Assessing the international parity conditions and transmission mechanism for Malaysia-China

Tze-Haw Chan

School of Management, USM

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Tze-Haw, Chan [1,ψ]

[1]School of Management, Universiti Sains Malaysia, Malaysia

Abstract
We construct a structural system that jointly examines Purchasing Power and Interest Parity conditions for Malaysia-China during 1996Q1-2010Q4. Structural VARX, VECMX, over-identifying restrictions, bootstrapping and persistent profiles are utilized in the analyses. We find support for interaction between the goods and capital markets of Malaysia-China, when Asia crisis and subprime crisis are taken into accounts. The faster pace of adjustment towards price instead of interest equilibrium implies the non-appearance of sequencing problem in economic integration. Nevertheless, it is of concern that maintaining a rigid foreign exchange with major trading partner could be costly with potentially contagious price instability and financial risk.

Keywords: International Parity Conditions, Economic Integration, Transmission Mechanism, VARX, VECMX

JEL Classification: F14, C53, C32, O24

[ψ] Corresponding Author: CHAN, Tze-Haw, Finance Section, School of Management, Universiti Sains Malaysia, 11800 USM, Penang, Malaysia; Tel: 604-653-5284; Fax: 604-657-7448. thchan@usm.my

1. Introduction

Being a small and open economy, Malaysia is highly exposed to global economic. While foreign investment and trade have accelerated the domestic growth, the vulnerability to global price instability, financial risks and exchange rate variability is someway inevitable. It is thus crucial to scrutiny the links between the domestic and foreign economies, so that the dynamics of economic transmission mechanism can be better understood.

In the past decades, Malaysia has been closely linked to the US and Japan. But since 2009, China has become Malaysia's largest trading partner—the largest source of imports and second largest export destination. Likewise, Malaysia remains as China's major business and investment platform in the ASEAN region[1]. Malaysia-China trade reached $59 billion—about 18.9% of Malaysia's global trade volume, surpassing the Malaysia-US trade share (10.9%). In recent years, local banks have also introduced Renminbi Trade Settlement Services. Together, the trade and investment expansion is likely to accelerate with the formalization of a bilateral trade liberalization pact on track under the ASEAN-China Free Trade Agreement (Wang, 2005). While Malaysia-China economic integration has grown in greater and faster pace, there are worries that such linkage may be destructive. McKibbin and Woo (2003), for instance, suggests that the full integration of Chinese labor force into the international division of labor could de-industrialize the ASEAN (including Malaysia) when it leads to reduction of FDI flows to

[1] For China, Malaysia is the 8th largest trading partner–7th as source of imports and 14th as an export destination.

them. Some observers have also, directly or indirectly, related the resurgence of China since the late-1980s and the devaluation of the renminbi (or, Chinese yuan) in 1994 to the Asia financial crisis (Makin, 1997; Corsetti, *et al.*, 1999; among others).

The Malaysia-China economic ties can be hampered by the exchange rate regime. Both Malaysia and China have maintained an undervalued exchange rate regime since 1990s[2]. And, the ringgit and yuan have moved closely in the past two decades (Chan and Hooy, 2011). Such policy coordination would imply that the chances of contagious-financial turmoil and -inflation are highly feasible in the future, as long as monetary sovereignty against China remained.[3] Due to the fact that China has been the major source of imports—both consumer goods and industry inputs, fluctuations of the Chinese labor costs and producer prices are highly concerned. Similarly, the increased risks in Chinese asset market and their recent speculative capital flows to Malaysia have gained attention of domestic authority. Nevertheless, the potential impacts are still questionable. Unless a comprehensive study is conducted, the transmission mechanism cannot be fully understood.

To tackle the mentioned issues, an inclusive inspection of the international parity conditions is necessary. As theoretical propositions, both the Purchasing Power Parity (PPP) and Interest Rate Parity (IRP) provide clues of market integration and how the price and monetary effects transmitted globally. By implication, PPP acts as a backward

[2] Big Mac Indexes show that Chinese yuan and Malaysian ringgit continue to be substantially undervalued as much as 40%-45% and 30%-40% respectively, in the past decade (*The Economist, various issues*).
[3] According to the macroeconomic trinity, it is impossible for a nation to have a fixed exchange rate, free capital flows and independent monetary system at the same time.

adjustment mechanism in the goods market whereas the IRP (e.g. Covered Interest Parity-CIP; Uncovered Interest Parity-UIP; Real Interest Parity-RIP) can be thought of an arbitrage relationship that function as forward-looking market clearing mechanism in capital market (Juselius, 1995).

PPP and IRP are algebraically linked in such way that real interest parity builds on the assumption that PPP holds (Eijffinger and Lemmen, 2002; Chan and Baharumshah, 2012). A separate examination of the international parity conditions to gauge the extent of market integration or exchange rate determination may not be methodologically apposite. Many studies that reported better supports for IRP instead of PPP may violate the theoretical prediction and hence confront the sequencing problem of economic integration. In fact, there is growing interest to explore the connection and sequence between trade and financial integration (see Pomfret, 2005; Eichengreen, 2006; Chan et al, 2012; for such issue in Asia).[4] In policy view, capital account liberalization (financial integration) initiated before the current account openness (trade integration) can lead to distortionary effects.[5] Among developing nations, ASEAN and East Asia (including China and Malaysia) have been striking to become the world leading recipients of FDI and capital inflows. However, there has been less progress in implementing regional trade integration (Pomfret, 2005). It is only more recently that the connections between trade

[4] The five levels of integration–preferential trading arrangements, free trade area, custom union, common market, economic union–are often treated as a sequencing pattern towards closer integration as well as taxonomy of deeper economic integration, in modern economics. The idea was well applied to the European Union.

[5] Eichengreen, *et al* (2003) argued that if trade barriers continue to protect an uneconomical import-competing sector, foreign capital will flow there, attracted by rent and artificially inflated profits. Since the country has no competitive advantage in those sectors, devotion of more resources to import-competing production can be growth and welfare reducing. The cost of the resources that the country utilizes to service the foreign finance may exceed the cost of capital, thus reducing domestic incomes and starving other sectors of inputs to growth.

and monetary integration have been examined, leading some analysts to claim, for instance, that conventional OCA criteria are endogenous (Frankel and Rose, 1998).[6]

Frankel and Rose's work has implied that countries highly integrated with each other in the sphere of international trade in goods and services are likely to exhibit more synchronized business cycle for an OCA formation. This was supported by recent studies on regional integration which suggest that OCA would provide a collective defense mechanism against systemic failures and monetary instability (see Bharumshah et al, 2005; 2011; Chan and Baharumshah, 2012). However, concerns about global integration and shocks transmission emerged lately following the subprime crash and financial turmoil in the US and Euro zone, especially for small and open economies like Malaysia (Park, 2011; among others). Debates have been further elevated among scholars by the recent proposal of Trans-Pacific Partnership (TPP) negotiations on regional trade arrangements during the Honolulu APEC meeting (Armstrong, 2011). Putting together, we are highly concerned with three research questions that ought to be answered:

1) Do PPP and IRP hold for Malaysia-China during the liberalization era?
2) How does the price and monetary transmission worked for Malaysia-China?
3) Does sequencing problem presence for Malaysia-China?

Motivated by the mentioned issues, we hereby construct the joint assessment of PPP and IRP between Malaysia-China using the structural modeling method. The study

[6] Frankel and Rose (1998) suggest that intra-union trade is encouraged by reducing the risk of exchange rate changes and that this in turn increases the degree of synchronization between business cycles of countries comprising the union which is itself a criterion for an Optimal Currency Area (OCA).

period spans from 1996Q1 to 2010Q4, where both Malaysia and China are experiencing trade expansion and economic liberalization. Unlike previous works that study the PPP or IRP separately, our study assesses the interaction and transmission effects of prices, interest rates and exchange rates within a full system framework, as inspired by Juselius (1995) and Juselius and MacDonald (2004). The modeling approach allows for the possible interactions between goods and capital market, which will potentially constitute the foundation of an early warning system particularly for Malaysia, against external shocks. Our approach also recognizes the importance of distinguishing the short-run and long-run effects in the model so that the error correction terms of the PPP and IRP are empirically valid and in line with theoretical prediction.

Before we proceed with the analysis, there are few significant considerations that distinguish our study from the literature. The first concerns the fact that Malaysia is a small and open economy. When compared to the Chinese population of 1.3 billion people, the Malaysian market size is relatively small, with only 28 million residents. Though Malaysian trade openness is now among the highest in the world (about 200% of its GDP), the economic size and financial influence are significantly lesser as compared to China. Apart from being the largest economy body in Asia (second world largest) since 2008, China has also become the world's second-largest trading nation after the US. As such, the conventional VAR and cointegration procedure do not seem apposite in the methodological sense. It is thus necessary to develop an econometric model that allows the possibility of drawing a distinction between endogenous and exogenous variables, which are integrated of I*(1)*. This paper employs the structural modeling procedures advanced by Pesaran *et al*. (2000) and Assenmacher-Wesche & Pesaran (2009). We construct a cointegrating VARX with two long-run equilibrium relationships (PPP and IRP) in the presence of I*(1)* weak exogenous or long-run forcing variables (which, in our case, the Chinese variables). A reduced-form error correction of the VECMX short-run model can then be estimated, where variables are separated into the conditional model and marginal model, respectively. Such structural modeling methodology builds on transparent and theoretically coherent foundation that offers a practical approach to relationships suggested by economic theory. To further assess the effect of system-wide shocks on the cointegrating relations, we apply the Persistence Profile analysis developed by Pesaran and Shin (1996). Subsequently, we follow Pesaran and Pesaran (1997) to gauge the out-sample causality effects using the generalized forecast error Variance Decompositions (VDCs). To our best knowledge, such comprehensive study has not been conducted for any of the developing nations.

Then, what follows involves the estimation issue for small sample study, particularly, in regard to the size and power properties of time series analysis. In our case, the study period covers 15 years with 60 quarterly observations. Given this, we use the nonparametric bootstrap method, an alternative to the large sample data tests based on asymptotic theory. Bootstrap's ability to provide asymptotic refinements often leads to a reduction of size distortions in finite sample bias and it generally yields consistent estimators and test statistics (Mantalos and Shukur, 1998; Chang, Park and Song, 2006). This method is employed to test the number of VARX cointegrating ranks. It is later applied in the estimation of log-likelihood ratio (LR) critical values for the PPP and IRP normalized (exactly identified) and over-identified restrictions as well as for the marginal model and conditional model in the VECMX error correction representation. Bootstrapping is also used to estimate the confidence intervals of Persistent Profile. Then again, the 1990s-2000s are well known as a period of financial instability and currency crises. A preliminary Zivot-Andrew (1994)'s test of endogenous break(s) on each series is conducted and we impose the break dates (e.g. Asia crisis, Subprime crisis) as dummy variables in the VARX and VECMX models.

Our study is organized in the following manner. Section 2 reviews the relevant literature briefly. Section 3 then shows the theoretical representation of PPP and IRP that forms the basis of our empirical model. This is followed by the estimation procedures of VARX and VECMX and data description. Estimation results are discussed in section 4. Finally, in section 5, conclusion and policy implications are drawn.

2. Brief Review of Literature

Empirically, PPP requires a constant real exchange which at least exhibits reversion towards the long run mean rate over time, and not driven by stochastic trends. IRP, on the other hand, is commonly verified via the interest differential hypothesis or interest rates co-movement as indication for financial asset substitutability and capital integration across borders. While PPP is an elegant hypothesis, much failure appears in the early studies. Among others, see Hakkio (1984), Edison (1985), Frankel (1986), and Meese and Rogoff (1988), Mark (1990), Edison and Pauls (1993). These studies generally found that real exchanges rates contain unit roots at level and stationary is detected only after first-differencing. The advancement of cointegration test by Engle and Granger (1987), Johansen (1988, 1991) and Johansen-Juselius (1992) re-popularized the examination of exchange rate-price ratio relationship to verify PPP in long run. Somehow, cointegration studies tend to reject the null of non-cointegration when using the Engle-Granger approach (e.g. Taylor, 1988), but failed to reject non-cointegration if relying on the Johansen-Juselius method (e.g. Kugler and Lenz, 1993; MacDonald, 1993; MacDonald and Marsh, 1994), or testing the null of cointegration (see *inter alia*, Fisher and Park, 1991; MacDonald & Moore, 1994). In addition, the consensus arrived by recent literature survey (Rogoff, 1996; Obstfeld and Rogoff; 2000; Taylor and Taylor, 2004) suggests that despite the presence of excessive short-term exchange rate volatility, the deviations from the long run equilibrium PPP rates are too persistent with the estimated half-life of real exchange shocks at about 3-6 years. In recent studies, the puzzle continues. Finke and Rahn (2005) and Coudert and Couharde (2007) discovered that Chinese yuan significantly deviates from PPP, whereas Gregory and Shelley (2011) found evidence of PPP – only for the Chinese real effective rates but not the real yuan/USD rates.

Likewise, the empirical supports were overwhelmingly poor when the absolute condition of IRP was being examined in the 1980s (see *inter alia* Mishkin, 1984; Cumby and Obstfeld, 1984; Frankel and MacArthur, 1988). Numerous efforts using both univariate and multivariate techniques have emerged in the literature to empirically examine IRP and the German- or US-dominant hypothesis[7] among developed nations. Yet, the empirical evidences are at best mixed. Due to the recognition of 'Asia Miracle' and the outbreak of 'Asia Financial Crisis', a sizeable literature on Asian economies emerged (Bhoocha-Oom and Stansell, 1990; Chinn and Frankel, 1995; Phylaktis, 1997, 1999; Chan *et al.*, 2003; Sun, 2004; among others). The findings are generally supportive for capital market integration but still, the US- and Japan-leading role in the Asia Pacific region is inconclusive[8]. Cheung, *et al.* (2003), in addition, examined PPP, UIP and RIP simultaneously and concluded that parities hold among China-Taiwan-Hong Kong. Cavoli, *et al.* (2004) adopted a similar research strategy but failed to find clear indication of intensified financial integration for ASEAN-5, China, Hong Kong, Taiwan, Japan and South Korea.

Alternatively, Johansen and Juselius (1992) and Juselius (1995) argued that previous studies may have overlooked the links between goods and asset markets, and partly due to the lack of a precise specification of the sampling distribution of the data. They are able to show supportive evidence for the PPP and IRP relations in the UK case when a multivariate cointegration framework is adopted. They jointly examined PPP and IRP in a full system approach which allows for possible interactions between prices, interest rates, and exchange rates. A short-run dynamics of the system was further

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[7] See Kirchgassner and Wolters (1993) and Moosa and Bhatti (1996) for the German-dominance hypothesis; Cumby and Mishkin (1986) and Modjtahedi (1988) for the US-dominance hypothesis; Pain and Thomas (1997) and Awad and Goodwin (1998) for the US- and German-dominance joint hypothesis.

[8] Chinn and Frankel (1995), for instance, found that although Indonesia and Thailand were integrated with Japan, RIP holds only for US-Singapore, US-Taiwan and Japan-Taiwan. On the other hand, Phylaktis (1997, 1999) found that Asia-Pacific capital markets are considerably integrated but that the results regarding the US' and Japan's leading roles in the regional market are contradictory. In similar works, Baharumshah et al (2005) confirmed Japan's leading role while Chan and Baharumshah (2005, 2012) found high degree of regional capital mobility and substantial financial integration among the East Asian economies as well as vis-à-vis China.

developed as error correction mechanism. Similar analyses have been performed on different series of developed nations (e.g. Australia, German, Norway, Sweden) and some non-identical but similar conclusions were observed (see *inter alia*, Sjoo, 1995; Caporale, *et al*., 2001; Juselius and MacDonald, 2004). On top of that, assessment of such models on the developing nations is notably lacking.

3. Theory and Methodology

Being the first equilibrium theory of exchange rate, PPP postulates that the nominal exchange rate is proportional to the relative price so that the real exchange rate remains constant overtime. The theoretical motivation for PPP is based on the assumption that internationally produced goods are perfect substitutes for domestic goods. On the other hand, the second equilibrium theory of exchange rate—UIP, states that the interest rate differential between two countries is equal to the expected change in the spot exchange rates. UIP assumes zero risk premium so that financial assets are substitutes in cross-border capital markets.

If we let EX_{Mt} be the log spot exchange rate of RM/yuan, P_{Mt} and P_{Ct} be the log domestic (Malaysia) and foreign (China) price levels respectively, the PPP condition is defined as

$$P_{Mt} = P_{Ct} + EX_{Mt} \qquad (1)$$

while UIP condition is represented by

$$R_{Mt} = R_{Ct} + E_t(EX_{Mt+1}) - EX_{Mt} \quad (2)$$

with R_{Mt} and R_{Ct} being the respective nominal interest rates denominated in domestic and foreign currencies compounded over the time period *t - (t - 1)*, and E_t (.) denotes the expected value formed at time *t*. When the forecast horizon grows, it seems reasonable to expect deviations from long-run PPP to be increasingly important in the formation of expectations, thereby providing a link between the goods and the capital markets. More specifically, if the expected exchange rate is given by

$$E_t(EX_{Mt+1}) = P_{Mt} - P_{Ct} \quad (3)$$

a relation combining the PPP and UIP conditions can be derived by inserting (3) into (2):

$$R_{Mt} - R_{Ct} = P_{Mt} - P_{Ct} - EX_{Mt+1} \quad (4)$$

(l) - (4) are simple economic hypotheses which define ‘long-run’ equilibrium in the capital and goods markets in a very simplified world. For empirical analysis purpose, Eq. (4) will be adopted in our VARX ad VECMX estimations.

3.1 The VARX and VECMX Estimation

Pesaran *et al*. (2000) modified and generalized the approach to the problem of estimation and hypothesis testing in the context of the augmented vector error correction model. Garratt *et al*. (2003, 2006) extended the idea and developed the VECMX model along the same lines. They distinguish 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 $z_t = (y'_t, x'_t)$ with $m = m_y + m_x$. In our case, the two exogenous variable as 'long-run forcing' variables are the Chinese price and interest rates. 'Forcing' variable means that changes in P_{Ct} and R_{Ct} have a direct influence on, but not affected by Malaysian variables in the model. This ends up with a conditional vector error correction model (VECMX) with five variables and two structural cointegration relations, in which the two long-run relations (r = 2) correspond to PPP and IRP.

Since our sample period consists of the Asia financial crisis and the global subprime crisis, structural break(s) are necessarily included in the model. Depending on the break dates detected by Zivot-Andrews (1992) test, we impose the shift dummy variable ($D_{crisis,t}$) and the impulse dummy variable ($\Delta D_{crisis,t}$), where $\Delta D_{crisis,t} = D_{crisis,t} - D_{crisis,t-1}$. The former captures the shift in the long-run relations, whereas the latter applies for the short-run dynamic models. The VECMX is then given by

(5)

(6)

with the VARX cointegrating model:

$$z_t = (R_{Mt}, R_{Ct}, P_{Mt}, P_{Ct}, EX_{Mt+1})' \quad (7)$$

There are $r=2$ cointegrating relations among the 5 × 1 vector of variables z_t in the conditional model (5) contains three endogenous (Malaysia) variables, $y_t = \{P_{Mt}, R_{Mt}, EX_{Mt}\}$ plus deterministic variables (trend, crisis98, crisis2008), and marginal model (6) with two weakly exogenous foreign (China) variables, $x_t = \{P_{Ct}, R_{Ct}\}$. $\Pi_y = \alpha_y\beta'$, α_y is an $m_y \times r$ matrix of error correction coefficients and β' is an $m \times r$ matrix of long-run coefficients and Ψ_i and Λ are the short-run parameters, t is time trend, c_0 is the intercept, and p is the order of VECMX. In the marginal model, Γ_{xi} are the short-run parameters, and c_{xo} is the intercept. It is assumed that u_t and v_t are serially uncorrelated and normally distributed. Notice that we need to restrict the trend coefficients in equation (5) in order to avoid the quadratic trends and the cumulative effects of $D_{crisis,t}$ in the level solution (Pesaran *et al*., 2000), as follow:

$$c_1 = \Pi_y d_1, \qquad c_2 = \Pi_y d_2 \quad (8)$$

where c_1 and c_2 are an arbitrary $m_y \times 1$ vector of fixed constants. Note that d_1 and d_2 are unrestricted if Π_y is full rank; in that case $d_1 = \Pi_y^{-1} c_1$ and $d_2 = \Pi_y^{-1} c_2$. However, if Π_y is rank deficient, d_1 and d_2 cannot be fully identified from c_1 and c_2 but can be estimated from the reduced form coefficients. In this case, the reduced form trend coefficients are restricted.

Now, assumes that nominal interest rates, exchange rates, and prices behave in a nonstationary manner. For PPP condition in (1) and UIP condition in (2) to have an empirical meaning, economic theory predicts that:

$$(P_{Mt} - P_{Ct} - EX_{Mt}) \sim I(0) \quad (9)$$

and $$(R_{Mt} - R_{Ct}) \sim I(0) \quad (10)$$

These structural long-run relations imply the following (over)-identification restrictions on the cointegration matrix β ($\Pi_y = \alpha_y \beta'$) in equation (5).

$$\beta' = \begin{pmatrix} 1 & 0 & -1 & -1 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & -1 & 0 & 0 & 0 \end{pmatrix} \quad (11)$$

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

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

with $\beta_{16} = 0$, $\beta_{26} = 0$ denote the deterministic trend restrictions,

$\beta_{17} = 0$, $\beta_{27} = 0$ denote the Asia crisis 1998 restrictions,

$\beta_{18} = 0$, $\beta_{28} = 0$ denote the Subprime crisis 2008 restrictions

3.2 Data Description

Our analyses are based on quarterly series, spanning from 1996:Q1 to 2010:Q4—a period of economic liberalization and trade expansion for both China and Malaysia. Due to the fact that most of the trade settlements are in US dollars, the nominal effective Malaysian ringgit that adjusted for trade weightage is used. For interest rates, the Malaysian 3-month Treasury bills and Chinese lending rates are used. As for price variables, the Malaysian and Chinese producer prices are used. All data are sourced from DataStream and cross-checked with the International Financial Statistics, IMF.

4. Empirical Discussion

The preliminary examination of the data properties is conducted using the unit root test of Zivot-Andrew (1992). The data are overwhelmingly integrated of I*(1)* where unit roots are rejected at first difference. This test allows for endogenous structural break, and, for most cases (P_M, R_M, EX_M), the break dates fall on the Asian financial crisis (1997/98) and subprime crisis (2008) periods.[9] We thereby impose two dummy variables on the following long run VARX and error correction VECMX models.

4.1 Dynamic Long-run Relationship and Error Correction Modeling

Before proceeding to the cointegration test of long-run relationship, we have to determine the lag orders of endogenous and exogenous variable outlined in Eq (5). For this purpose, the Akaike Information Criterion (AIC) and the Schwarz Bayesian Criterion (SBC) are applied to the underlying unrestricted VARX model. SBC has selected the lag orders of 1 for both conditional and marginal models ($k_{SBC}=1, 1$). In Table 1, the log-likelihood ratio

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

statistics that adjusted for small samples (Adj LR) does not reject the VARX model of order (1, 1). As such, the subsequent analyses are based on the VARX (1, 1).

Insert [Table 1] about here

Next, we need to determine the number of cointegrating relations given by r = rank (Π_y), as defined by Eq(5). The cointegration model contains three domestic variables–P_M, R_M, EX_M, and two foreign variables–P_C, R_C. Following Pesaran, *et al*. (2000), the modified Johansen-Juselius (1992) cointegration test is conducted using trace statistics for model with weakly exogenous regressors. The test result is reported in Table 1. It appears that the trace statistic indicates the presence of two cointegrating relations (*r = 2*) at 5% and 10% significant level respectively based on the bootstrapped critical values by 1000 replications. Such result is in line with our theoretical expectation that PPP and IRP may jointly hold. The PPP relation captures the long run equilibrium of domestic (Malaysia) and foreign (China) prices measured in common currency due to bilateral trading. The IRP relation then captures the equilibrium outcome between domestic (Malaysia) and foreign (China) interest rates due to the effect of the arbitrage process between the two in capital market.

In order to produce the long run estimate of the Malaysia-China parities model, we then impose exact-identifying / normalized restrictions ($\beta_{11} = 1$, $\beta_{12} = 0$, $\beta_{21} = 0$, $\beta_{22} = 1$). In Table 2, the exactly identified ML estimates of the two cointegrating vectors and their asymptotic standard errors are presented. For CV1 (PPP), exchange rate and foreign price carry the expected negative sign. It indicates an established long run PPP relation that goods-market arbitrage will tend to move the exchange rate (RM/yuan) to equalize prices in the two countries. As for CV2 (IRP), foreign rates of interest also signed correctly, suggesting a potential UIP relationship. UIP states that the financial market (or, the capital account between two currency areas) will only be in equilibrium if, after adjusting for differential risks investors receiving the same rate of return (interest) in both markets. So, if the return on a Malaysia *n*-period interest is one percentage point higher than that on China rate, one would expect, on average, the yuan to appreciate by one percent over the next *n* periods. In addition, possible positive crises effects are reported for PPP and negative crises effects are reported for IRP.

Insert [Table 2] about here

To further justify the PPP and IRP theorem, we proceed to re-estimate the cointegration relations with nine additional hypotheses using over-identifying restrictions (see Table 3). Since LR tests (χ^2) could over-reject in small samples (Affandi, 2007; Garratt, *et al.*, 2006), the bootstrapped critical values based on 1,000 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 data set 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– if the trend coefficients are zero in the two cointegrating relations ($\beta_{16} = 0$, $\beta_{26} = 0$). The bootstrapped critical values for the joint test are 11.32 (95%) and 8.5595 (90%) respectively, while the LR statistic (χ^2) of over-identifying restriction is reported as 4.2601 in Table 3, hypothesis (a). Hence, the restriction cannot be rejected and the co-trending assumption holds. We proceed with the two co-breaking hypotheses and both restrictions failed to be rejected. This would imply that the presence of Asia crisis and Subprime crisis as dummy variable does affect the long run relationships of PPP and IRP.

Insert [Table 3] about here

Next, Equation (9) suggests that exchange rate (EX_M), foreign price (P_C) and foreign interest (R_C) enter the long run PPP relations with β_{13}= -1, β_{14}= -1, β_{15}=0. The reported χ^2 (1.08) is well below the bootstrapped critical values of 16.9719 (95%) and 13.2636 (90%). Hence, long run PPP holds. Similarly, IRP holds when we do not reject the IRP restriction (β_{23}=0, β_{24}=0, β_{25}=-1), neither at 95% nor at 90% confident levels. In fact, the result in (f) also supports for the cointegrating relationships when PPP and IRP are jointly restricted. More important, results in (g), (h) and (i) confirm the validity of joint PPP-IRP for Malaysia-China during 1996-2010 under the combined assumption that the cointegrating relations are co-trending and co-breaking. Such finding is established on a series of advanced econometric procedures and theoretical formulation which allow for possible interactions between the goods and the capital markets. In literature, empirical evidences on PPP and IRP are most likely to be found between countries of similar technological development with strong trade associations (Juselius, 1995). These conditions seem to be approximately fulfilled for Malaysia and China.

To this end, it is still early to conclude how the price and monetary transmission mechanism worked. One should consider the error correction representation of PPP and IRP. The following modeling of VECMX short run dynamics is presented in Table 4 and several points are noteworthy. First of all, the lagged error correction terms ($ECT1_{t-1}$ and $ECT2_{t-1}$) for both Price (ΔP_M) and Interest (ΔR_M) equations carry the expected negative and significant sign, indicating that the system - once being shocked, will necessarily adjust back to the long run equilibrium. These estimates shows that the error-correcting coefficient of PPP is greater in the price equation (-0.236) but lower in the interest equation (0.0261). On the contrary, IRP adjustment is of greater pace in the interest equation (0.388) but slower in the price equation (0.1109). Then, the lagged ΔP_{Ct-1} and ΔR_{Mt-1} are significant in explaining Malaysian price changes. Also, ΔP_{Ct-1} is significant in the interest equation. Together, the results suggest a direct price transmission from China to Malaysia in the short-run, and Malaysian monetary policy responded to Chinese price to ease domestic inflation. Though with correct signs, the ΔR_{Ct-1} is insignificant in both equations, suggesting for rooms of monetary autonomy in the short run. On the other hand, exchange rate does not seem to significantly affect the price changes and interest movements in short-run.

Insert [Table 4] about here

Despite the R^2 reported as 0.5721 and 0.3597 for the respective price and interest equation in Table 3, four additional diagnostic tests are also conducted. For serial correlation, we use the Lagrange Multiplier (LM) test. The error correction model is clean of autocorrelation problems as the null hypothesis of serial correlation in residuals failed to be rejected, in the presence of lagged dependent variable. The insignificant *F*-statistics are reported at 2.0833 (p-value=0.115) for price equation, and at 2.1080 (p-value=0.100) for interest equation. Using the square of the fitted values, the Ramsey Regression Equation Specification Error Test (RESET) then examines the functional misspecification. The price equation and interest equation are both considered as correctly specified with the *F*-statistics reported as insignificant (p-values=0.805 and 0.366). Likewise, the heteroscedasticity test statistics are also within the insignificant bounds. And lastly, there are no evidences of non-normal errors in the two error-correcting equations.

A subsequent and important inspection of model stability is to apply the cumulative sum (CUSUM) and cumulative sum of squares (CUSUMSQ) tests to the residuals of the error-correction VECX* model and the long-run VARX coefficient estimates. For the CUSUM test, the recursive residuals are plotted against the break points, while the CUSUMSQ plots the squared recursive residuals against the break points. As a graphical presentation, these two statistics are then plotted within two straight lines, which are bounded by 5% significance level. If any point lay beyond this 5% level, the null hypothesis of stable parameters is rejected or otherwise. Clearly, Figure 1 supports the stability of estimated coefficients for our Malaysia-China parities model as both statistics are within the critical lines.

Insert [Figure 1] about here

4.2 Shock Responses and Speed of Convergence

In addition to error correction modeling, a good way of measuring the speed of convergence of the cointegrating relations to equilibrium is to examine the dynamic responses of the endogenous variables to various types of shocks. This paper focuses on the effect of system-wide shocks on the cointegrating relations using the Persistence Profile analysis developed by Pesaran and Shin (1996). On impact, the Persistence Profile is normalized to take the value of unity, but the rate at which it tends toward zero provides information on the speed with which the equilibrium correction takes place in response to shocks. In addition to the point estimates, the 2.5% and 97.5% Confidence Bounds—which are generated by employing the nonparametric bootstrap method using 1,000 replications—are also illustrated as dotted lines in Figure 2.

Insert [Figure 2] about here

The system-wide shock has affected all long-run relations significantly in the beginning, before the effects eventually disappear in the long run. The half-life for PPP relation is about 3.5 quarters (about 10-11 months), and the whole effect takes around 6-7 quarters to complete. The speed of convergence is generally faster than what was documented by Rogoff (1996) but in line with the recent Asian PPP studies (e.g. Baharumshah, Aggarwal and Chan, 2007; Baharumshah, Chan and Fountas, 2008; Chan, Chong and Hooy, 2011). As for RIP relation, the half-life is shown at about 4.5 quarters (13-14 months) and the adjustments completed by 18 quarters. The result seems to be consistent with the error correction representation of VECMX model that the convergence process in the goods market is faster than in financial market. The faster pace of adjustment (following system-wide shocks) towards price instead of interest equilibrium is also in line with theoretical prediction. Such finding implies the nonappearance of sequencing problem in market integration for Malaysia-China.

Subsequent analysis of the Variance Decompositions (VDCs) attempts to gauge the extent of shocks to a variable that can be explained by other variables considered in the VARX model. VDCs can be considered as an out-sample causality test, which provides a quantitative measurement of how much the movement in one variable can be explained by other variables in the VAR system in terms of the percentage of forecast error variance. However, the results based on conventional orthogonalized VDCs are found to be sensitive to the number of lag lengths used and the ordering of the variables in the equation. The errors in any equation in a VAR are normally serially uncorrelated by construction, but there may be contemporaneous correlations across errors of different equations. To overcome this problem, we estimate the generalized VDCs of forecast error (see Pesaran and Pesaran, 1997).

Insert [Table 5] about here

Table 5 presents the generalized VDCs for our VARX model. Among the five variables in the system, the Chinese variables (P_C and R_C) seem to be the most exogenous variables, as most of the shocks are explained by their own innovations (74%–87% and 94%-95%) over the horizon of 16 quarters. Such a finding provides the methodological support for the VARX and VECMX modeling approach employed in this study. On the other hand, Malaysian price (P_M) and interest rate (R_M) are found to be endogenously determined. In line with the long-run estimates, innovation from the effective exchange rate (>30%) and Chinese price (>50%) explain a substantial portion of the forecast error variance in the P_M, especially after the 4th quarter horizon. Apart from the direct effect of imported inflation, exchange rate also plays a significant role in the price transmission mechanism. As for R_M, the major innovation comes from the effective exchange rate (4%-56%) at increasing rate. Meaning that Malaysian remains the relative monetary autonomy but the exchange rate regime will affect the extent of IRP condition in the long run. In addition, about 25%-38% errors of effective exchange rate are jointly explained by domestic (P_M) and foreign prices (P_C), which support for the PPP relation.

5. Conclusion and Policy Implications

This study constructs a structural system that allow for possible interactions between the PPP and IRP so that the transmission mechanism among interest rates, prices, and exchange rates can be better understood. The empirical framework was constructed based on the VARX and VECMX modeling procedures put forward by Pesaran *et al*. (2000), Garratt *et al*. (2006) and Assenmacher-Wesche & Pesaran (2009). The application of Persistent Profile and generalized VDCs shows how the core variables (P_M, R_M, EX_M) evolve with respect to economic shocks. With non-parametric bootstrapping, we are able to reduce size distortions in finite sample bias and yield consistent estimators and test statistics. As such, the empirical results are interpretable and can provide new insights to the dynamics of the short-run and long-run adjustment processes of a small open economy (Malaysia) facing the major and large trading partner (China).

Generally, the results show that the goods and the capital markets in Malaysia and China are integrated and the exchange rate holds an important long run link between the two markets. We confirm that both PPP and IRP hold in the liberalization era, given the nine over-identifying restrictions that based on theoretical prediction failed to be rejected. Additionally, the faster pace of adjustment towards price instead of the interest rate equilibrium implies the nonappearance of sequencing problem in market integration. In other words, the present economic linkage provides a concrete platform for closer economic collaboration and financial arrangements.

Yet, policy warnings are as well in attendance. The PPP relation implies that any short run deviation of the exchange rates (e.g. real currency depreciation) will be adjusted in the price of tradable goods and hence the trade flows, which steadily revert the exchange rates back to the equilibrium level. However, if RM/yuan remains stable within a rigid regime, both PPP and IRP hold to imply that the price hikes will transmit as imported inflation under the capital mobility atmosphere. Policy makers should be aware that maintaining a rigid foreign exchange with major import source could be costly with potential contagious price instability and financial risk. A close monitor of the Chinese prices and interest movement is essential, and supply channel diversification should be highlighted. In brief, our study constitutes the basis of an early warning system for Malaysia's economic defense against global shocks.

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Table 1: VARX Cointegrating Test, 1996Q1-2010Q4

H_0	H_1	Trace Statistic	Bootstrapped Critical Values 95%	Bootstrapped Critical Values 90%
$r = 0$	$r \geq 1$	96.8556**	74.2452	70.4917
$r \leq 1$	$r \geq 2$	44.7480*	46.7084	42.1938
$r \leq 2$	$r = 3$	16.8072	24.6198	21.3047
lag	*(1, 1)*	SBC = 910.8761	Adj LR test = 190.7867[0.277]	

Notes: ** and * denote significant at 95% and 90% confidence level respectively. Trace statistics are cointegration LR tests based on trace of the stochastic matrix. The 95% and 90% critical values are generated by bootstrap method using 58 observations and 1000 replications. The underlying VARX Parity model contains unrestricted intercept with trend and the optimal lag order based on SBC is shown at the bottom of Table 1.

Table 2: Exact-identifying Restrictions, 1996Q1-2010Q4

	Exact-identifying Restrictions							
	P_M	R_M	EX_M	P_C	R_C	T	D_{98}	D_{08}
CV1(PPP)	1.000	0.000	-0.6335 (0.6421)	-1.4429 (1.1507)	-2.2562 (7.0638)	0.0008 (0.0054)	0.0139 (0.0676)	0.1184 (0.1210)
CV2(IRP)	0.000	1.000	0.0304 (0.0360)	0.0871 (0.0650)	-0.8520 (0.3981)	0.0004 (0.0003)	-0.0082 (0.0037)	-0.0031 (0.0068)

Note: standard errors are reported in the parentheses.

Table 3: PPP and IRP Restriction Tests, 1996Q1-2010Q4

	Hypotheses	Over-identifying Restrictions	LR (χ^2)	Bootstrapped Critical Values 95%	Bootstrapped Critical Values 90%
(a)	co-trending	$\beta_{16} = 0, \beta_{26} = 0$	4.2601	11.3210	8.5595
(b)	co-breaking 98	$\beta_{17} = 0, \beta_{27} = 0$	5.0326	8.8343	6.8948
(c)	co-breaking 08	$\beta_{18} = 0, \beta_{28} = 0$	0.3074	9.5230	7.0267
(d)	PPP	$\beta_{13}= -1, \beta_{14}= -1, \beta_{15}=0$	1.0800	16.9719	13.2636
(e)	IRP	$\beta_{23}=0, \beta_{24}=0, \beta_{25}=-1$	2.7317	17.4637	15.1311
(f)	PPP+IRP	$\beta_{13}= -1, \beta_{14}= -1, \beta_{15}=0, \beta_{23}=0, \beta_{24}=0, \beta_{25}= -1$	2.9841	23.6545	20.2434
(g)	PPP+(a)+(b)+(c)	$\beta_{13}= -1, \beta_{14}= -1, \beta_{15}=0, \beta_{16}=0, \beta_{17}=0, \beta_{18}=0, \beta_{26}=0, \beta_{27}=0, \beta_{28}=0$	6.3147	31.9775	27.9610
(h)	IRP+(a)+(b)+(c)	$\beta_{23}=0, \beta_{24}=0, \beta_{25}= -1, \beta_{16}=0, \beta_{17}=0, \beta_{18}=0, \beta_{26}=0, \beta_{27}=0, \beta_{28}=0$	0.4296	28.2717	24.7537
(i)	PPP+IRP+ (a)+(b)+(c)	$\beta_{13}= -1, \beta_{14}= -1, \beta_{15}=0, \beta_{16}=0, \beta_{17}=0, \beta_{18}=0, \beta_{23}=0, \beta_{24}=0, \beta_{25}= -1, \beta_{26}=0, \beta_{27}=0, \beta_{28}=0$	9.5846	38.9991	34.4744

Notes: ** denotes significant at 95% confidence level. The respective 95% and 90% critical values are generated by bootstrap method using 58 observations and 1000 simulations. All ML estimates converged within 100 iterations. The underlying VARX trade model is of lag order (1, 1) and contains unrestricted intercept.

Table 4: Error Correction Representation in VECMX Modeling

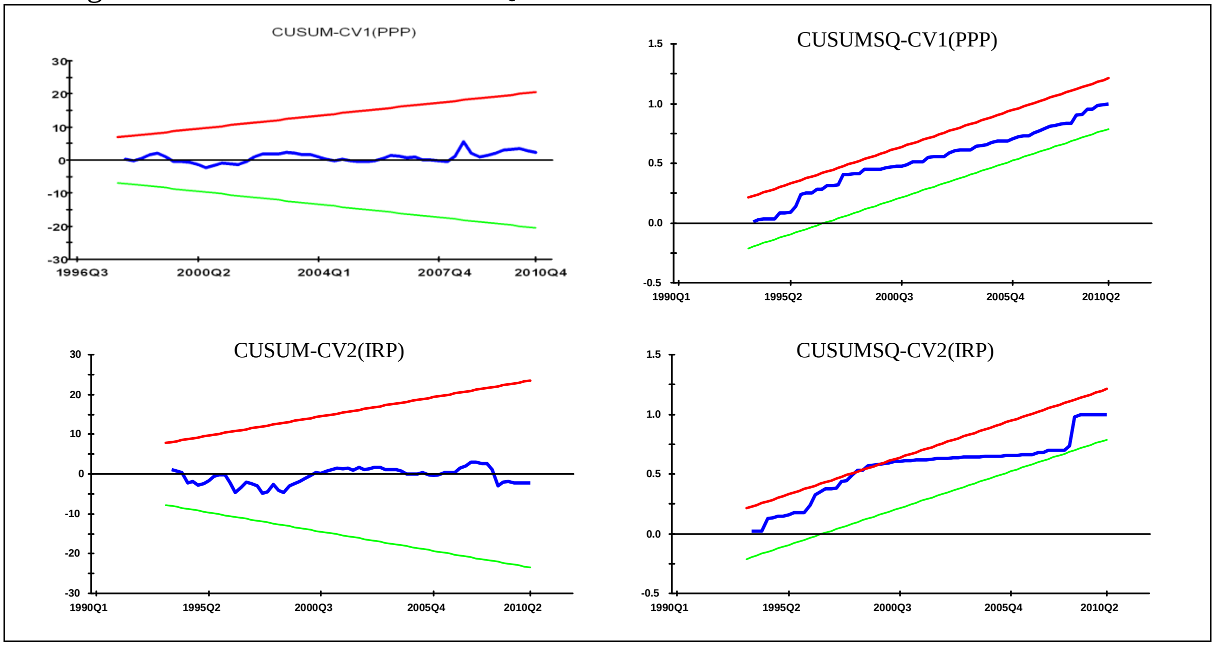
Regressor	Dependent Variable			
	ΔP_M		ΔR_M	
	Coefficient	t-sta [P-value]	Coefficient	t-sta [P-value]
	Conditional Model			
ΔP_{Mt-1}	0.1235	1.0241[0.311]	-1.0130	-0.6889[0.494]
ΔR_{Mt-1}	2.0651 [b]	2.2101[0.032]	0.1426	0.97591[0.334]
ΔEX_{Mt-1}	-0.0160	-0.5238[0.603]	-0.0038	-0.8017[0.427]
c	0.1273 [b]	2.4322[0.019]	-0.0005	-0.0634[0.950]
T	-0.0004 [c]	-2.9216[0.005]	-0.0004 [a]	-1.8076[0.077]
ΔD_{98}	0.0024	0.6134[0.543]	0.0014	0.2290[0.820]
ΔD_{08}	-0.0110 [c]	-3.3585[0.002]	-0.0004	-0.0891[0.929]
$ECT1_{t-1}$	-0.2360 [c]	-4.5094[0.000]	-0.0261 [c]	-3.1899[0.003]
$ECT2_{t-1}$	-0.1109 [c]	-4.3984[0.000]	-0.3880 [c]	-3.5081[0.001]
	Marginal Model			
ΔP_{Ct-1}	-0.1188 [b]	-2.1278[0.039]	0.0132 [a]	1.9024[0.064]
ΔR_{Ct-1}	0.4890	0.5799[0.565]	-0.1682	-1.2760[0.208]
	Diagnostic Tests			
R^2	0.5721		0.3597	
AUTO	2.0833[0.115]		2.1080[0.100]	
RESET	0.0619[0.805]		0.8312[0.366]	
Normal	1.5086[0.470]		3.8064[0.149]	
Hetero	0.6923[0.409]		0.6190[0.435]	

Notes: [a, b, c] denote significant at the 10%, 5%, and 1% levels, respectively. AUTO is the Lagrange Multiplier test for serial correlation; RESET is the Ramsey Regression Equation Specification Error Test for functional form; Normal is a test that examines for normality in the errors; and Hetero tests for heteroscedasticity. Except for the Normal test that uses chi-squared statistics, all diagnostic tests are conducted using *F*-statistics.

Table 5: Generalized Variance Decomposition

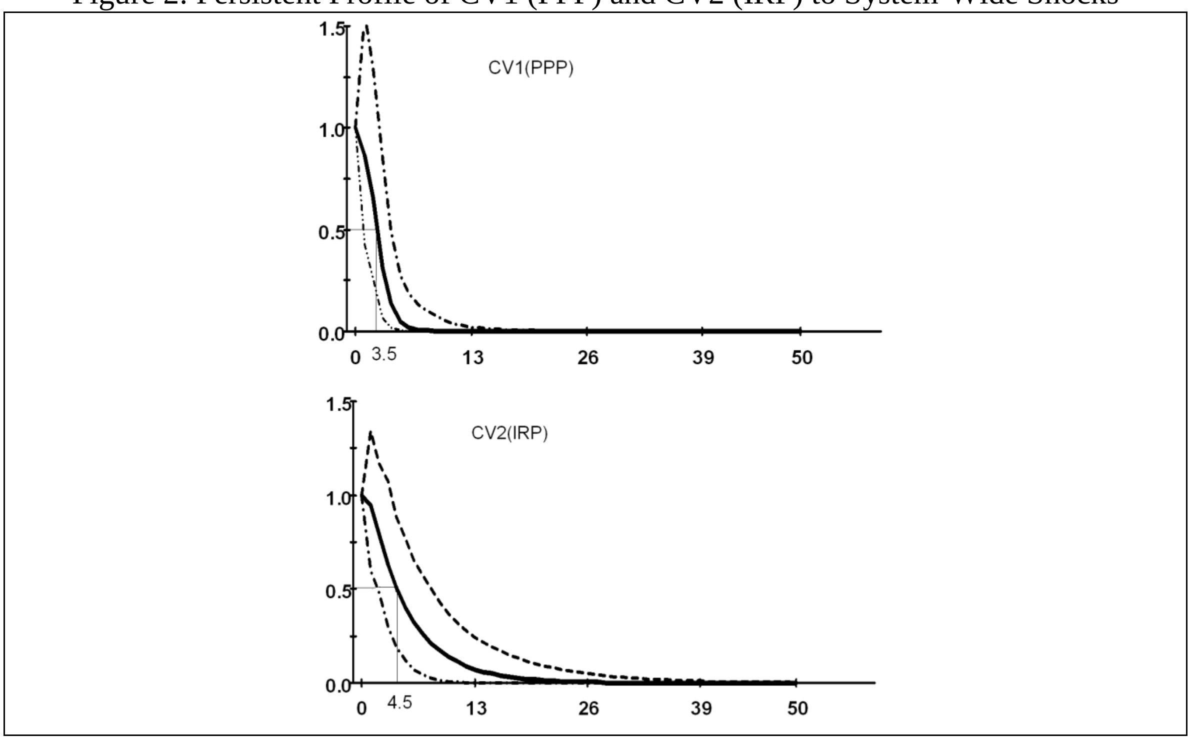
Variables	Horizon	% of Forecasted Variance Explained by Innovations in				
		P_M	R_M	EX_M	P_C	R_C
P_M	1	**0.67866**	0.01698	0.06433	0.26760	0.01898
	4	**0.32092**	0.01291	0.17422	0.46487	0.03911
	8	**0.15890**	0.01169	0.26009	0.52116	0.04409
	12	**0.09896**	0.00947	0.30946	0.52850	0.04374
	16	**0.07012**	0.00778	0.34027	0.52632	0.04270
R_M	1	0.03342	**0.87761**	0.04833	0.02472	0.05448
	4	0.16185	**0.63780**	0.05432	0.02330	0.07480
	8	0.22081	**0.37140**	0.26632	0.02659	0.05042
	12	0.16949	**0.20011**	0.46507	0.02935	0.07938
	16	0.12094	**0.11707**	0.56407	0.03020	0.11756
EX_M	1	0.10128	0.00392	**0.71172**	0.15362	0.00304
	4	0.12654	0.00355	**0.67662**	0.16529	0.00308
	8	0.14999	0.00328	**0.64493**	0.17532	0.00319
	12	0.17130	0.00307	**0.61668**	0.18393	0.00331
	16	0.19043	0.00290	**0.59165**	0.19135	0.00345
P_C	1	0.00751	0.00785	0.04065	**0.87362**	0.06688
	4	0.00922	0.00495	0.06645	**0.84849**	0.07309
	8	0.01050	0.00418	0.10279	**0.80326**	0.08181
	12	0.01065	0.00372	0.13316	**0.77021**	0.08391
	16	0.01052	0.00342	0.15959	**0.74261**	0.08429
R_C	1	0.00012	0.00109	0.01070	0.03957	**0.95734**
	4	0.00022	0.00043	0.02447	0.03434	**0.94853**
	8	0.00014	0.00024	0.02484	0.03683	**0.94612**
	12	0.00012	0.00017	0.02331	0.03918	**0.94572**
	16	0.00011	0.00014	0.02168	0.04135	**0.94557**

Figure 1: CUSUM and CUSUMSQ Tests of Recursive Residuals for CV1 and CV2



Note: The straight lines represent critical bounds at 5% significance level

Figure 2: Persistent Profile of CV1 (PPP) and CV2 (IRP) to System-Wide Shocks



Note: The dot-lines represent the top 97.5% and low 2.5% bootstrapped confidence intervals respectively.