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ECONOMIC FEASIBILITY OF A BRICS MONETARY UNION

Abstract

This paper attempts to assess the feasibility of monetary integration between the world's fastest growing economies today, namely China, Russia, Brazil, India, and South Africa (BRICS) by reviewing variables according to the classical optimum currency areas (OCA) framework and recent considerations. The proposition is that, with greater trade and financial cooperation between the BRICS through the Contingent Reserve Arrangement (CRA), New Development Bank (NDB), and Asian Infrastructure Investment Bank (AIIB), there should be greater multilateral economic and monetary interconnectedness in the long run. In addition, tighter monetary integration between the BRICS can be a potential strategic reaction to the financial instabilities originated in the financial centers of the West. Since China is the largest economy, it is designated as the monetary anchor country in the exercise. The examined period spans from 2000 to 2013, including the periods before and after the peak of the 2008-09 global financial crisis. While the findings are mixed, results suggest Brazil as the most feasible candidate to unify monetarily with China.

JEL CLASSIFICATION: E62, F31, F32, F41, F42, O53.

KEYWORDS: CURRENCY, MONETARY UNION, BRICS, RENMINBI, YUAN.

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1. Introduction

The strength of the dollar is grounded on its status of international reserve currency. In the absence of this privilege, foreigners' willingness to purchase the American government liabilities will diminish sharply (Stokes 2014). Confidence in the health of the US economy and the dollar can plunge because of continued large and rising current account deficits, unfunded liabilities of the federal government, expansionary monetary policy, and unreliable financial regulation system.

Against this gargantuan stock of foreign debt, there is little doubt that the US federal authorities will choose to inflate prices and depreciate the value of the dollar to diminish the real value of the amount owed rather than to default outright (Ryan 2011). As a reaction to this, the Chinese government has begun to diversify and minimize devaluation risk by purchasing other assets such as gold and eurozone bonds.

At the same time, with the rise of China, India, Brazil and other emerging economies, today the US no longer towers over the global economy and hence the dollar will not be as dominant as that after the Second World War (Eichengreen 2010). As a matter of fact, the emerging Brazil, Russia, India, China, and South Africa (BRICS) are home to more than 40 percent of the world's population and account for 55 percent of global economic growth between 2000-08 (Carmody 2013). The BRICS's common agendum of pushing international economic governance away from neoliberalism and western dominance was manifest when they denounced that austerity in the West was holding back world growth and that their central banks' unconventional monetary policy encouraged speculation worldwide instead of real growth (Desai 2013).

Led by China, the emerging economies have organized alternative sources of credit flows in the attempt to circumvent the conditionality of the IMF loans and to counter the hegemony of the US (Sen 2015). This is not surprising because, as of 2014, The BRICS possessed just 11% of the votes in the IMF, despite accounting for more than 20% of global economic activity (Eichengreen 2014).

To reduce their dependence on the dollar, in 2015 the BRICS established the Contingent Reserve Arrangement (CRA) to provide liquidity and precautionary instruments against actual or potential short-term balance-of-payment pressures. The launch of these financial institutions by the BRICS,

when combined with the proposed intra-BRICS clearing arrangement in local currencies, shall help to mitigate shocks brought about by the American economy.

Another institution is the New Development Bank (NDB) created by BRICS in July, 2014 which serves the mandate of investing in infrastructure and renewable energy projects. The first set of loans at 811 million dollars was approved in May 2016. At the same time, China also led the formation of the Asian Infrastructure Investment Bank (AIIB) that began operation in 2015, aimed at financing infrastructure development in the Asia Pacific region.

Just as the US used its control over the IMF to exert pressures on debtor nations, a successful BRICS bank and AIIB can, by offering loans to governments, be used in the similar way in other situations (McMaken 2015). By making loans in currencies other than the dollar, they can loosen the dollar's clutch on the default reserve status. Once these alternative institutions diminish the value of holding dollar assets, foreign holders can aggressively dump dollars just like the way the Americans dumped the pound-sterling bonds in 1956.

Despite the above potentials, there are several flaws in the present BRICS agreement. Firstly, balance of payments constraints for BRICS members will not be relieved as the present arrangement requires an IMF intervention after just 30 percent of the quota is borrowed. Secondly, NDB appears close to the Bretton Woods model, promoting frenetic extractivist calculations based on US dollar financing (Bond 2016). On top of that, further progress depends upon BRICS capability to overcome structural obstacles under which huge growth discrepancies and heterogeneous domestic priorities are the most prominent ones (Liu 2016).

Nevertheless, in the light of the declining dollar and the emergence of BRICS, this paper assesses the feasibility of a form of monetary integration between the BRICS countries. The analytical tool deployed is the criteria of real convergence stemming from the optimal currency area (OCA) theory and recent developments in the literature. The method used is straightforward and does not conceal actual characteristics of data through aggregation which may be present in econometric analysis.

Since today China is the most promising contender to the US in the economic and monetary arenas, China is designated as the monetary anchor country in the present analysis. A total of nine dimensions are explored of which most of the items are measured with respect to China whilst the other

facets are measured in absolute terms. Whilst findings are mixed, Brazil stands out as a potential candidate to integrate monetarily with China.

The remainder of this paper consists of two sections. The second section introduces the OCA-related variables and simultaneously evaluates these criteria in relation to the BRICS countries. The third section discusses the key findings and concludes.

2. Criteria and evaluation

The foundations of the OCA theory are laid out by Mundell (1961), McKinnon (1963), and Kenen (1969). In essence, the OCA theory outlines the criteria under which an economic zone can reap the benefits and reduce the costs of joining a currency area. Following Quah (2017, 2016b, 2015, 2014b, 2014a, 2013b, 2013a, 2012a, 2012b), Quah and Crowley (2010, 2012a, 2012b), the OCA criteria investigated here are trade openness, business cycle synchronization, exchange rate variability, inflation convergence, and real interest rate symmetry. The efficacy of the criteria was confirmed when Artis and Zhang (2001, 2002) accurately singled out Portugal, Italy, Greece, and Spain as the euro states with the least conforming OCA features against Germany.

To assess the appropriateness of monetary integration between the BRICS countries and constrained by data availability, the characteristics of these economies are examined from 2000 to 2013, a period that includes the 2008-09 global financial crisis episode. Observations are made to check for significant changes after this crisis period. If a BRICS country comparatively conforms to the criteria and/or vis-à-vis the others, it indicates greater readiness for exchange rate fixation with China. Data sampled for each variable are constrained by availability for the period concerned.

2.1 Business Cycle Symmetry with China

When business cycles of two currency areas are highly synchronous, the role of exchange rate flexibility as a temporal external shock absorber becomes less important. For present purpose, the greater the degree of symmetry in business cycle with China, the smaller will be the costs from renouncing independent monetary policy for a peripheral country. In other words, the stronger is the case for a monetary unification with China.

In terms of measurement, this criterion is measured using synchronicity of business cycles through evaluation of cyclical component of output (see Gerlach 1988; Baxter and Stockman 1989). Over here, the cyclical component is extracted by detrending annual real GDP¹ series using Hodrick-Prescott filter (see Quah 2015; Artis and Zhang 2001, 2002).

Figure 1 compares each of the business cycles of Brazil, Russia, India, and South Africa with that of China for 2000-2013. Correlation coefficients of the cycles by periods of 2000-08, 2009-13, and 2000-13 are provided in the accompanying Table 1. Since China plays the anchor country in this exercise, the business cycle of each of the other countries is correlated with that of China. As an indication of relative variation in national output, standard deviations² (SD) of the cycles are also furnished in the table.

As reflected by the charts, in the pre-crisis period of 2000-08, it is apparent that each output cycle of the other countries does move substantively in tandem with China. The visibly synchronous trajectories are corroborated by the corresponding correlation coefficients. For this pre-crisis period, China experiences huge swing in production and the country most convergent with China during this time is South Africa.

As for the post-crisis period of 2009-13, extent of symmetry with China has increased for all. Indeed, Brazil and India have been most synchronous with China with most parallel paths and statistically high correlation coefficients. While increased synchronicity might be largely due to the global crisis shocks, this observation should not be a hindrance to present analysis. Not all countries are equally affected by the crisis.

As can be seen here, Russia and South Africa have not increased much their symmetry with China in the post-crisis period. Hence, one cannot easily claim that greater business cycle symmetry with China is due to the global crisis per se. Unquestionably, fundamental factors may play a role in bringing about the increased symmetry with China for Brazil and India.

When the whole period of 2000-13 is observed, synchronicities with China are moderated but are still significant as shown by the still substantial correlations. Amongst all, Russia is the least parallel with China.

In respect of variation in real production, variability of China has remarkably reduced as shown by milder oscillation and smaller standard

¹ Real GDP at annual frequency is used for consistency across all countries.

² Standard deviation for each case equals to unity for the whole period because standardized detrended values are used for consistency and comparability.

deviation in the post-crisis period. A similar pattern is also seen for South Africa. On the contrary, Brazil's output variation has somewhat risen after the global crisis. Also interesting is the relatively stable China during the crisis period of 2008-09, as shown by its moderate swing. This moderation could be a result of its massive fiscal stimulus in infrastructure and energy and increased growth in domestic demand (see Nolan 2015).

In a nutshell, despite the greater output gyration in Brazil, the business cycles of Brazil, Russia, India, and South Africa have somewhat increased their convergence with that of China. If one were to rank business cycle convergence with China as indicated by correlation of the post-crisis period, the first place will be taken by Brazil, the second place by India, the third place by South Africa, and the last place by Russia.

2.2 Trade Intensity with China

The OCA theory suggests that countries which trade a great deal with each other are good candidates for monetary integration as the benefits in terms of transaction cost savings and exchange rate certainty would be greatly enhanced (McKinnon 1963). Also, the more open the economies are to each other, the less asynchronous would be their output fluctuations arising from demand shocks (Frankel and Rose 1998).

A bilateral trade measure as used by Quah (2015) and Artis and Zhang (2001, 2002) is adopted here to quantify trade openness with China. For a country as denoted by i trade openness is measured by bilateral trade intensity, $(x_{i,r} + m_{i,r}) / (x_i + m_i)$ where x_i and m_i are the dollar values of exports and imports of goods of that country and subscript r indicates destination to or source from the reference country, or China in this analysis. Figure 2 puts together 4 lines, each depicting percentage share of goods trade with China over total goods trade from 2000Q1 to 2013Q4.

As shown by Figure 2, in the early years, Russia records the greatest trade with China, standing at around 5 percent. Its growth, however, has been relatively slow and its level has only reached at about 10 percent in 2013. Similarly, India's trade linkage with China has only risen slightly from about 2 percent in the beginning of the period to about 8-9 percent at the end of the period. For Russia and India, their growth trends are increasingly convergent but their pace has virtually stagnated after the global crisis. Quite the opposite, beginning with trade relation with China as small as India's, Brazil has enjoyed greater increase in the post-crisis period. Meanwhile, South

Africa has persisted with its growth pace throughout the entire period despite the crisis.

To summarize, in regard to trade linkage with China, the findings indicate a persistent rise for Brazil and South Africa and a stabilizing trend for India and Russia despite India and Russia's close physical distance with China. Judging by both the growth rate and intensity level in the post-crisis period, Brazil can be ranked first as the closest trading partner with China, followed by South Africa, Russia, and lastly India.

2.3 Exchange Rate Variability Against the Chinese Yuan

Exchange rate variability is one indicator of synchronicity of economic forces between currency zones. It is an important factor for accession into a monetary union because exchange rate changes are clearly measurable and automatically give the appropriate weights to the economic forces of which the changes are the result (Vaubel 1978). These economic forces include inflation, openness, economy size, prices, wage flexibility, factor mobility, commodity diversification, goods market integration, and fiscal integration (Tavlas 1993). Hence, Quah and Crowley (2012a) suggest that stability in nominal exchange rate might indicate lack of asymmetric shocks and presence of business cycle synchronicity.

In brief, since the mid-2000s and ever since the global financial crisis, the Chinese yuan has been more flexible against the US dollar under managed float regime. In contrast, prior to 2005, the Chinese yuan had been pegged to the US dollar.

Figure 3 shows the percentage change in nominal exchange rate against the Chinese yuan for 2000:2-2013:12. Standard deviations for 2000-08, 2009-13, and 2000-13 are collected in Table 2. As signified by the plots and the standard deviations, the Chinese yuan rates of the Brazilian real and the South African rand are somewhat stabler in the post-crisis period. In greater detail, the real has already been much steadier since as early as the mid-2000s. As for the rand, its variation is smaller after the mid-2000s and after the global crisis. On the contrary, the Russian ruble and the Indian rupee have shown larger gyration since the mid-2000s. On top of that, their renminbi rates are remarkably volatile against the Chinese yuan in the post-crisis period.

To conclude, yuan rates of the real and rand have become stabler but only to a relatively small extent. On the other hand, the ruble and rupee have been

significantly more volatile. On the conformity to this criterion of exchange rate stability, Brazil can be ranked first and South Africa the second because of their reduction in variability while India can be ranked third and Russia fourth due to their increase in volatility.

2.4 Convergence in Inflation with China

The traditional OCA literature originated during the era of ‘fix-price’ economics, so introducing inflation convergence as a criterion can be regarded as a theoretical normalization (Artis and Zhang 2001). Besides, convergence in inflation also reflects similarity in trade union aggressiveness and labor costs, implying lesser need for flexibility of exchange rate in correcting current account imbalances (Fleming 1971). Parallel rates of price inflation also matter in equilibrating real cost of capital between high and low growth areas when interest rates are unified within a monetary union (Quah 2015).

Figure 4 plots the 2000:1-2013:12 CPI inflation rates by contrasting the rate of each country against the Chinese rate. Period averages of absolute difference, $|x_i - x_{China}|$ where x_i and x_{China} are the respective rates of inflation in country i and China are given in Table 3. Absolute differential is used to quantify extent of convergence regardless of direction. Standard deviation indicating the variability of the differential is also provided in the table.

As the charts and the differential averages show, it is apparent that Brazil is most convergent with China in CPI inflation over the entire period of 2000 to 2013, exhibiting increased convergence in both the movement of the rate and the level in the second half of the period. Notably, India is also highly convergent with China but only in the pre-crisis period. India’s price inflation has noticeably deviated to a higher long-run level after the global turmoil.

Meantime, South Africa closely tracks China in the run-up years to the global crisis but follows China with sharp divergent swings after the crisis. As for Russia, it’s path is converging with China when the entire period is considered. Amid these findings, change of trajectory after the crisis describes India and South Africa of which both have somewhat diverged from China.

With regards to variation in inflation differential, Brazil reports the greatest reduction in variability, followed by Russia. Putting it all together,

Brazil and Russia have increased convergence with China with greater stability. On the other hand, both India and South Africa have deviated with China with greater variation.

To summarize, convergence in inflation, a critical prerequisite stressed by Mundell (2000) for monetary integration has been increasingly satisfied by Brazil and Russia. To rank their conformity looking at their tendencies, Brazil meets this criterion best, followed by Russia, South Africa, and lastly India.

2.5 Synchronicity of Real Interest Rate with China

Though not formally listed as one of the criteria based on the classical OCA theory (Tavlas 1993), this factor is indicated by a “revealed preference” argument (Artis and Zhang 2001). If the monetary policy of a candidate country has historically differed little from that of a partner country, the cost of relinquishing monetary independence should be accordingly low. Thus, synchronicity in real interest rate can be interpreted as a measure of coordination in monetary policy. To compute real interest rate, lending rate and CPI inflation are used. Detrending is accomplished by H-P filter to extract the cyclical component from the series (see Quah 2015; Artis and Zhang 2001, 2002).

Figure 5 compares the detrended real interest rates of 2000:1-2013:12. For comparability over countries, the detrended series are normalized. Correlations with China and the standard deviations of the detrended series are provided in Table 4. As the plots and the correlations reveal, Brazil tracks China at correlation coefficient of .54 in the pre-crisis period but deviates at coefficient of .20 after the global crisis. Quite the opposite, Russia diverges with China at coefficient .19 before the crisis but traces China at .55 after the crisis.

Despite that, both Brazil and Russia are somewhat parallel with China in the run-up to the 2008-09 financial debacle and during the subsequent credit crunch. Meanwhile, India and South Africa have not shown any significant degree of symmetry with China throughout.

Meantime, standard deviation of the detrended real interest rates can indicate extent of certainty in the lending market in the short run. On this evidence, Brazil has increased its variation slightly after the crisis just as China has whilst India and South Africa have varied their real interest rates

by greater extents. Distinctively, the very short-run movement of real interest rate has been somewhat stable for Russia.

In short, only Russia conforms substantively to this interest rate criterion and hence can be ranked first. South Africa can be ranked second since it has progressed from negative correlation to positive correlation with China. India can be ranked third because its divergence with China has diminished. In contrast, Brazil is ranked last because it has shifted from convergence to divergence with China.

2.6 Diversity in Export

As put it by Kenen (1969), when an economic area produces a sufficiently large variety of goods, even if each of its export sectors is subject to adverse shocks, the law of large numbers comes into play so that total production will not suffer much. Accordingly, it is easier to fix the exchange rate of a diversified economy than that of a specialized economy. Logically, change in the diversity level should be more important than the level itself when assessing the potential cost of fixing the exchange rate. If a country has been experiencing decreasing diversity in exports, it will find itself increasingly difficult in mitigating adverse demand shocks to its current account.

Following Quah and Crowley (2010), export diversification is quantified by a diversification index, namely the inverse of the Herfindahl index. The Herfindahl index is a common indicator of degree of specialisation, computed as $H = \sum_{i=1}^n s_i^2$ where s_i is share of the export of product i , and n being the number of products exported.

The higher the value of diversification index, the more diversified the export sector. Since data of individual export products are unavailable, annual export data according to the first-digit sub-industries of the United Nation Standard International Trade Classification (SITC) Revision 3 are used. The categories are displayed in Table 5. The computed indexes for 2001-2013 are plotted in Figure 6.

Consideration has to be made when evaluating this criterion. Since China is strategically designated as the monetary anchor country for BRICS for present analysis, logically the burden of adaptation is hence largely shouldered by member nations. Nonetheless, since ultimate decision must also take into account the stakes of member countries, the centre China may still need to compromise domestic needs for union-wide interests. Along this

line, it is also crucial to examine the extent of export diversification of the centre country China.

Looking at Figure 6, all five nations have shown gradual decline in export diversity over the whole sampled period. Specifically, Brazil and India lead a declining path after the global crisis whilst those of China, South Africa, and Russia have somewhat levelled off since the mid-2000s through the post-crisis period. This finding is in line with division of labour which predicts that open economies tend to exploit comparative advantage and scale economies by producing fewer variants of goods in a globalized competitive economy.

Another interesting observation is that no apparent change in the level of diversification is seen after the global crisis. This is intuitive since export structure is very much dependent on fundamental factors such as natural endowment, technology, fixed capital, and labour skills which are relatively inelastic to short-term business cycle.

Recall that China is proposed here as the monetary anchor country should a BRICS monetary union is formed. Hence, the burden of adjustment to the policies of the anchor country should largely be borne by peripheral member countries. For this reason, only potential member nations are ranked on suitability. South Africa and Russia can be ranked higher (say rank 1) in terms of conformity to this criterion whilst Brazil and India can be given a lower rank (rank 2) because Brazil and India have shown diminishing export diversity in the most recent years in relation to the relatively stable South Africa and Russia.

2.7 Flexibility of Labour Market

Mundell (1961) argues that within a monetary area, labour mobility is the primary mechanism that restores equilibrium in the labour markets following adverse asymmetric shocks over different economic zones. Meantime, Ingram (1962) and Kenen (1969) reason that labour market flexibility also plays the function. In short, the more flexible the labour market, the easier the adaptation of workers to employment changes, the better the chances of getting a new job, the greater the feasibility of fixing the exchange rates.

Constrained by available data, movement in the national unemployment rate is used as a proxy to indicate change in labour market flexibility. Decline in unemployment rate can be viewed as one indicator of higher

flexibility whereas increase in unemployment can be a result of greater rigidity in the labour market.

The respective unemployment rates for 2001-2013 are plotted in Figure 7. All data are scaled on the left vertical axis except that of South Africa which is scaled on the right vertical axis. Due to data constraint, only four data points are available for India, namely that of 2005, 2010, 2012, and 2013. Meantime, for Brazil, published figure for 2010 is not available.

As the chart shows, Brazil and Russia are noticeably parallel in their falling unemployment since the early 2000s boom up until the post-crisis period. The falling trend is interrupted only by a spike in the 2009 recession. Meanwhile, South Africa experiences an upswing and then a downswing prior to the recession, before reaching to a stable and somewhat greater level after the crisis. The Chinese unemployment rate is substantively stable throughout the whole period except only for a significant drop in 2010. As for India, based on just a few data points, the unemployment rate increased to a higher post-crisis level in 2013.

Looking at the trend and the pace of decline in unemployment rate, Russia can be ranked first while Brazil the second. The post-crisis stable South Africa can take the third place and the recently risen India the fourth position. Again, for meaningful interpretation, China as the proposed anchor country is not ranked.

2.8 Adequacy of Reserves

Based on the currency crisis model of exchange rate, the collapse of a pegged exchange system is associated with an erosion of foreign reserves (Markiewicz 2006). Concerted attacks against a currency deplete foreign reserves and force monetary authorities to abandon the fixation parity. Thus, a country which chooses to fix its exchange rate but that still maintains its national currency must hold sufficient reserves to back its monetary liabilities. For present purpose, this might be essentially true in the early stages of a BRIC monetary integration prior to a full currency union.

To reflect this facet, this section introduces the ratio of money and quasi money (M2) over total reserves, under which the smaller the ratio, the better the coverage of reserves to money supply. In other words, the smaller the ratio, the better the ability of monetary authorities meeting a “redemption run” against its notes and deposits. This measure has been used by Calvo (1998) for similar purpose.

The ratios for 2001-2013 are displayed in Figure 8. Visibly, South Africa boasts a long-run declining trend in M2 ratio, interrupted only in 2003 with a sharp spike probably due to increased lending and property bubble since interest rates were aggressively lowered in that year. Meantime, Brazil shows greater M2 ratios in 2004-2006, a finding consistent with its economic recovery (increased lending) from its previous recession triggered by the Argentine crisis and a confidence crisis due to uncertainties of a new president. Following that, a stable trajectory can be seen through 2013. China too shows a downward sloping trajectory; in particular a relatively steep reduction in the early 2000s and a slight and gradual rise in the recent years. Likewise, India reveals a similar pattern with China but with a much lower level in the beginning of the period. Finally, whilst being parallel with India, Russia's level is the lowest and the stablest throughout the whole period.

Fascinatingly, South Africa, Brazil, China, and India are seen to be converging toward the end of the period. Also, no significant change is signified after the global crisis. In short, boasting the greatest reduction in the M2 ratio, South Africa can be ranked first in respect of conformity to this criterion. By the same token, Brazil the second, India the third, and Russia the fourth.

2.9 Convergence in Real Growth

In regards to the Eurozone crisis since the end of 2009, politicians and intellectuals have blamed the financial failures in Greece, Portugal, Italy, Spain, and Ireland largely on fiscal profligacy and government indebtedness. In addition, substantial reduction in real borrowing costs following harmonization of nominal interest rates across states of low and high price inflations has also helped to fuel housing and asset bubbles in high growth countries (Taylor 1998). Whilst free movements of goods, labour, and capital can restore market equilibriums, natural and political hurdles such as geographic, language, cultural, and trade barriers could perpetuate divergences in real economic growth.

Along these lines, convergence in the paths of real growth should be a matter of consideration if BRICS were to form a monetary union and to harmonize interest rates. For this reason, indexes of real GDP of the countries are hence plotted in Figure 9. Notably, Russia shows a significant

slide in the growth level after the global crisis while the declines of South Africa and Brazil are less noticeable.

In theory, the country of which rate of real growth is closer to that of China should be more fitting to adopt the Chinese monetary policy. On this judgment, the best candidate will be India, followed by Russia, then South Africa, and lastly Brazil. But then again, the fact that China's real growth is increasingly divergent with the rest, as shown by the chart, suggests an increasingly different policy need in China.

3. Discussion and conclusion

Hitherto, the paper has inspected the OCA-related criteria evaluating the feasibility of a monetary integration arrangement between China, Brazil, Russia, India, and South Africa, five of the dominant emerging economies today. In this exercise, China is designated as the monetary anchor country since it is the largest economy with the largest currency zone. The first five dimensions and the last dimension of convergence in real growth are dependent on a reference country, namely China as the monetary anchor. Diversity in exports, labour market flexibility, and adequacy of reserves are meanwhile measured in absolute terms, needing no reference country. A summary of the observations is listed in Table 6.

Findings are mixed. On business cycle symmetry with China, relatively increased convergence has been experienced by Brazil and India. On bilateral trade with China, Brazil and South Africa have enjoyed persistently rising trade intensity. With respect to variability of exchange rates, the Indian and Russian currencies have significantly increased their volatility with the Chinese yuan. On convergence in price inflation, Brazil and Russia have become more parallel with China. In terms of interest rate movement symmetry, only Russia is noticeably synchronous with China. This is an indication of coordination in monetary policy between these two neighbouring states.

For export diversification, Brazil and India have shown diminishing trend whilst for Brazil and Russia, their labour markets appear to have been more flexible. In terms of adequacy of reserves, only South Africa has notably boosted its ratio of reserves to liabilities. Lastly, for convergence of real growth, China is diverging significantly with the rest.

If scores are given for the rankings in accordance with extents of conformity, and if the scores are averaged over the nine criteria for each

country as reported in Table 6, Brazil with the lowest average score at 2.0 will be the most conforming country, followed by South Africa at 2.2, Russia at 2.4, and lastly India at 2.9.

Classifying notable conformity by country, Brazil is relatively compliant in respect of five dimensions, namely business cycle symmetry, trade intensity, inflation convergence, export diversification, and labour market flexibility; Russia is conforming in inflation convergence, interest rate symmetry, and labour market flexibility but is non-conforming in exchange rate stability; India is compliant in business cycle symmetry but incompliant in the exchange rate and diversification criteria; and South Africa is conforming with the trade and reserves adequacy dimensions. In short, Brazil is relatively prepared for a monetary unification with China.

This finding is consistent with present relations between Brazil and China that include sharply increased bilateral trade, foreign direct investment flows, bilateral cooperation agreements, and enhanced cohesion of negotiating positions in international arena (Whalley and Medianu 2012). In particular, Brazil's exports are concentrated in primary goods while imports from China are of manufactured goods, a trade relation which is mutually beneficial (Jenkins 2012). Politically, Brazil and China signed in 2010 the Joint Action Plan Brazil-China 2010-2014 in Brasilia to foster cooperation in arms control, climate change, and coordination in the UN, WTO, and G20 (Haibin 2010).

With sufficient political and social will, Brazil and China can begin monetary integration initiatives first. As the founding nations, they can reap the gains from stabilizing their exchange rates while at the same time providing enormous stability and certainty to the rest of BRICS. Of course, if a monetary bloc between them is to be instituted, it would have to subsume a common market or at least significantly greater liberalizations in movements of labour, goods, and capital (see Stojanović 2011).

Despite the above, it must be noted that the analysis is limited in the sense that consistent measures across the countries are sometimes not available. For instance, the main monetary tool used in China is adjustment of reserves ratios in the banking system and this can be different with other BRICS nations.

Lastly, future scholars may need to corroborate the findings here using other techniques and to explore other aspects of integration such as extents of cross-border movement of labour; social and linguistic barriers; and

compatibility in political systems. Alternative monetary systems proposed in Quah (2016a) are also worthwhile for consideration.

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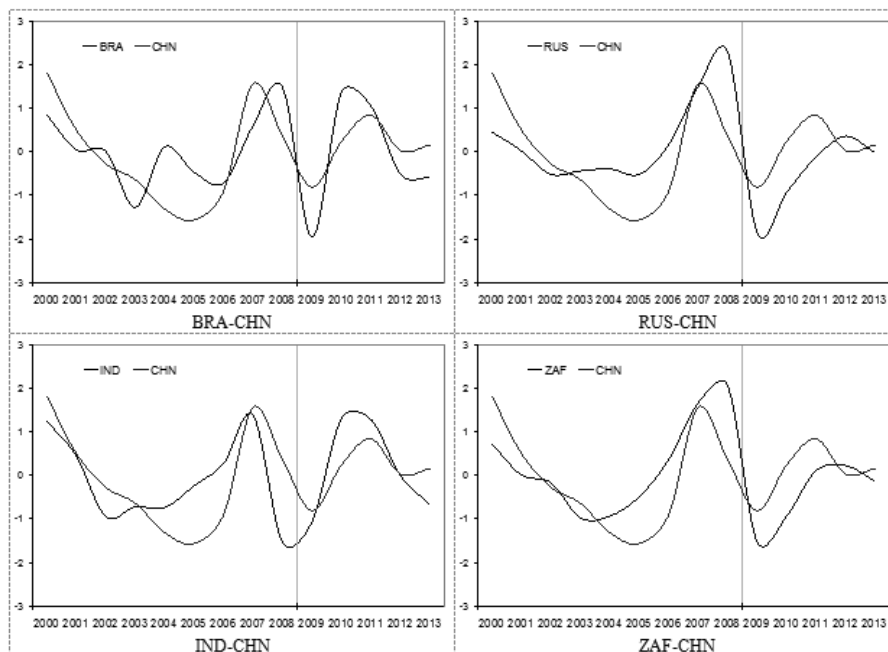
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Appendix

Figure 1. Business cycle using real GDP, 2000-2013.



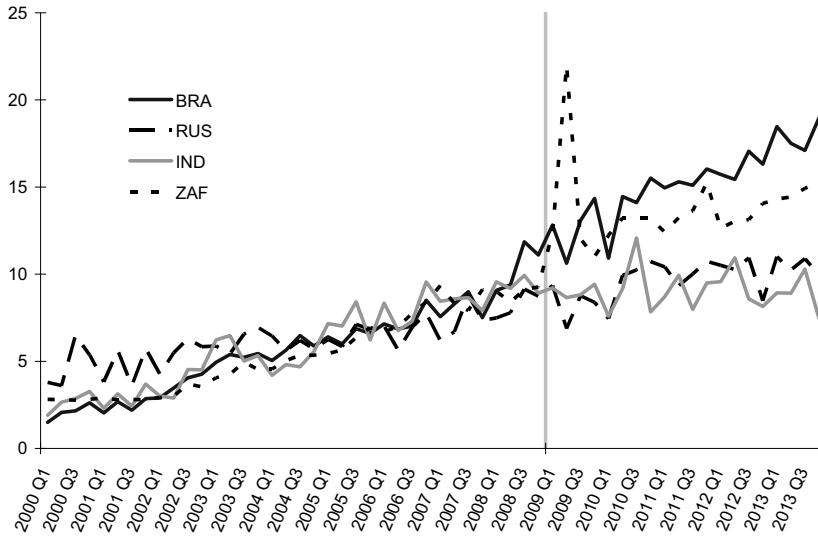
Source: Computed using WDI data.

Table 1. Correlation coefficient and standard deviation, business cycle.

		BRA-CHN	RUS-CHN	IND-CHN	ZAF-CHN	
Corr.	2000-08	0.64	0.60	0.61	0.69	
	2009-13	0.86	0.67	0.80	0.72	
	2000-13	0.60	0.52	0.62	0.62	
		BRA	RUS	IND	ZAF	CHN
SD	2000-08	0.83	0.99	1.00	1.07	1.20
	2009-13	1.35	0.88	1.09	0.75	0.59
	2000-13	1.00	1.00	1.00	1.00	1.00

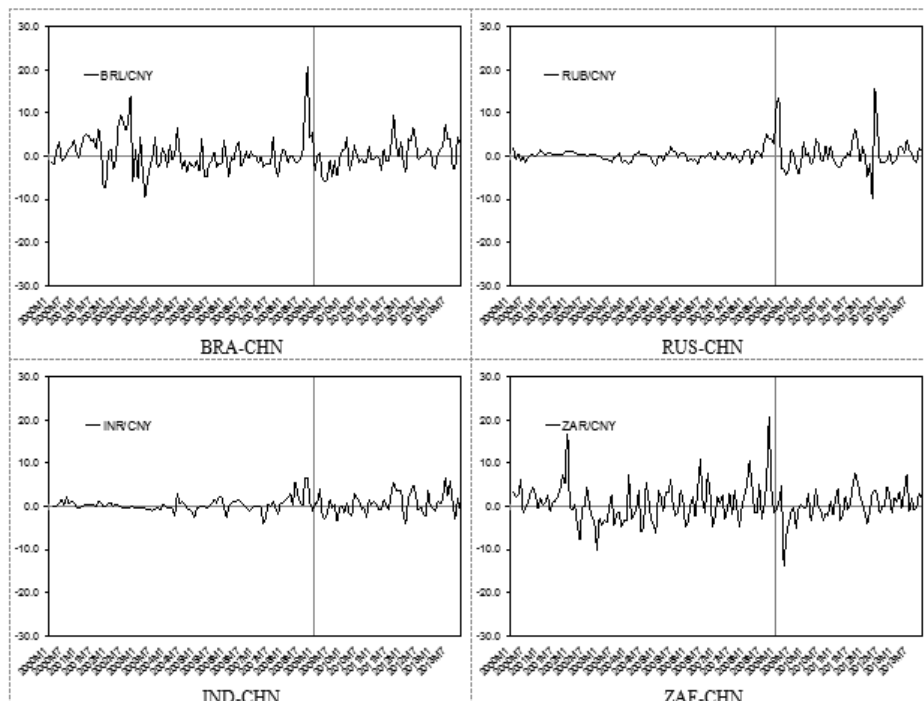
Source: Computed using WDI data.

Figure 2. Trade openness with China (%), 2000Q1-2013Q4.



Source: Computed from IMF: DOTS data.

Figure 3. Percent change of exchange rate against the Chinese yuan ($\times 10^2$), 2000:2-2013:12.



Note: Original nominal exchange rates are against the dollar. That against the Chinese yuan is computed assuming triangular arbitrage.

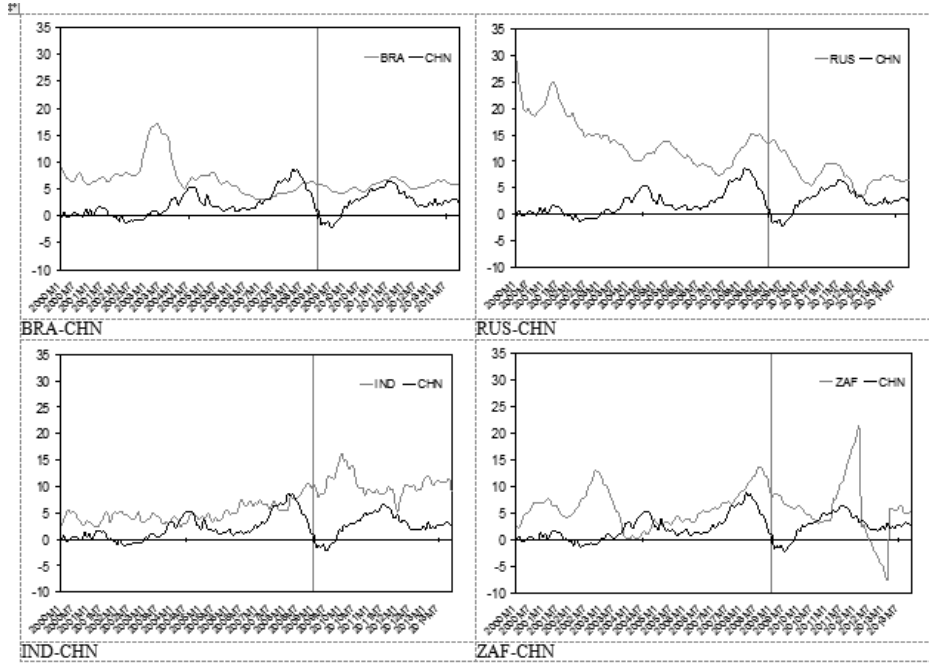
Source: Computed from IMF: IFS data.

Table 2. Standard deviation, percent change of exchange rate against the Chinese yuan, 2000:2-2013:12.

		BRL/CNY	RUB/CNY	INR/CNY	ZAR/CNY
SD	2000-08	4.32	1.20	1.50	4.61
	2009-13	3.18	4.15	2.41	3.48
	2000-13	3.94	2.66	1.88	4.24

Source: Computed from IMF: IFS data.

Figure 4. CPI Inflation (%), 2000:1-2013:12.



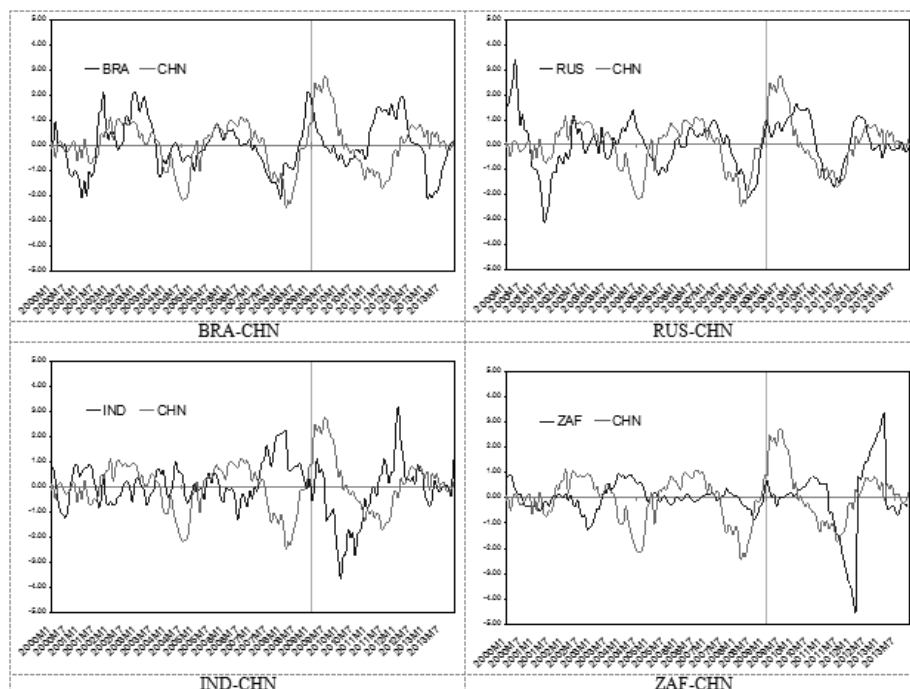
Source: Computed from IMF-IFS data.

Table 3. Average and standard deviation, inflation differential, 2000:1-2013:12.

		BRA-CHN	RUS-CHN	IND-CHN	ZAF-CHN
Avg.	2000-08	5.57	12.13	3.16	4.61
	2009-13	2.97	5.12	7.74	5.02
	2000-13	4.64	9.62	4.80	4.76
SD	2000-08	4.03	5.98	1.89	3.07
	2009-13	1.81	4.06	3.36	4.04
	2000-13	3.62	6.33	3.33	3.44

Source: Computed from IMF-IFS data.

Figure 5. Real lending rate cycle, 2000:1-2013:12.



Source: Computed from IMF-IFS data.

Table 4. Correlation coefficient and standard deviation, real lending rate cycle, 2000:1-2013:12.

		BRA-CHN	RUS-CHN	IND-CHN	ZAF-CHN	
Corr.	2000-08	0.54	0.19	-0.49	-0.32	
	2009-13	-0.20	0.55	-0.02	0.25	
	2000-13	0.24	0.33	-0.26	0.07	
		BRA	RUS	IND	ZAF	CHN
SD	2000-08	0.98	1.05	0.74	0.45	0.91
	2009-13	1.03	0.89	1.31	1.57	1.12
	2000-13	1.00	1.00	1.00	1.00	1.00

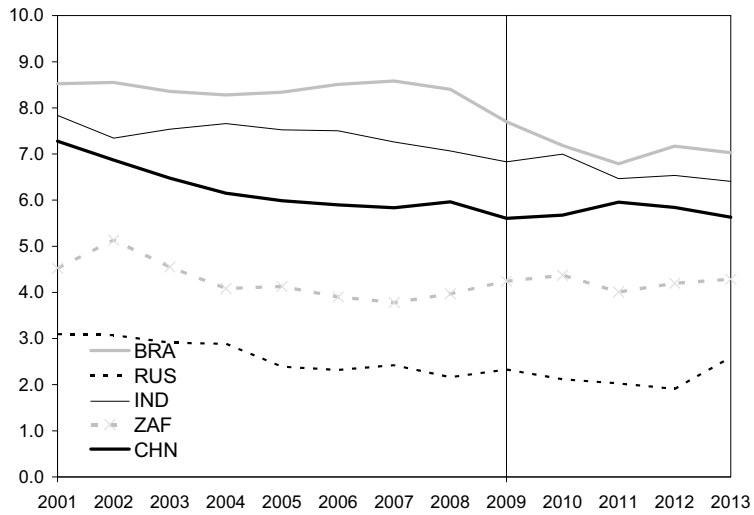
Source: Computed from IMF-IFS data.

Table 5. United Nation’s Standard International Trade Classification (SITC) Revision 3

Code	Product type
0	Food and live animals
1	Beverages and tobacco
2	Crude minerals, inedible, except fuels
3	Mineral fuels, lubricants, and related materials
4	Animal and vegetable oils, fats and waxes
5	Chemicals and related products
6	Manufactured goods classified chiefly by material
7	Machinery and transport equipment
8	Miscellaneous manufactured articles
9	Commodities and transactions not classified elsewhere

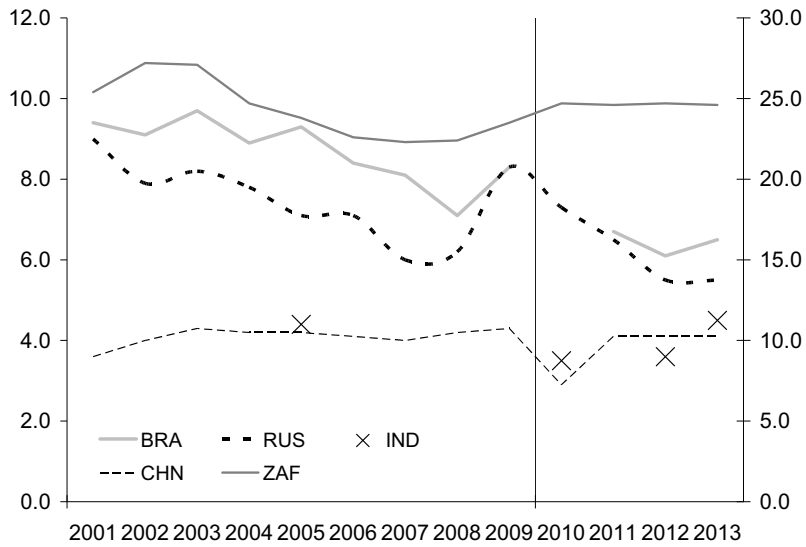
Source: United Nations Statistics Division Website

Figure 6. Diversity of exports, 2001-2013.



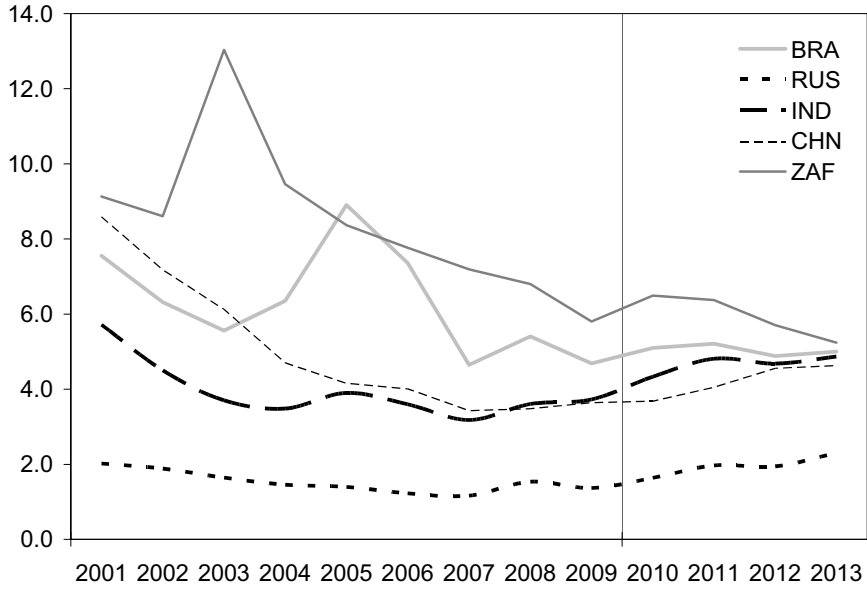
Source: Computed from International Trade Center, Trade Map data.

Figure 7. Unemployment rate, 2001-2013.



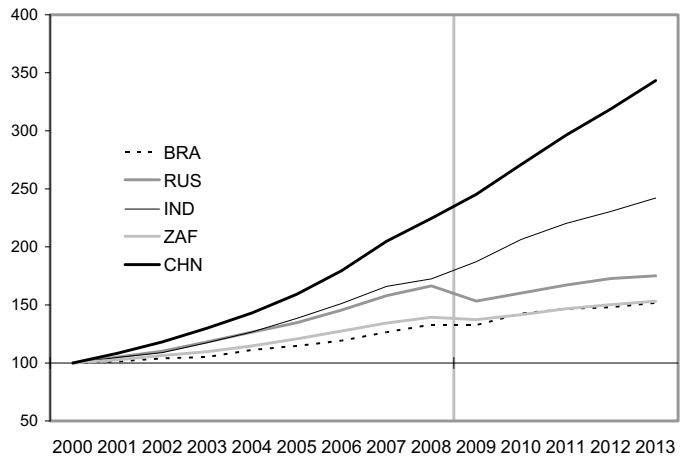
Source: World Bank: WDI.

Figure 8. Money and quasi money (M2) to total reserves ratio, 2001-2013.



Source: World Bank: WDI.

Figure 9. Real GDP, 2000Q1-2013Q3 (2000Q1=100).



Source: Computed from IMF-IFS data.

Table 6. Summary of findings

	Dimensions	Key Findings	Ranking			
			Brazil	Russia	India	South Africa
1	Business cycle synchronization	Brazil and India have increased convergence with China to a greater extent.	1	4	2	3
2	Bilateral trade intensity	Persistent rising trade linkage with China for Brazil and South Africa	1	3	4	2
3	Exchange rate volatility	India and Russia have remarkably greater exchange rate volatility with the Chinese yuan.	1	4	3	2
4	Inflation convergence	Brazil and Russia have increased convergence with China with smaller variability	1	2	4	3
5	Real interest rate symmetry	Only Russia conforms substantively to this interest rate criterion.	4	1	3	2
6	Diversity of exports	Brazil and India have shown falling trend in export diversity.	2	1	2	1
7	Labor Market Flexibility	Brazil and Russia are noticeably parallel in their decreasing unemployment.	2	1	4	3
8	Reserves Adequacy	South Africa has boosted adequacy tremendously over the years.	2	4	3	1
9	Convergence of Real Growth	China's real growth is increasingly divergent with the rest.	4	2	1	3
	Average Rank Score		2.0	2.4	2.9	2.2

Note: The most conforming country to any criterion is given a score of 1, followed by 2, 3, and the least conforming one is given a score of 4.

