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Jean-Claude Maswana

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JICA Research Institute
10-5 Ichigaya Honmura-cho
Shinjuku-ku
Tokyo 162-8433 JAPAN
TEL: +81-3-3269-3374
FAX: +81-3-3269-2054

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Jean-Claude Maswana*

Abstract

The likelihood that China's economic recovery will affect the growth of selected African economies (Botswana, Ghana, Kenya, Nigeria, and South Africa) was investigated by examining annual co-movements in GDP. Using aggregate outputs as proxies for business cycle indicators along with a threshold autoregressive estimation technique, we found evidence that the aggregate outputs of three of the aforementioned African countries are nonlinearly co-integrated with that of China. Unexpectedly, we also found that the adjustment responses of African output to downturns far outweighs responses to upturns: In particular, Nigerian output adjusts relatively quickly to offset lower levels with respect to its long-run trend vis-à-vis China's GDP. In Kenya, by contrast, the speed of adjustment is more rapid for positive discrepancies than for negative ones. Other findings support the proposition that African economies will benefit from a China-led global recovery, though at different rates for different countries depending on whether the exports contribute to China's production chain (as raw materials) or to its consumption chain. Over the long run, the gains from synchronization via trade of the outputs of African economies with those of China and other major economies will depend strongly on the Africans' preparedness for the development of efficient and supportive physical infrastructure.

Keywords: macroeconomic interdependence, economic recovery, China, Africa, economic growth.

* JICA-RI Research Fellow (Maswana.Jean-Claude@jica.go.jp)

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Introduction

The recent global financial crisis has refocused attention on the importance of understanding international economic linkages and aggregate output synchronization. As the downturn spread from its epicenter out to the rest of the world, the expectation arose that ultimately strong recovery in the emerging economies would similarly spread out into the global economy. In fact, by the end of 2009, the global economy had expanded, pulled up by the strong performances of countries like China, which contributed to boosting the global economy in the process of forging their own recoveries (IMF 2009). China's particular contribution to the global recovery was enabled by a 4-trillion-yuan (US$585 billion) stimulus package. To stimulate its economy and achieve its 2010 growth target of greater than 10%, China imported record levels of raw materials in 2009 (IMF 2010).

The impact on African trade of China's demand for raw materials has been immense. Trade between Africa and China was severely affected by the global crisis, but the recovery in exports from African countries to China was rapid and occurred in synchrony with an overall recovery in imports to China at a time when imports to other major industrialized economies were still morose. This trend in Africa-China trade has heightened interest in a key question: What is the likelihood that an upturn in China's growth will affect Africa's growth? Or, in econometrics terminology, to what extent is the synchrony of cycles in the economic activities of China and those of Africa driven by cointegrating relationships?

Increased Chinese demand for raw materials has been met in part by an increase in commodity imports from Africa, a situation which is expected to raise output and incomes in the exporting African economies and ultimately to induce output co-movements between China and Africa. This suggests that synchronization of African economies with that of China may be a necessary condition if the recovery in China is to sustainably enhance African growth. The theoretical argument underlying this is that as countries trade more with each other, they tend to display higher degrees of business cycle co-movement (see, for example, Frankel and Rose 1998;

Baxter and Kouparitsas 2005, and references therein). As a consequence of increases in trade linkages, countries' aggregate outputs are likely to co-move over time. Studying these output co-movements — even in terms of econometrics — is useful from a policy perspective (Enders and Siklos 2001). The aim of this paper is to use insights gained from the study of macroeconomic interdependence, or co-movement, to determine the extent to which the aggregate output of China can influence that of selected African economies (Botswana, Ghana, Kenya, Nigeria, and South Africa). It is worth noting here that this study is not concerned with the specific channels through which business fluctuations in China are transmitted to the African economies; rather, it is based on Dornbusch's (1980) elementary trade repercussion assumption which asserts that economic changes are transmitted from importing countries to exporting countries. Based on this assumption, the study focuses on the detection of co-integration relationships in bilateral aggregate outputs.

For the most part, studies on bilateral outputs derive measures of co-movement by assuming that the co-integration relationship of economic growth between two countries is linear. One exception to this is the paper by Henry and Summers (2000) which documents the existence of a threshold nonlinearity in the relationship between the economic growth of Australia and that of the U.S. Similarly, our approach allows for nonlinearity in the co-movement between China and African countries; specifically, we use threshold co-integration (Ender and Siklos 2001), which implies that the dynamic response to a shock may differ if one or both economies are in recession (Henry and Summers 2000).

Foreshadowing its results, this paper finds statistically significant asymmetries in the responses of Kenya, Nigeria, and South Africa to changes in Chinese aggregate output, with responses to downturns much outweighing responses to upturns in Nigeria and South Africa. In Kenya, by contrast, the speed of adjustment is more rapid for positive than for negative discrepancies. Admittedly, different African economies might benefit from a China-led global recovery at different rates, depending on whether their exports contribute to China's production process (as raw materials) or to its consumption chains. To the best of our knowledge, this study is

the first attempt to bring empirical evidence to bear on understanding such dependencies in the post-global recession era. While there is a significant literature — as well as anecdotal accounts — on the international transmission of the macroeconomic shock that originated in China and its impact on developing economies of Africa during the boom of the first decade of the 21st century (see, for example, UN 2008; Maswana 2009), nonlinearity has heretofore not been used to analyze the current state of China-Africa economic co-integration.

The rest of the paper is organized as follows: Section 2 briefly overviews the literature on output synchronization. Section 3 outlines pertinent methodological considerations. Section 4 presents the threshold co-integration results and discusses the research findings and their policy implications. Section 5 concludes with perspectives on economic interdependence between China and developing economies.

1. Theoretical and factual considerations

1.1. Stylized economic facts about China-Africa links

The global financial crisis led to a plunge in bulk commodities on the international market from the third quarter of 2008, negatively impacting China-Africa trade which recorded the largest fall among African export destinations. African exports to China dropped by 40% in Q4-2008 relative to the previous period (compared to drops of 38% for the US and 22% for the Eurozone). In spite of this, as the first major economy to increase its volume of imported goods in 2009 — in sharp contrast with the U.S., Germany, and Japan — China's imports recovered in Q1-2009 (see Figure 1 in the Appendix), triggering recovery of its imports from Africa along the way (see Figure 2). Evidence that the key global exporters of natural resources have started to benefit from growth in China's commodity purchases can be seen in Africa's trade performance with China.

Sino-African trade exceeded the $100 billion benchmark in 2008 but declined to $90 billion in 2009 (Sandrey and Edinger 2010). Nevertheless, trade with China is one of the fastest-growing components of Africa's trade total. Africa's share of exports to China in 2008 was nearly 15%, third

overall, behind the EU (36%) and the U.S. (27%). And although early in the 2000s China had been the third-highest source of imports to Africa, behind the U.S. and the EU, since 2008 China has overtaken the U.S. to be the second-highest source (UN COMTRADE 2009). Meanwhile during the period 2000–2008, African exports to China grew faster than those to other regions: 30% growth to China against 14% to the EU and 17% to the U.S. (WTO 2009).

In terms of individual countries, imports to South Africa from China grew by 29% over the period 2000–2008 against growth of only 10% in imports to South Africa from the U.S. and 11% from the EU. Similar figures were observed for Nigeria, with 35% growth in imports from China during that period against 15% from the U.S. and 13% from the EU (Sandrey and Edinger 2010). Furthermore, China overtook the United States in the first half of 2009 as South Africa's biggest export destination with a surge in exports to China of iron ore, copper, chrome, timber and paper pulp. South African exports have rebounded strongly since Q1-2009 due to strong demand for its primary commodities from China and developing Asia as a whole (see Figure 3). Similar trends are evident in other African countries. For instance, a strong rebound in Q2-2009 for Nigerian exports is due to the 2,720% growth in exports to China (compared to the 48% and 40% growth in exports to the U.S. and U.K., respectively). In Ghana, export recovery followed the country's strong Q2-2009 575% growth to China, compared to 37% to the US and 79% to developing Asia (IMF 2009; DOTS 2009).

The rapid increase in China-Africa bilateral trade stems not only from the fact that the two regions have been experiencing rapid economic growth, but also from complementarity in their production and trading structures. As primary commodity exporters, African countries export their comparative advantage in oil and mineral products to China; in return, China exports labor-intensive manufactured products to Africa. The end-result has been the growing trade intensity between the two regions.

Table 1 shows the total bilateral trade intensity[1] (see Frankel and Rose, 1998, for further information) between the five African countries and China over the period Q1-2007 to Q2-2009. As can be seen from Table 1, there also is a clear upward trend in the trade intensity with China of all five countries from Q1-2009 (on average, their lowest ever) to Q2 of that same year. The bilateral trade intensity is significantly higher for South Africa relative to the four other countries as it is one of China's largest African trading partners, representing nearly 20 percent of China's trade with the continent in 2009. The trade intensity index for Kenya has remained relatively stable, while for Ghana and Nigeria it has exhibited a more volatile pattern. Since the index for Nigeria has nonetheless remained strong, the observed volatility is perhaps rooted in the composition of its exports to China which remain essentially dominated by petroleum — with some gas, and leather products — while its principal imports from China are electronics, drugs, toys, and ethyl alcohol.

Table 1. Bilateral trade intensity index

	2007				2008				2009	
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2
Botswana	0.017	0.047	0.092	1.175	0.720	2.073	1.806	1.464	1.280	0.535
Kenya	0.048	0.089	0.107	0.091	0.100	0.108	0.084	0.067	0.059	0.090
Ghana	0.251	0.347	0.178	0.188	0.312	0.373	0.544	0.076	0.035	0.176
Nigeria	0.062	0.167	0.178	1.041	2.049	3.161	0.042	0.057	0.009	2.158
S. Africa	1.281	0.971	0.847	0.901	0.970	0.922	0.920	0.649	1.849	1.507

Source: Author's calculations, raw data from the IMF *DOT*, 2009

[1] Total bilateral trade intensity $Trix_{i,j}$ is defined as the share of country *i*'s export trade with China, *j,* relative to China's share in imports from the rest of the world (reduced by country *i*'s exports):

$$Trix_{i,j} = \frac{\left(\frac{X_{i,j}}{X_i}\right)}{\left(\frac{M_j}{Mw - M_i}\right)},$$

where *X* and *M* stand for exports and imports, respectively.

Variations in trade intensity are thought to have transferred shocks from China to Africa through demand linkages. In late 2008 and early 2009 China's imports from the region nearly collapsed (see Table 2), spreading to Africa the effects of the global recession. Yet, since the second quarter of 2009 China's imports from countries such as Botswana, Ghana, Kenya, Nigeria and South Africa have returned to their Q1-2008 levels, or have even exceeded them.

Table 2. Recent Chinese trade flows with selected African countries (US$ millions)

	2008				2009	
	Q1	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**
Exports to Botswana	18.79	28.54	32.64	37.93	29.09	43.33
Imports from Botswana	1.28	1.54	2.00	21.62	32.84	65.19
Exports to Ghana	314.139	417.647	506.181	495.541	348.912	381.33
Imports from Ghana	8.158	32.657	46.954	5.753	1.968	13.301
Exports to Kenya	220.159	305.091	353.014	338.566	234.57	267.617
Imports from Kenya	9.304	10.741	8.501	6.391	4.721	8.888
Exports to Nigeria	1166.43	1634.932	2084.092	1872.677	1163.914	1264.521
Imports from Nigeria	73.129	287.822	80.292	68.675	5.671	160.124
Exports to South Africa	205631.00	228554.00	258336.00	263743.00	264544.00	302569.00
Imports from South Africa	1137.91	1013.38	937.10	1078.19	1047.37	1243.26

Source: Thomson Reuters, Datastream (2009); IMF *DOT* (2010) for Botswana and South Africa.

Finally, besides the dramatic increase in trade, it is noteworthy that in recent years Africa has become one of the fastest rising destinations for China's overseas direct investment. In 2009, China's non-financial direct investment to Africa was US $1.36 billion, surpassing by 36.8% that of the previous year and constituting 3.8% of China's overseas direct investment. With the establishment of China-Africa economic and trade cooperation zones, not only has investment in Africa by Chinese firms increased dramatically, Africa's investment in China has been gradually growing, reaching nearly US $10 billion and covering over 4000 projects in 2009 (FOCAC 2010). Cheap imported capital goods from China, commodity prices boosted by strong demand from China

and multibillion-dollar minerals-for-infrastructure deals between China and Africa, all are contributing to increases in macroeconomic co-movement between the two regions.

1.2. Literature overview

From a theoretical perspective, there is no consensus in the literature on a definition of "co-movement" and there is no unique measure associated with the concept (Baur 2003). This conceptual ambiguity has generated a variety of approaches to international macroeconomic synchronization. The term *co-movement* as used in this paper means a strong correlation among aggregate outputs of different economies, sometimes referring to a situation of different economies sharing a common long-term equilibrium relationship or experiencing a long-term trend in synchronized movement.

Different researchers take different approaches to international macroeconomic synchronization, depending on the main focus of their investigations. Major studies, mainly business cycle studies (e.g., Glick and Rogoff 1995; Doyle and Faust 2002), distinguish the effects on economic growth of country-specific and common shocks. Some shocks are assumed to be neutral in the long run (e.g., monetary shocks), while others are assumed to have permanent effects on economic growth (e.g., productivity/technology shocks). The latter class of models is in line with those that emphasize endogenous technological development and cross-country interactions in terms of technological diffusion (see for example Stock and Watson 2003; Tan 2007; Kose et al. 2008).

Despite the importance of the above distinction, some studies are more concerned with identifying the presence of common shocks (e.g., Gregory et al. 1997; Kose et al. 2008) than with analyzing the nature of their duration (transitory or permanent). The latter focus on measuring the level of synchronization between the outputs of the economies involved. Although disentangling common shocks from transmitted shocks might be important for economic interpretation of the sources of international macroeconomic synchronization, such differentiation may be less relevant

for studies that do not set out to test any particular model. Moreover, from a policy perspective, common and rapidly transmitted shocks are likely to be treated similarly.

Relevant literature has tended to deal with the formation of world business cycles (Selover and Jensen 1999), the relationship between international monetary regimes and the transmission of macroeconomic shocks (Dibooglu 2000), or the sources and channels of propagation of international cycles (Canova and Dellas 1993; Schmitt-Grohé 1998; Canova and Marrinan 1998). Most of these studies have identified a number of variables that can influence or mediate the transmission of a shock from one country to another. Among them, Backus et al. (1992), Bowden and Martin (1995), Baxter and Kouparitsas (2005), and Frankel and Rose (1998), to mention just a few, find evidence in favor of international output synchronization, with trade being the main channel of transmission. Frankel and Rose (1998) argue that trade helps shocks propagate from one region to others through demand linkages because in a recession the demand by an economy for imports decreases, leading to a decline in the output of other countries. The trade repercussion model suggested by Dornbusch (1980) indicates that economic changes are transmitted from importing countries to exporting countries.

An increase in bilateral trade flows could lead to higher business cycle synchronization between the trading partners. Trade flows would strengthen the propagation of shocks in cases where demand shocks are dominant, especially through their effects on import demand. These effects could be either amplified or weakened depending on the production structure and specialization patterns induced by the trade flows (Sosa 2008). In this respect, Kraay and Ventura (1995) present empirical evidence that commodity trade transmits economic fluctuations across economies, resulting in a high degree of growth rate synchronization. It is obvious that for developing economies lacking market opportunities and facing financing constraints, a rapid expansion of exports can increase productivity and offer greater economies of scale (Helpman and Krugman 1985). Moreover, exports are likely to alleviate foreign exchange constraints and thereby provide greater access to international markets (Esfahani 1991).

Recent empirical evidence has typically relied on two measures of output synchronization: bilateral output correlations which capture co-movements in the output fluctuations of two countries, and the share of output variances that can be attributed to synthetic (unobservable) common factors (IMF 2007). The extent of bilateral co-movement of real GDP across countries has been empirically investigated by researchers such as Gregory et al. (1997), who provide evidence of co-movements in aggregate output, consumption, and investment for G-7 countries. Canova and Marrinan (1998) find that the presence of a common shock and production interdependence plays a crucial role in the cyclical dynamics of output for the U.S., Germany, and Japan.

Empirical studies such as that of Selover and Jensen (1999) have developed a mode-locking explanation of business cycle synchronization which is relevant to the influence that China can exert on African economic growth. Mode locking is a phenomenon whereby systems with a tendency to oscillate, such as economies, will affect the timing of each other's oscillations in such a way as to bring about co-movement even if they are only weakly linked. In this regard, Girardin (2005) suggests that output fluctuations can be strongly correlated between trading partners even in the absence of high trade volume. In sum, Selover and Jensen (1999) and Girardin (2005) both support the idea that a co-integration relationship is technically possible even among weakly linked economies.

Perhaps the most serious weakness with empirical studies in this field is the assumption that adjustment to long-term co-integration is linear. Dumas (1992) raised the issue of the cost of transferring goods and/or physical capital from one country to another. In the presence of transaction costs, no rebalancing will occur until the marginal benefit of rebalancing exceeds its marginal cost. In the standard co-integration framework, the adjustment to long-term equilibrium is linearly dependent on the magnitude of the deviation. In practice, however, market frictions introduce nonlinear adjustments (Balke and Fomby 1997). A number of studies (e.g. Barrett 2001; Fackler and Goodwin 2001; Goodwin and Piggot 2001) have questioned the appropriateness of linear co-integration models, arguing that they ignore the transaction costs that might be incurred.

In contrast to the conventional notion that co-integration necessarily has a linear adjustment mechanism, threshold autoregression (TAR) models posit a threshold below which co-integration is inactive due to transaction costs or policy indifference. Once the threshold value is exceeded, however, co-integration becomes active (Dufrenot and Mignon 2002). These considerations have led researchers such as Henry and Summers (2000) to apply a nonlinear co-integration model in analyzing fluctuations in Australian economic growth. Their analysis found that an exogenous negative shock will be more persistent, lead to greater output volatility, and have a greater impact on growth than a positive shock of equal magnitude. Naturally, such a result is of much interest in times of large fluctuations in output.

2. Methodological considerations and data

To detect whether and how the growth rates of individual African countries change under different economic conditions in China, the starting point is to consider the Engle and Granger (1987) co-integration relationship that defines a dynamic, long-term equilibrium relationship in some economic variable between one country and another (or among three or more countries). For the purposes of our study, which focuses on the relationship between China and certain African economies, this can be written as

$$y_t = \alpha + \beta X_t + u_t, \tag{1}$$

where y_t is the output of an individual African country at time t (measured in years), X is the output variable for China, α and β are constants to be estimated, and u_t is the disturbance term. In the standard co-integration test, the ordinary least-squares (OLS) method is used to estimate ρ, the adjustment parameters, in the following equation, which can be derived from Equation (1):

$$\Delta u_t = \rho u_{t-1} + \varepsilon_t, \tag{2}$$

where ε_t is the error term. For several reasons, the use of Equation (2) for testing co-integration is problematic. For one thing, Equation (2) suggests that the defined equilibrium or attractor occurs at a single rate determined by ρ, and that $\rho < 0$, regardless of whether the convergence occurs from

above or below equilibrium (Cook 2005). In addition, it is well known that the international correlation of aggregate outputs may differ between growth cycles, since economic conditions in a given country at the time of a major shock — such as a sharp fall in output growth — could affect the magnitude of the correlation (Girardin 2005). And thirdly, there is a consensus among economists that key macroeconomic variables display asymmetric adjustments over time (Enders and Siklos 2001).

Threshold co-integration methodology (Enders and Granger 1998; Enders and Siklos 2001) is one recent approach designed to account for nonlinearity in the adjustment to long-term equilibrium. The single-variable model introduced by Balke and Fomby (1997) was extended by Tsay (1998) and Hansen-Seo (2002) to a multivariate model for the unknown co-integration vector.

The threshold autoregression method is a three-stage procedure (Dufrenot and Mignon 2002). In the first stage, Equation (2) is estimated using the OLS method. The second stage focuses on the OLS estimates of ρ_1 and ρ_2 in the following TAR model:

$$\Delta u_t = I_t \rho_1 u_{t-1} + (1 - I_t)\rho_2 u_{t-1} + \sum_{i=1}^{l} \phi_i \Delta u_{t-i} + \varepsilon_t, \qquad (3)$$

where ε_t is the white-noise disturbance, the residuals u_t from Equation (1) — the residuals of the long-term OLS — are substituted into Equation (3) to obtain better estimates, l is the optimal lag length, and I_t is the Heaviside indicator function such that

$I_t = 1$ if $u_{t-1} \geq \tau$ (for a period of economic expansion)

and

$I_t = 0$ if $u_{t-1} < \tau$ (for a period of economic slowdown),

where τ is the threshold value. A necessary condition for u_t to be stationary is that $-2 < (\rho_1, \rho_2) < 0$ (Petrucelli and Woolford, 1984; Enders and Siklos, 2001). In either of the cases, under the null hypothesis ($\rho_1 = 0 = \rho_2$, i.e., the hypothesis of no convergence), the *F*-statistic has a nonstandard distribution (Enders and Siklos 2001). Enders and Granger (1998) also show that if the

sequence is stationary, the least-squares estimates of ρ_1 and ρ_2 have an asymptotic multivariate normal distribution.

The value of τ is generally unknown and needs to be estimated along with ρ_1 and ρ_2. Enders and Siklos (1999) suggest using Chan's (1993) grid-search method to find a consistent estimate of the threshold. The estimated residuals from Equation (1) are sorted in ascending order and those in the top and bottom 15% are discarded. The remaining 70% of the residuals act as possible thresholds, and Equation (3) is run with each. The τ that results in the lowest residual sum of squares is chosen to be the preferred threshold value. In the present study, the threshold was set to zero, meaning that the autoregressive structure oscillates during periods of expansion and periods of contraction, but with a greater magnitude in the former (Hansen 1997). Besides enabling the identification of asymmetric responses, the proposed model was useful in analyzing the effects of changes in China's economy on the developing countries in our sample. Finally, according to the Equation (3) specification, the threshold effect is the mechanism by which economic fluctuations in China can affect African economies.

In the third stage of the threshold autoregression method, an error-correction mechanism can be inserted in the co-integrated equation, just as in the standard co-integration model. Empirically, the threshold vector error-correction model (TVECM) can be expressed as follows (Enders and Granger 1998; Enders and Siklos 2001):

$$\Delta Y_t = \gamma_1 Z_{t-1}^{+} + \gamma_2 Z_{t-1}^{-} + \sum_{i=1}^{k_1} \delta_i \Delta Y_{t-i} + \sum_{i=1}^{k_2} \theta_i \Delta X_{t-i} + v_t , \qquad (4)$$

where $Z_{t-1}^{+} = I_t u_{t-1}$ and $Z_{t-1}^{-} = (1 - I_t) u_{t-1}$. Z^{+} and Z^{-} are the error-correction terms from the threshold co-integration regressions and show the adjustments to positive and negative shocks; respectively; γ_1 and γ_2 are the corresponding coefficients; k_1 and k_2 are the corresponding lag lengths; and v_t is the white-noise disturbance.

As in Enders and Siklos (2001) and Gonzalo and Pitarakis (2006), the analysis consists of four steps. First, before estimating the empirical TAR model, unit root tests are conducted to

diagnose the time series properties of the data (Granger 1986; Engle and Granger 1987; Dickey and Fuller 1981). Since macroeconomic time series data are usually nonstationary, it is important to test the stationarity of the data series to avoid spurious regression. Stationarity signifies that the mean and variance of the series are constant through time and the autocovariance of the series is not time variable (Enders 2004). The commonly used test for unit root is the Augmented Dickey-Fuller (ADF) test (see Dickey and Fuller 1979), which is used to determine if a variable is stationary; it essentially involves testing for the presence of a random walk using the following:

$$\Delta X_t = \alpha + \rho t + \beta X_{t-1} + \sum_{i=1}^{n} \lambda_i \Delta X_{t-i} + \varepsilon_t \quad (5)$$

where X is the variable under consideration; Δ is the first difference operator; t is a time trend; and ε is a random error term. If the null hypothesis that $\beta = 0$ is not rejected, the variable series contains a unit root and is nonstationary. The optimal lag length in the above equation can be determined by the Akaike criteria (Akaike 1974). The ADF test can also include a drift (constant) and time trend.

Second, provided that the two variables are of the same order of integration, the Johansen co-integration is estimated to ascertain the linearity of the model. Third, as in Enders and Siklos (2001), whenever the standard Johansen co-integration test failed to detect a long-term equilibrium relationship between variables at the conventional significance levels, in the following step the results of the threshold co-integration test were estimated. Finally, to investigate short run adjustment dynamics a threshold vector error-correction model was also estimated.

The input data used in our TAR estimation are the values of annual real GDP (in current $US) for 1980 through 2009 for Botswana, Ghana, Kenya, Nigeria, and South Africa.[2] The source of the data for 1980 to 2005 is the World Bank's *World Development Indicators* (2008), while the data for 2006 to 2009 are from the IMF, 2009 (the GDP data for 2009 are estimates). We included two African countries with significant trade flows with China and for which quarterly GDP data are

[2] These countries were chosen on a data availability basis as well as for the significance of expansion of their bilateral trade flows with China in recent years.

available, namely, Botswana and South Africa, to get a closer look at the recent global economic situation. For both of these countries, the quarterly GDP data for the sample period Q1-1995 to Q3-2009 are from the IMF International Financial Statistics (IFS) January 2010 CD-ROM. The quarterly data for China are from two sources: the IMF IFS for the period Q1-1999 to Q2-2009, and our own calculations based on quarterly growth rates provided in Abeysinghe and Rajaguru (2004) for the period Q1-1995 to Q4-1998. The original quarterly data were converted to constant U.S. dollars (with 2002 as base year).

3. Empirical Results

3.1. Results of integration properties and linear co-integration[3]

ADF tests were performed in levels and first difference, respectively, with intercept as well as intercept and trend. As is shown in Table 3, the null hypothesis of $\beta=0$ is rejected for the series in levels, except for the case of Ghana in the model with intercept and trend. In other words, the series in levels have been found to contain a unit root and are thus nonstationary. However, practically all the series turn stationary in their first-difference, regardless of whether the model includes an intercept or an intercept and a trend. This means that all series are found to be integrated of order one, or *I(1).* Therefore, in the next step we tested whether the pair series are linearly co-integrated.

[3] The technical details surrounding the Johansen co-integration approach are well known (see, for example, Johansen [1995] and Granger [1986]).

Table 3. ADF unit root test results

Annual series

	Level		First Difference	
Annual Series				
	Intercept	Intercept & Trend	Intercept	Intercept & Trend
China	–2.436 (0.110)	–2.878 (0.196)	–5.226 (0.002)**	–5.112 (0.001)**
Kenya	–3.080 (0.393)	–3.032 (0.140)	–5.728(0.000)**	–5.615 (0.000)**
Ghana	–3.256 (0.127)	–3.343 (0.080)*	–5.841(0.000)**	–5.797(0.000)**
Nigeria	–2.082 (0.307)	–2.999 (0.197)	–9.703 (0.000)**	–9.706 (0.000)**
Quarterly series				
China	–0.516 (0.857)	–1.150 (0.910)	–3.441(0.013)**	–3.624 (0.037)**
Botswana	–0.515 (0.879)	–3.709 (0.29)	–11.880(0.000)**	–11.774 (0.000)**
South Africa	1.100 (0.997)	–1.615 (0.774)	–3.602 (0.008)**	–3.926 (0.012)**

Notes:
1. The figures in parentheses are p-values. They are based on MacKinnon (1996).
2. ** and * denote significance at the 5% and 10% levels, respectively.

The maximum likelihood estimation procedure proposed by Johansen (1988, 1995) was used in estimating long-term equilibrium relationships based on pairs of corresponding GDP series for the African countries and China. The standard Johansen co-integration test was not able to detect long-term equilibrium relationships between all pairs of nonstationary variables, except in the case of Ghana.[4] The existence of co-integration was dismissed, since λ_{trace} and $\lambda_{\max}$ yielded conflicting conclusions and the overall estimation failed the usual diagnostic tests. Even in the case of Ghana, where the null hypothesis was rejected, the diagnostic tests were inconclusive. Gregory and Hansen (1996) have shown that the failure to detect co-integration may result from the presence of a structural break in the co-integration vector or from the presence of any sort of nonlinearity in the adjustment. Since co-integration relationships could still be uncovered if additional, higher-

[4] Results of these tests are not included here but can be provided upon request.

powered co-integration tests are performed (Cook 2006) further investigation is required. Following Siklos (2002), the analysis was extended to possibilities of asymmetric adjustment in pairwise co-integration relationships.

3.2. Results of TAR tests

Specification and diagnostic tests were performed to evaluate the statistical appropriateness of the models obtained. The Jarque–Bera Lagrange multiplier test for normality supported rejection of the null hypothesis (the hypothesis of a normal distribution), indicating that, except in the case of Ghana, errors in the estimated models are normally distributed (Table 4). Moreover, the Breusch–Godfrey statistic reveals that there is no autocorrelation present in any of the models except the one for Kenya. We consider the latter to be a minor problem since the related Durbin–Watson test (2.018) did not confirm the presence of autocorrelation in the nonlinear part of the model. Overall, most of the estimated model specifications appear adequate.

The co-integration results given in Table 4 show that the null hypothesis ($\rho_1 = 0 = \rho_2$) is unambiguously rejected (which implies the existence of long-term co-integration) for three of the African nations studied: Kenya, Nigeria and South Africa. For Ghana the null hypothesis was not rejected, thereby implying that the GDP variables of Ghana and China have no long-term relationship, that hence, in principle, they can wander arbitrarily far from each other (Dickey et al. 1991). For Botswana, $\hat{\rho}_1$ is significant while $\hat{\rho}_2$ is not. The interpretation of this result is tricky, as the case of a unit root in one regime is complicated. Caner and Hansen (2001) study an interesting intermediate case in which there is a threshold effect but only one of the regimes is stationary; this they term a "partial unit root model," given that the first regime would follow a stationary mean reverting process while the second would follow a random-walk process, i.e. a process which does not "mean revert" and fluctuates randomly. Tentatively, it can be speculated that Botswana's result is related to the fact that it is the only country in our sample which has had a growth rate close to that of China, its output fluctuating primarily in the positive regime with a period of negative

equilibrium that is statistically too short.

Table 4. TAR and TVECM tests on annual GDP

$\hat{\rho}_1$	$\hat{\rho}_2$	$\hat{F}_C$	$\hat{F}_A$	l	γ_1 [3]	γ_2 [3]	JB-LM[4] (p-val.)	BG[5] (p-val.)-
4.1. Kenya–China								
–0.006 (–3.167)**	–0.001 (-2.02)*	4.895*	5.863*	1	–0.18 (0.23)	–0.002 * (0.06)	3.416 (0.388)	6.061 (0.098)
4.2. Ghana–China								
–0.055 (–1.242)	–1.025 (–1.42)	0. 640	2.516	1	0.136 (1.731)	0.022 (0.367)	2.21 (0.000)	10.36 (0.269)
4.3. Nigeria–China								
–0.001 (–2.121)*	–0.013 (–2.27)**	5.224*	6.114**	1	–0.002** (0.003)	–0.015** (0.032)	16.731 (0.304)	9.127 (0.360)
TAR tests on Quarterly GDP								
4.4. Botswana–China								
–0.0006 (–2.445)**	–0.026 (–1.49)	4.138*	5.927*	3	–0.003 (-0.366)	–0.009 (-0.175)	12.64 (0.645)	27.896[5] (0.101)
4.5. South Africa–China								
–0.001 (–1.966)*	–0.03 (–3.18)**	7.968*	8.004**	2	–0.006 *(0.058)	–0.029 **(0.002)	21.61 (0.523)	4.722 (0.519)

Notes:

1. ** and * denote significance at the 5% and 10% levels, respectively. The selection of the lag length l is based on the Akaike Information Criterion, AIC (Akaike, 1974).
2. The t statistics are in parentheses. $\hat{F}_C$ and $\hat{F}_A$ denote, respectively, the F-statistics for the null hypothesis of symmetric adjustment ($\rho_1 = \rho_2$) and the test statistic for the null hypothesis of no-co-integration ($\rho_1 = \rho_2 = 0$). The critical values are taken from Enders and Siklos (2001).
3. γ_1 and γ_2 are the error-correction terms associated respectively with Z^+ and Z^- as in Equation (4)
4. Results of the Jarque–Bera normality test (see Jarque and Bera, 1980).
5. Results of the Breusch–Godfrey serial correlation.

The tests for asymmetric adjustment ($\rho_1 = \rho_2$) reject the null hypothesis for the same four countries (Botswana, Kenya, Nigeria and South Africa) but fail to reject the null hypothesis in the case of Ghana. The latter result comes without surprise because of the evidence of Johansen co-integration discussed early. Still this results deserves further comment. It is tempting to view the increase in trade intensity between Ghana and China during the middle of the first decade of the 21st century as an indication of increased economic co-integration; but when viewed in detail, Ghana's trade intensity (with China) has declined since 2006, suggesting the absence of co-

integration. Those results could support the conclusion by Bernard and Durlauf (1995) that the sources of Ghana's growth fluctuations might primarily have been in factors other than trade flows.

Focusing only on the countries with asymmetric adjustment, the estimated coefficients for adjustment to long-run equilibrium in the TVECM (γ coefficients in Table 4) indicate a significant reaction to lagged GDP of China for Nigeria, South-Africa and partially for Kenya. Although it is not this paper's specific aim, this result suggests the existence of causality relationships (in the Granger sense: Granger, 1969) between China's economic GDP and that of these three countries in the long-run. Although a thorough interpretation is not straightforward, at least the results for economic growth in Nigeria and China suggest that the speed of adjustment is more rapid for negative discrepancies (at –0.015) than for positive ones (at –0.002). The same conclusion applies in the case of South Africa.

Before moving to the study findings and discussions, three points are worth noting: First, in this study the annual sample size was relatively small, though that was tempered somewhat by the quarterly series used alongside the limited annual data.

Second, China's business cycle has become deeply synchronized with those of Africa's traditional trading partners, implying that the effect of either the EU or the US might be reflected in China's output performance and ultimately might impact African economic growth. Our implicit assumption has been that China's critical role as an assembly and global production center has caused its macroeconomic condition to be deeply synchronized with those of Africa's traditional trading partners — such as the EU and the US — so that any effect originating from either of these two can be expected to be reflected in China's economic condition. This means that given the close correlation between China and any possible omitted third variable, China can be considered as a proxy variable of the inferred omitted variable.

Third, while co-integration of output is useful in understanding degree of synchronization, co-integration is but one simple single-dimension indicator of output concordance. Any analysis of international synchronization is necessarily faced with trade-offs between the sophistication of the

modeling framework — notably, the distinction between spillover effects and common shocks — and the availability of data. Empirical verification of such a conjecture is beyond the scope of this paper; nevertheless, these limitations may not be severe in this study since, as noted in the Introduction, the study is focused on detecting co-integration relationships rather than on exploring common shocks or spillover effects.

3.3. Findings and discussions

One major practical implication of our findings is that among African countries there are differences in GDP adjustment patterns relative to that of China. The aggregate outputs of Nigeria and South Africa adjust relatively quickly to offset lower levels of aggregate output with respect to their long-term trends with China's GDP. In Kenya, by contrast, the speed of adjustment is more rapid for positive than for negative discrepancies. A possible explanation is in the different levels of economic integration and bilateral trade intensities for different African countries, as well as differences in the composition of the economies of these countries and of their trade with China. Nigerian and South African exports to China consist mainly of oil and mining-related commodities which enter the production process (as supply-side factors) and can be expected to recover as soon as an upturn in output occurs. Kenyan exports, by contrast, are textile and food-related (hence, demand-side/consumption factors) so they are not expected to exhibit significant recovery until much later.

Another important practical implication is that given the drastic fall in African GDP over the 2008 global recession relative to that of China, it is plausible to assume that African outputs are below their long-term equilibrium vis-à-vis the output of China. This leads to the conclusion that, China being the engine of global economic recovery, *ceteris paribus* Nigeria and South Africa are likely to reap the benefits of China's recovery at a faster pace than is Kenya.

Overall, from a policy-making perspective with respect to commodity-exporting countries, the above findings have changed our view in two respects: First, although China is not the top

trading partner of any of the countries in our sample, it nevertheless exerts detectable economic influence on them — influence which is likely to strengthen in the future. This is in line with the conclusion by Girardin (2005) that output fluctuations between trading partners can be strongly correlated when trade volumes are small but rapidly growing. Second, output co-integration between Kenya and China generally tends to fluctuate in a narrower range than that between Nigeria and China or between South-Africa and China. This difference may be rooted in the specific characteristics of trade between those countries and China. In comparative terms, Kenya's exports to China fluctuate less than those of Nigeria or South Africa, thereby resulting in more stable trade links.

In the long-run, long standing African constraints such as those mentioned by Ekanem (2006) in the Africa-US context could prevent Africa from reaping the benefits of its trade with China. Those constraints are in the inability of the African countries to provide quantities of export products in response to significant increases in Chinese demand for them. The most important reason for this is that most African countries lack the capacity to expand production in the short run. Another reason is that their exports are not competitive in price and quality; hence they face considerable competition from other potential exporters to the Chinese market.

4. Conclusion and implications

This study set out to determine the potential for China's economic recovery to exert a pull on the economic growth of selected African countries: Botswana, Ghana, Kenya, Nigeria, and South Africa. Two important messages emerge from the analysis. First, the evidence points to the presence of nonlinear cointegration relationships in three out of the five cases. This finding suggests that countries with intensive trade linkages also tend to display macroeconomic co-movement in the long run. Second, there are noticeable differences in the patterns of aggregate output co-movements between individual African countries and China. The GDPs of some countries adjust relatively quickly to offset lower levels in their respective long-run trends with China's GDP; in other

countries, the speed of adjustment is more rapid for positive discrepancies than for negative ones. Taken together, these two aspects of the analysis suggest that an increase in growth and/or demand on the part of China could exert a pull on the economies of China's African trading partners and help put them on the path to a firm recovery.

These findings raise additional issues with regard to the capacity of African economies to capitalize on their growing trade integration with China. Though the benefits to these economies of being co-integrated with China are manifest, perhaps the most critical question is whether African economies are prepared to realize their full potential for trade with China. Given the limits of Chinese markets, in order to capitalize on their potential they have to lay the groundwork for sustainable growth instead of merely increasing their export volume.

Another area of policy concern is that, unlike in other regions, the surge in economic interactions between Africa and China is not associated with a trend toward intra-industrial trade or vertical integration. To circumvent limitations, it must be recognized that in "new" trade relationships, the gains from synchronization of outputs via trade derive not only from Africa's ability to collaborate with China, but also from improvements in communications and transport infrastructure of the type that facilitates smooth connections between countries for purposes of "production sharing" (Petri 2006). In this regard, investment in efficient physical infrastructure becomes a central variable in maximizing gains from macroeconomic synchronization in the long term as well as an important policy objective.

Other policy objectives should ensure that as China rapidly moves up along the global value chains, industrial and technological gaps between the two regions are reduced. This will require that African firms take the lead. For example, South-African firms with technological capacity might choose to focus on high-value niches to achieve global scale via a strategic presence in Chinese markets as well as focusing on initiatives such as teaming up with low-cost Chinese firms in joint operations both in China and in Africa. The role of African states could be that of providing

incentives for Chinese market penetration by innovative African firms while technical assistance from external donors could take the form of managerial and technological support.

There is a serious need for research on appropriate policy stances for African nations to assume in their dealings with China. The ways in which China's growth could influence that of Africa or exert an impact on African economies are multiple, vary across different countries, and are as yet relatively poorly researched. Analysis of output correlations between China and African countries remains one fruitful area for further research. It is hoped that much longer time series data will become available to allow for more robust empirical analyses. This can help in formulating appropriate national and regional policies for African economies to enhance their resilience to global shocks while benefiting from spillovers generated by major world engines of economic growth, such as China.

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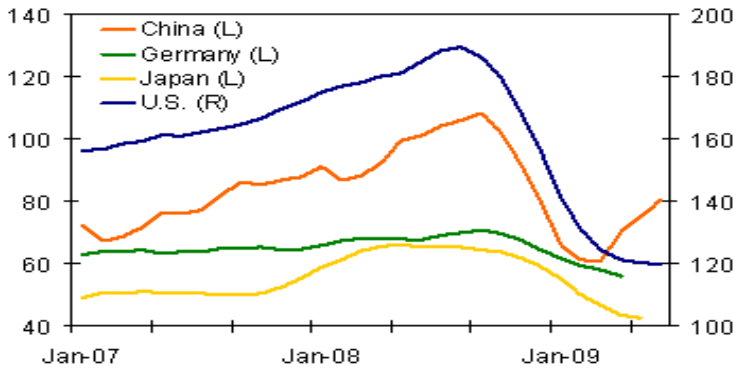
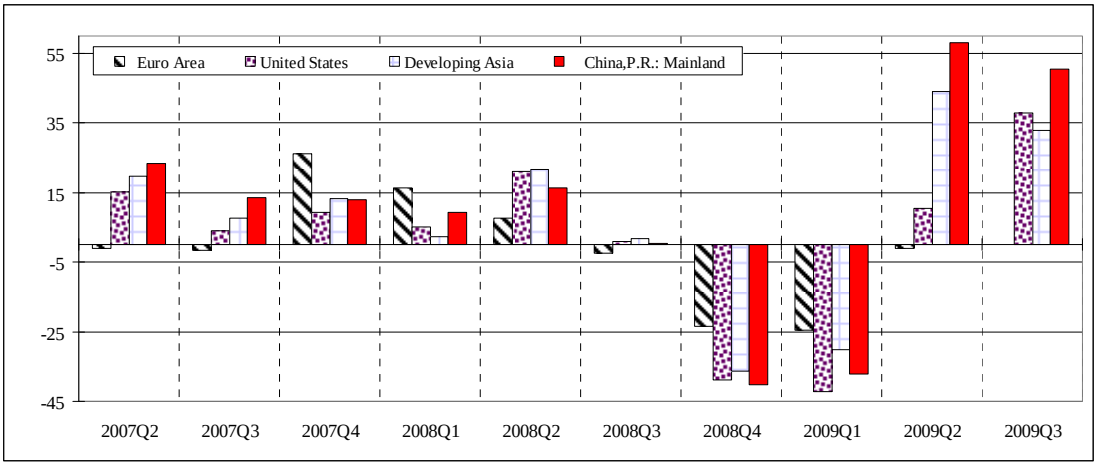
APPENDIXES

Figure 1. Merchandise Imports ($ bill, 3 mo. MA)



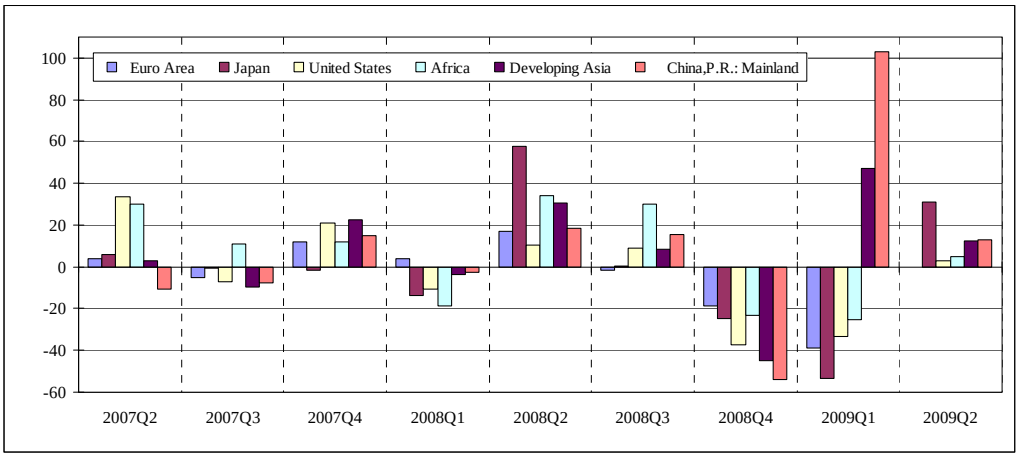
Source: Thomson Reuters DataStream, Economic View, 2009.

Figure 2. Recent growth in African Exports by destinations (% change from previous period)



Source: IMF's Directions of Trade Statistics (DOT), 2009

Figure 3. Recent growth in South-African Exports by destinations (% change from previous period)



Source: IMF's Directions of Trade Statistics (DOT), 2009

Abstract (in Japanese)

要約

本稿では、中国の経済回復がアフリカのいくつかの国々（ボツワナ・ケニア・ガーナ・ナイジェリア・南アフリカ）の経済成長に影響を及ぼす可能性を、アフリカと中国それぞれの年単位の GDP の動きの関連性に着目することによって検証する。総生産量を景気循環の代替指標として用いた閾値自己回帰分析を行った結果、上述のアフリカの国々のうち 3 カ国の総生産量については、中国の総生産量と非線形の関連性を示すことが明らかになった。意外なことに、アフリカ経済の生産量は、景気上昇に対するときよりも、景気後退に対する際の方がはるかに大きな調整が働く。特にナイジェリアにおいては、中国の GDP との長期的な関連性に着目すると、景気がより低いレベルにある際の生産量の調整の方が、比較的迅速に行われる。対照的にケニアでの調整の速度は、上昇局面の方が下降局面よりも早い。このことは、その他の分析結果をあわせて考えると、アフリカ経済は中国が牽引する世界的な経済回復の恩恵を受けるが、その度合いは、それぞれの国の輸出品が、中国の生産チェーンに向けられているか（すなわち原料品）、需要チェーンに向けられているかによって異なることを示している。長期的には、アフリカの生産が貿易を通じて中国や他の経済大国の生産とシンクロすることで得られる利益は、それらアフリカの国々が、発展を支援するような効率的なインフラ開発に対してどれだけ準備ができているかということに強く依存する。

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