 95% bootstrapped critical values and report two cointegrating vectors (*r=2*). This result is in line with our theoretical prediction that PPP and UIP may jointly hold for Sino-Japan in the liberalisation era.

Table 1: VARX Cointegration Tests, 1990Q1-2010Q2

H_0	H_1	λ-Max	Trace Statistics	Bootstrapped 95% Critical Values	
				λ-Max	Trace Statistics
r = 0	*r = 1*	48.21*	102.67*	45.15	82.35
r ≤ 1	*r = 2*	36.16*	54.45*	35.16	51.13
r ≤ 2	*r = 3*	18.29	18.29	25.55	25.55

Notes: * denotes significant at 95% confidence level. The underlying VARX model contains unrestricted intercept and trend.

We then impose exact-identifying restrictions (β_{11} = 1, β_{12} = 0, β_{21} = 0, β_{22} = 1) to produce the long-run estimate of the parities model. The ML estimates of the two cointegrating vectors are presented in Table 2. For first cointegrating vector (CV1), the exchange rate and Japanese price carry the expected negative sign that supports the long-run PPP. For CV2, the Japanese interest is also correctly signed to suggest an UIP relationship.

To further justify PPP and UIP, we impose six over-identifying restrictions on the cointegration relations. Because LR tests (χ^2) can over-reject in small samples (Garratt, *et al.*, 2006), the bootstrapped critical values based on replications of the LR statistic are computed. Using the observed initial values of each variable, the estimated model, and a set of random innovations, an artificial dataset is generated for each of the 1,000 replications under the assumption that the estimated version of the model is the true data-generating process. First, we test the co-trending hypothesis (a). The LR statistic (χ^2=5.292) fails to reject the null hypothesis. We then proceed with the co-breaking hypotheses and the results in Table 2 show that both restrictions cannot be rejected. This means that the two crises dummy variables do affect the long run parities relations. In between, positive effects due to the Asian crisis are reported whereas negative effects are reported due to the subprime crisis.

Eq (3) suggests that EX_{CJ}, P_J and R_J enter the long-run PPP relations with additional restrictions of β_{13}=-1, β_{14}=-1, and β_{15}=0. Since the reported χ^2=24.519 falls below the critical values (see Table 2), the long-run PPP holds. In other words, arbitrage activities in the goods market will move the exchange rate to equalize prices in the two countries under review. Additionally, as evident by the outcome of the LR test for hypothesis (e), UIP also cannot be rejected. More important, the non-rejection of hypothesis (f) confirms that PPP-UIP jointly hold (with co-trending and co-breakings) for Sino-Japan during 1990-2010. The results

[2] Results of unit root tests are not presented here but are available upon request.

generally indicate that the goods and capital markets are integrated with the exchange rate, holding an important long-run link between the two markets. This economic link is also possibly driven by similar policy responses to external shocks and complementarities in the Sino-Japan economic structures.

Table 2: Restriction Tests, 1990Q1-2010Q2

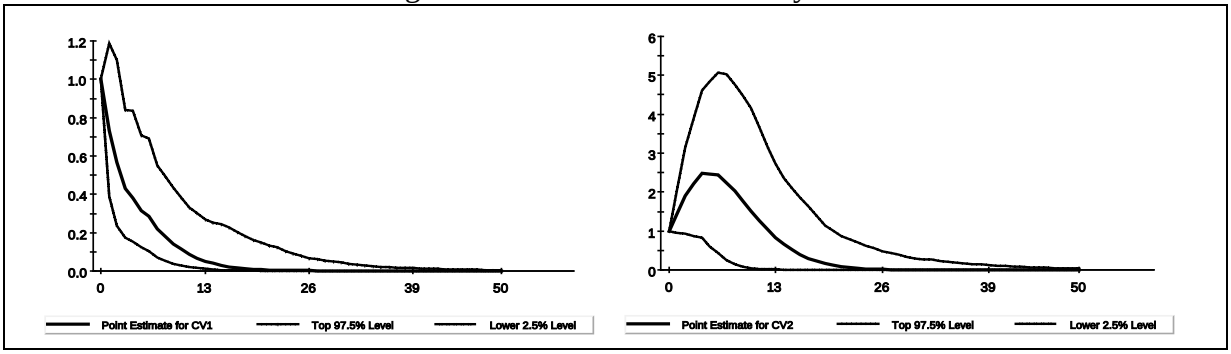
Exact-identifying Restrictions								
	P_C	R_C	EX_{CJ}	P_J	R_J	T	D_{97}	D_{08}
CV1(PPP)	1.000	0.000	-31.316	-56.453	107.113	0.025	1.501	-4.547
CV2(IRP)	0.000	1.000	1.429	2.498	-3.047	0.001	0.069	-0.205

	Hypothesis	Additional Over-identifying Restrictions	χ^2	95% CV
(a)	co-trending	$\beta_{16} = 0, \beta_{26} = 0$	5.292	6.787
(b)	co-breaking 97	$\beta_{17} = 0, \beta_{27} = 0$	1.986	6.978
(c)	co-breaking 08	$\beta_{18} = 0, \beta_{28} = 0$	2.579	10.551
(d)	PPP+(a)+(b)+(c)	β_{13}=-1, β_{14}=-1, β_{15}=0, β_{16}=0, β_{17}=0, β_{18}=0, β_{26}=0, β_{27}=0, β_{28}=0	24.519	31.658
(e)	UIP+(a)+(b)+(c)	β_{16}=0, β_{17}=0, β_{18}=0, β_{23}=0, β_{24}=0, β_{25}=-1, β_{26}=0, β_{27}=0, β_{28}=0	23.184	30.619
(f)	PPP and UIP	β_{13}=-1, β_{14}=-1, β_{15}=0, β_{16}=0, β_{17}=0, β_{18}=0, β_{23}=0, β_{24}=0, β_{25}=-1, β_{26}=0, β_{27}=0, β_{28}=0	27.305	38.519

Notes: The 95% CV are generated by the bootstrap method using 82 observations and 1,000 simulations.

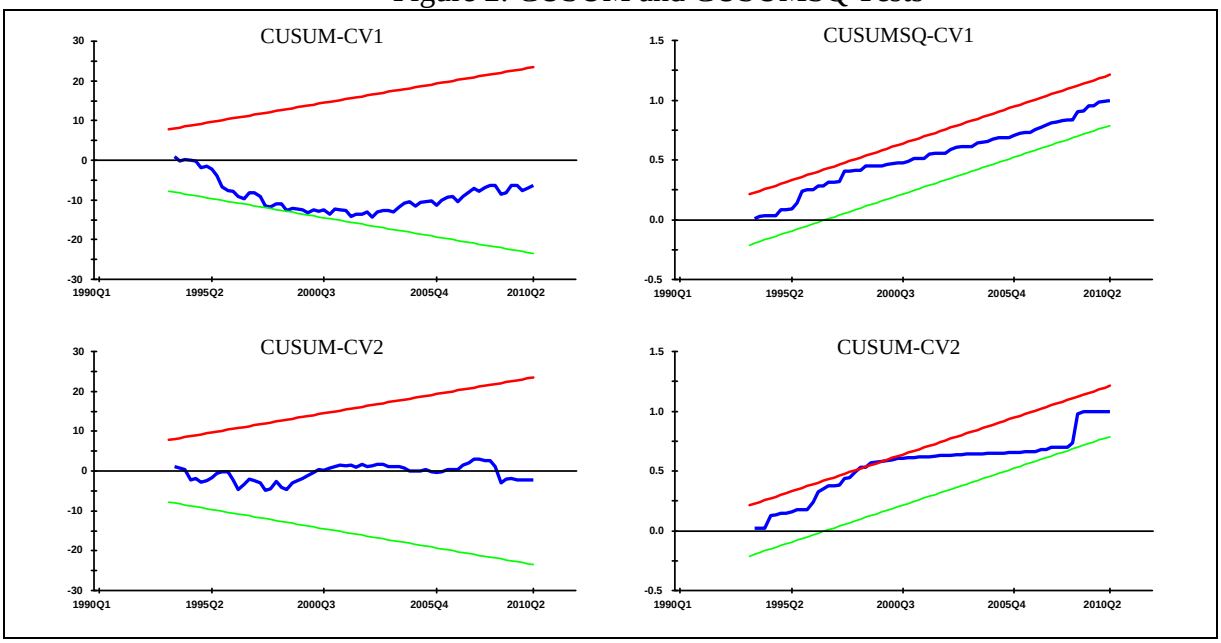
The evidences presented above have offered little information about the speed at which deviation from the equilibrium dies out. So, we scrutinize the time profile of system-wide shocks up to 50 quarters on cointegrating relations. The persistence profiles plotted in Figure 1 is normalised to take the value of unity, but the rate at which it tends towards zero provides information on the speed with which the equilibrium correction takes place in response to shocks (Yazgan, 2003). Despite the point estimates, the bootstrapped 2.5% and 97.5% confidence bounds are also constructed and illustrated as dotted lines in Figure 1. For the PPP relation, the half-life is approximately 3.5 quarters (< a year), while the whole effect (total life) is completed at around 15-16 quarters. The speed of convergence is generally faster than what was documented by Rogoff (1996) but is in line with recent Asian PPP studies (e.g., Baharumshah, *et. al.*, 2007). For the UIP relation, the half-life is much longer, at approximately 13 quarters (>3 years), and the adjustments are completed by 22 quarters. The result seems to suggest that the equilibrium corrections in the goods market integration are faster than in the financial market integration. Thus, both PPP and UIP hold without the sequencing problem, that is, trade integration should come first and financial integration second, is not an issue for Sino-Japan.

Figure 1: Persistent Profile Analysis



A final inspection of the model's stability is to apply the cumulative sum (CUSUM) and cumulative sum of squares (CUSUMSQ) tests to the residuals of the VARX model. Clearly, Figure 2 supports the stability of the estimated coefficients for our Sino-Japan parities model as both statistics are within the 5% critical lines.

Figure 2: CUSUM and CUSUMSQ Tests



5. Conclusion

Inspired by the work of Pesaran *et al*. (2000) and Garratt *et al*. (2006), this study constructs a structural VARX modeling system that jointly assess PPP and UIP for Sino-Japan, which concurrently allowing $I(1)$ exogenous variables in the analysis. Two important findings emerged from our analysis. First, we find overwhelming evidence of both PPP and UIP in the liberalization era, when structural breaks of Asia crisis, subprime crisis and six over-identifying restrictions were taken into accounts. Such supportive empirics are established based on a series of advanced econometric procedures and theoretical formulation which consider possible interactions between the goods and the capital markets. Second, deviations are shorter lived for PPP. The faster pace of adjustment towards price instead of the interest rate equilibrium implies that sequencing problem in market integration is not an issue. In other words, the present economic linkage provides a platform for closer economic collaboration and financial arrangements.

References

Alper, C. E., Ardic, O. P. and Fendoglu, S. (2009) "The Economics of the uncovered interest parity condition for emerging markets' *Journal of Economic Surveys*, **23(1)**, 115-138.

Baharumshah, A.Z., Aggarwal, R. and Chan, T.-H. (2007) "East Asian real exchange rates and PPP: new evidence from panel-data tests" *Global Economic Review*, **36(2)**, 103-119.

Cavoli, T., R. Rajan, S. and Siregar, R. (2004) "A Survey of Financial Integration in East Asia: How Far? How Much Further To Go?" CIES Discussion Paper No. 0401, University of Adelaide, Australia.

Coudert, V. and Couharde, C. (2007) "Real equilibrium exchange rate in China: is the renminbi undervalued?" *Journal of Asian Economics*, **18(4)**, 568-594.

Cheung, Y.-W., Chinn, M. D. and Fujii, E. (2003) "China, Hong Kong and Taiwan: a quantitative assessment of real and financial integration" *China Economic Review*, **1(3)**, 281-303.

Eichengreen, B. J. (2006) "On the sequencing of regional integration: General considerations and an application to Asia" *The North American Journal of Economics and Finance*, **17(3)**, 329-334.

Finke, M. and Rahn, J. (2005) "Just how undervalued is the Chinese renminbi?" *World Economy*, **28**, 465-631.

Garratt, A., Lee, K., Pesaran, M. H. and Shin, Y. (2006) "Global and National Macroeconometric Modelling: A Long Run Structural Approach" Oxford University Press, Oxford.

Gregory, R. P. and Shelley, G. (2011) "Purchasing power parity and the Chinese yuan" *Economics Bulletin*, **31(2)**, 1247-1255.

Juselius, K. (1995) "Do purchasing power parity and uncovered interest rate parity hold in the long run? An example of likelihood inference in a multivariate time-series model" *Journal of Econometrics*, **69**, 211-240.

Kargbo, J. M. (2009) "Financial integration and parity reversion in real exchange rates of emerging markets" *Applied Economics Letters*, **16(1)**, 29 — 33

Özmen, E. and Gökcan, A. (2004) "Deviations from PPP and UIP in a financially open economy: the Turkish evidence" *Applied Financial Economics*, **14(11)**, 779-784.

Pesaran, M. H. and Y. Shin (1996) "Cointegration and speed of convergence to equilibrium" *Journal of Econometrics*, **71**, 117-143.

Pesaran, M. H., Shin, Y., and Smith, R. J. (2000) "Structural analysis of vector error correction models with exogenous I(1) variables" *Journal of Econometrics*, **97**, 293-343.

Pomfret, R. (2005) "Sequencing trade and monetary integration: issues and application to Asia" *Journal of Asian Economics*, **16(1)**, 105-124.

Rogoff, K. (1996) "The purchasing power parity puzzle" *Journal of Economic Literature*, **34**, 647-668.

Yazgan, M. Ege (2003) "The purchasing power parity hypothesis for a high inflation country: a reexamination of the case of Turkey" *Applied Economics Letters*, **10(3)**, 143-147.