What Brings China to Africa? An Analysis of Market Size, Natural Resource Availability and Macroeconomic Risk

KOMLA D. DZIGBEDE

ABSTRACT

This study applies the fixed effects vector decomposition procedure on a panel of 38 African countries to analyze factors that determine China’s trade engagement with African countries. Results show that China’s trade engagement with Africa is driven mainly by African countries’ market size, natural resource availability, and bilateral trade cooperation with China. Macroeconomic and infrastructural risk factors in African countries do not seem to be major considerations in China’s trade engagement with Africa. These findings highlight key factors that should be at the core of regional and international level discussions on China-Africa trade strategy and policy.

Key words: China; Africa; trade; determinants; fixed effects vector decomposition

JEL Codes: F14

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1. THEORETICAL PERSPECTIVES ON CHINA-AFRICA TRADE ENGAGEMENT

One of several theories that attempt to explain strategic factors underlying international trade and commerce is that proposed by Heckscher and Ohlin (1991).¹ Their theory postulates that international commerce compensates for the uneven geographical distribution of productive resources, and exchange of commodities is an indirect factor arbitrage which transfers the services of otherwise immobile factors of production from locations where factors are abundant to locations where factors are scarce.²

China’s trade strategy in Africa tends to support some of the Heckscher-Ohlin (1991) theory’s postulations. Robert Rotberg (2008) notes that China’s high demand for liquid forms of energy and raw materials that support its industries makes Africa a strategic market for acquiring relatively abundant supplies of oil, gas, unprocessed metals, diamonds and gold, while Africa also benefits from a ready market for African timber, cotton, sugar and other agricultural crops.

Recent data on shares and composition of China’s trade engagement with individual African countries (see Table 1) shows the potential for a win-win trade partnership between China and Africa. Average annual growth in China’s total trade with Africa (exports plus imports) grew by 39.4 percent between 2002 and 2008, compared to 20.6 percent between 1995 and 2001 (see Chart 1).³ Also, that period of significant growth was associated with less volatility in trade flows, giving evidence of stability in China’s growing trade engagement with African countries (see Chart 2). Benefits from trade can significantly improve economic growth and

¹ The original contributions of Heckscher and Ohlin were in 1919 and 1924 respectively – and were written in the Swedish language – but the theory was translated from Swedish and republished in 1991.
² See Leamer (1995) for an outline of critiques and justifications of this model.
³ In 2009, trade flows between China and Africa dipped by 15 percent compared to 2008. Given that the U.S financial crisis peaked in 2008, the decline in trade flows between China and Africa in 2009 could have been the delayed effect of the financial crisis on trade in jurisdictions outside the United States.
DZIGBEDE: WHAT BRINGS CHINA TO AFRICA?

Chart 1: China’s Trade with Africa in US$ billion (1995 to 2009)

Source: Author’s own compilation based on data from World Atlas

Chart 2: Volatility in China-Africa Trade Flows

Source: Author’s own computation based on World Atlas data

Table 1: China’s Top 10 Trading Partners in Africa (2005 to 2009)
Country | Share of Trade in 2009 (%) | Key Export to China | Key Import from China
--- | --- | --- | ---
Angola | 19 | Crude Oil | Cement products
South Africa | 17 | Iron Ore | Electricals
Sudan | 7 | Crude Oil | Electricals
Nigeria | 7 | Crude Oil | Electricals
Egypt | 7 | Bitumen Oil | Electricals
Algeria | 6 | Crude Oil | Electricals
Libya | 6 | Electronics | Electricals
Morocco | 3 | Crude Oil | Cotton fabrics
Congo | 2 | Crude Oil | Motor vehicles
Equatorial Guinea | 2 | Crude Oil | Electricals

Source: Author's own tabulation based on data from World Atlas

poverty reduction outcomes in Africa as size of trade flows to and from China becomes larger.

Much of the discourse on China’s trade with Africa have been based on descriptive analyses of trade flows and few studies have grounded their assessments of China’s growing trade engagement with Africa in robust empirical framework that can inform evidence-based discourse on China-Africa trade policy. Even among the few studies that examine the growing China-Africa trade partnership within an empirical framework, the extent of generalizability of empirical findings is limited because the studies either focus on China’s trade with an individual African country (e.g. Brautigam and Tang, 2012a; and Brautigam and Tang, 2012b), or China’s trade with a small group of countries in Africa (e.g. Holslag, 2006). Further, recent empirical studies on China-Africa trade engagement (e.g. Biggeri and Sanfilippo, 2009) attempt to explain the determinants of trade, investment and aid, all within a single study, and by combining these different aspects of China’s engagement with Africa into a single analysis, those studies limit the depth to which they analyze the determinants of either trade, aid, or investment.
This study fills those gaps in the academic literature. Drawing from the Heckscher-Ohlin theory, the study analyzes the strategic factors that drive China's international trade engagement with Africa by assessing how African countries' market size, macroeconomic risk, infrastructural risk, natural resource availability, and bilateral trade cooperation with China affect Chinese trade engagement with the African continent.4

Given the intense policy interest that China's growing trade engagement with Africa has generated in recent times, findings from this study are essential for highlighting key factors that should be at the core of regional and international level discussions on China's growing trade partnership with Africa. Also, this study provides African policymakers with insights on what strategic domestic factors are essential for sustaining development-enhancing trade partnerships with China, either as individual countries or as sub-regional trade blocs.

2. RECENT STUDIES ON DETERMINANTS OF CHINA-AFRICATRADE

Recent empirical work on China's trade engagement with Africa have ranged from scoping studies on evolution of trade shares and traditional trade similarity measures to empirical estimation of the determinants and effects of China's growing trade partnership with African countries. Of particular public policy relevance is an understanding of the key deterministic factors that motivate trade flows between China and Africa. Such scholarship can serve as a guiding post for African countries eager to use trade with China as a tool for sustainable development.

Cheung et al. (2012) categorized the determinants of China's trade with Africa on the basis of China's motives for trade with Africa: market-seeking motive, risk-avoiding motive, and resource-seeking motive. The authors found that market opportunities (measured in terms of an African country's economic size and the number of Chinese contract projects in that country), and to some extent availability of natural resources (such as minerals and oil) in an African country, were strong positive factors that drive China's motivation for trade with African countries.5 However, Cheung et al. found mixed evidence for the impact of African countries' political risk factors (measured by a corruption index) on China's motivation to trade with African countries.

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4 The present study does not undertake to test propositions of the Heckscher-Ohlin (1991) theory, even though part of the theory's predictions forms the background for analysis.

5 See also Asiedu and Lien (2011) who identified unique differences among resource (minerals and crude oil) and non-resource exporting developing countries in the extent to which democratic fundamentals in these countries enhance amount of foreign investments they receive.
While Cheung et al. can be credited for effectively categorizing China’s motives for trade within a robust empirical framework, their finding that China’s resource seeking motive “became prominent only recently” (that is since 2002) puts their study at variance with several other studies on China-Africa trade that find a strong positive relationship, unconstrained by time, between African countries’ natural resource availability and China’s trade partnership with those countries.

For example, of the five interrelated push and pull factors that Joshua Eisenman (2012) identified as driving China’s trade with Africa, natural resource endowment of African countries was the single most influential pull factor in China’s trade engagement with Africa. The other significant (push) factors were the comparative advantage China has in labor-intensive and capital-intensive production, the rapid growth in China’s economy, China’s policy emphasis on building infrastructure both at the domestic and African fronts, and economies of scale that China possesses in her shipping and light manufacturing sectors. Oyejide et al. (2009) also noted that China’s imports from Africa are heavily concentrated in relatively few countries which export petroleum, minerals and metals, but emphasize that China’s exports of relatively cheaper manufactured products have a wider dispersion in the African market.

Beyond the attraction that Africa’s natural resources present for China’s trade partnership with the continent, Besada, Wang and Whalley (2008) showed that China’s trade engagement with the continent is also motivated by factors such as China’s search for new habitats to deploy large foreign exchange reserves, improvements in African countries’ infrastructure availability, as well as the spread and stability of elected governments in Africa.

An example of China-Africa studies that attempt to explain the determinants of trade, investment and aid in one leap is that by Biggeri and Sanfilippo (2009).6 They applied instrumental variable estimation procedure for simultaneous equations on 43 African countries starting from 1998 to 2005 and showed that the key determining factors of China’s engagement with Africa stem

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6 Despite presenting a broader framework for assessing factors that underlie China’s move into Africa, Biggeri and Sanfilippo (2009) - as is common with studies that analyze foreign direct investment, trade and aid together - sacrifice depth of analysis for each of the three sectors while explaining dynamic interactions among all three sectors. Further, a common limitation of instrumental variable estimation of simultaneous equations, as used in Biggeri and Sanfilippo’s study, is that models often require restrictive assumptions to satisfy rank and order conditions for equation identification, which makes the estimation approach sensitive to specification errors. - See Brundy and Jorgenson (1971).
from a strategic interaction among outward foreign direct investment, trade and aid. Their study found that factors such as human factor endowment, infrastructure endowment, natural resource endowment, market potential, inflation, access to sea ports and political freedom in African countries are significant motivations for China’s aid, investment, and trade with Africa.

Montinari and Prodi (2010) focus their analysis solely on China’s trade with Africa but find results that are consistent with Biggeri and Sanfilippo (2009). Among the factors that Montinari and Prodi found as significant determinants of China-Africa trade are African countries’ market size, geographical distance to China, crude oil endowment and specific cultural factors in individual countries. Whereas Montinari and Prodi specified a gravity model in their study, Giovannetti and Sanfilippo (2009) employed an augmented gravity model to show a similar result - that market size, distance to market, access to the sea and existence of free trade agreements are all important factors in China’s trade relationship with Africa.

The present study analyzes most of the factors used in studies on China-Africa trade partnership but builds on the approach in previous studies by recognizing the time variant properties of different strategic factors driving China-Africa trade. The fixed effects vector decomposition procedure, which this study uses, accommodates estimation of time-variant factors such as market size, macroeconomic risk, infrastructural risk and bilateral trade cooperation, as well as time-invariant factors, such as natural resource availability, while maintaining the unbiasedness of the fixed effects model.

Plumper and Troeger (2007) presented the fixed effects vector decomposition procedure as a superior estimation technique for controlling correlation between observed and unobserved model characteristics. The decomposition approach takes account of systematic average differences between groups that may be ignored in traditional fixed effects estimation and does not require specifying exogeneity status of independent variables as required in Hausman and Taylor’s (1981) well-known improvement to the fixed effects estimator.

The present study builds on Breusch et al.’s (2011) specification of the fixed effects vector decomposition technique to study both time-variant and time-invariant characteristics motivating China-Africa partnership, which is a different approach compared with traditional fixed effects estimations that treat those characteristics similarly, leading to incorrect inferences. Fixed effects vector decomposition estimation of China-Africa partnership allows for increased explanatory power of the model and provides coefficient estimates that have
smaller standard errors compared to traditional fixed effects approaches. Results from fixed effects vector decomposition estimations offer an innovative way of assessing the importance of time variant and invariant factors in strategic international trade partnerships and should inform evidence-based policy in a more precise way.

Aside from the methodological novelty that this study’s use of the fixed effects vector decomposition procedure brings to the empirical literature on China-Africa trade, the study also stands out as more holistic in its coverage of a panel of 38 African countries - several works on China-Africa trade either focus on China’s trade with an individual country or with a small group of countries in Africa, making generalizations from such work suspect.

3. DATA AND METHOD

This study uses annual data on total trade (exports plus imports), GDP in constant prices, inflation, exchange rates and telephone lines per 100 people in a population to analyse determinants of China’s trade with African countries. The data on China’s total trade with African countries is taken from World Trade Atlas (China version). The World Bank’s World Development Indicators is the source of data for African countries’ GDP, inflation, exchange rate, and telephone lines per population. The logarithm of variables is used to ensure that observations of extremely high values do not receive excessive weights in estimations.

China’s total trade with an African country is used in this study as a gauge of China’s trade engagement with that country. For each African country, the study uses GDP as a gauge of market size, inflation and exchange rates as measures of macroeconomic risk and number of telephone lines per 100 people in the population as a gauge of infrastructure availability. Further, this study uses the

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7 The present study uses logarithmic values of exchange rates (rather than absolute values of exchange rates) which track appreciation and depreciation of currency and explain their association with trade flows. Since most economies in Africa maintained fixed exchange rate regimes for most of their recent history, use of either logarithmic or volatility measures of exchange rates in analyses may still be problematic for drawing inferences, for as Martin Melecky (2012) opined, “exchange rate volatility can be deceptive when a fixed exchange rate regime is maintained […] and to] adequately capture the expected co-variances in the context of managed exchange rate regimes, […] equilibrium instead of actual exchange rates [must be used…].” (p.133)

8 Use of telephone lines per 100 people as a measure of a country’s infrastructure, though reasonable, may not present a complete picture of infrastructure availability. The present study followed the approach of other researchers, such as Easterly (2001) and Loayza et al. (2005) who used indicators from a single-infrastructure sector (main telephone lines per 1,000 people) as a proxy for infrastructure. On the contrary, Calderon (2009) presented a more complete picture of a country’s infrastructure by aggregating individual physical measures of infrastructure in road (length of total road network, in kilometers), electricity (electricity-generating capacity, in megawatts per
lagged value of total trade as a measure of the persistence factor in international trade engagements which ensures that previous levels of bilateral cooperation and agreement among trading partners forms the basis for current trade flows. Finally, natural resource availability \(^9\) is represented in this study as a time-invariant variable and data on this variable is generated by assigning a value 1 when an individual country exports either crude oil or mineral resources or both to China. The value 0 is assigned when an individual country exports neither crude oil nor minerals to China. The main hypotheses for this study are that China’s trade engagement with Africa is driven by market size (positively), macroeconomic risk (negatively), infrastructure availability (positively), bilateral trade cooperation (positively) and natural resource availability (positively).

The study follows a general specification of the fixed effects vector decomposition model by Breusch et al. (2011) for a panel data set with \(N\)-groups (countries) and \(T\) observations (years). The fixed effects vector decomposition for a single scalar observation is:

\[
y_{it} = X_{it}\beta + Z_{i}\gamma + \mu_{i} + \epsilon_{it}, \quad i = 1, \ldots, N; \quad t = 1, \ldots, T \tag{1}
\]

In Equation 1, \(y_{it}\) is the dependent variable for an individual country \(i\) at time \(t\). \(X_{it}\) is a \(k \times 1\) vector of time-varying explanatory variables for country \(i\) at time \(t\). \(Z_{i}\) is a \(p \times 1\) vector of time-invariant explanatory variables for country \(i\). \(\beta\) and \(\gamma\) are unobserved parameters, \(\mu_{i}\) denotes group or interaction effects for country \(i\) and \(\epsilon_{it}\) is the unobserved error term.

Further, this study applies the limit conditions for a fixed effects vector decomposition model as proposed by Plumper and Troeger (2007), and theorizes that \(\mu_{i}\) is correlated with at least one of the time-variant variables, \(X_{it}\), and at least one of the time-invariant variables, \(Z_{i}\), such that Equation 2 and Equation 3 hold:

\[
p \lim_{N \to \infty} (1/N) x'_{1it}\mu_{i} = 0; \quad p \lim_{N \to \infty} (1/N) x'_{2it}\mu_{i} \neq 0; \tag{2}
\]

\[
p \lim_{N \to \infty} (1/N) z'_{1it}\mu_{i} = 0; \quad p \lim_{N \to \infty} (1/N) z'_{2it}\mu_{i} \neq 0; \tag{3}
\]

1,000 workers), and telecommunications sub-sectors (number of telephone lines, per 1,000 workers) to produce an index of infrastructure stocks. Nevertheless, the present study maintains the single-infrastructure-sector-measure used by Easterly (2001) and Loayza et al. (2005) for ease of analysis.

\(^9\) Since the study’s focus is on understanding what drives China to Africa, analysis of natural resources as a determining factor must concern the extent to which an African country’s mineral or oil resources are accessible (or available) to China through trade partnerships, rather than mere existence (or endowment) of those resources in a country. Unsurprisingly, Urban et al. (2013) mentioned natural resource access as one of the factors that underpin China’s trade strategy in low and middle income countries.
From the general model in Equation 1 and the limit conditions in equations 2 and 3, this study specifies an estimable model, shown in Equation 4, to study the strategic factors that impact the China-Africa trade relationship.

\[
\text{trade}_{it} = \beta_1 \text{bilateral cooperation}_{it} + \beta_2 \text{market size}_{it} + \beta_3 \text{macro risk}_{it} \\
+ \beta_4 \text{infrastructure}_{it} + \gamma_1 \text{resource availability}_i + \mu_i + \epsilon_{it}, \\
i = 1, ..., 38; \quad t = 1995, ..., 2009
\] (4)

Estimation of Equation 4 proceeds in three steps. First, the study estimates the unit fixed effects by the baseline panel fixed effects model excluding the time-invariant right hand side variable. Second, the study proceeds to regress the fixed effects vector on the time-invariant explanatory variable of the original model by OLS. Third, a pooled OLS model is estimated by including explanatory time-variant variables, the time-invariant variable and the unexplained part of the fixed effects vector. This third stage controls for multicollinearity and adjusts the degrees of freedom. Prior to these estimations, correlation and stationarity properties of the variables are examined.

4. RESULTS

Results of exploratory analyses show that all the independent variables (with the exception of macroeconomic risk factors) are fairly correlated with the dependent variable and have the expected signs (see Appendix Table A1). Granger causality test results also show that there is a two-way causality between market size and trade, one-way causality between a macroeconomic risk factor (inflation) and trade, and no causality between the infrastructural risk factor and trade (see Appendix Table A2). Finally, the results of panel unit root tests show that the series on trade and market size are not stationary in levels, whereas the series on macroeconomic risk (inflation and exchange rates) and infrastructural risk are stationary in levels. Based on the unit root test results (see Appendix Table A3), this study proceeds to use the first differences of the non-stationary variables in the estimation process. The estimation output is summarized in Table 2 (see Appendix Table A4 for the full estimation output).

The results indicate that China’s trade engagement with African countries is driven mainly by African countries’ natural resource availability, market size, and bilateral trade cooperation with China. These factors are significant at the 1 percent, 5 percent and 10 percent levels respectively. The variables also enter the model with expected signs thereby confirming the study’s hypotheses. Generally,

\[\text{See Plumber and Troeger (2007) for specific mathematical equations associated with the three steps.}\]
Table 2: Estimation Results

Dependent Variable: Trade
Method: Fixed Effect Vector Decomposition

<table>
<thead>
<tr>
<th>Dependent Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>bilateral cooperation (lag 3)</td>
<td>0.074</td>
<td>0.039</td>
<td>1.88*</td>
<td>0.061</td>
</tr>
<tr>
<td>market size (lag 2)</td>
<td>0.630</td>
<td>0.313</td>
<td>2.01**</td>
<td>0.045</td>
</tr>
<tr>
<td>macroeconomic risk</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>inflation</td>
<td>0.052</td>
<td>0.013</td>
<td>4.00***</td>
<td>0.000</td>
</tr>
<tr>
<td>exchange rate</td>
<td>0.006</td>
<td>0.005</td>
<td>1.330</td>
<td>0.184</td>
</tr>
<tr>
<td>infrastructure availability</td>
<td>0.003</td>
<td>0.009</td>
<td>0.310</td>
<td>0.757</td>
</tr>
<tr>
<td>natural resource availability</td>
<td>0.073</td>
<td>0.027</td>
<td>2.69***</td>
<td>0.007</td>
</tr>
<tr>
<td>residual term (lag 1)</td>
<td>-0.205</td>
<td>0.062</td>
<td>(3.31)***</td>
<td>0.001</td>
</tr>
</tbody>
</table>

Number of observations: 322
Number of cross sections: 38

<table>
<thead>
<tr>
<th>S.E. of regression</th>
<th>Weighted Statistics</th>
<th>Unweighted Statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.352</td>
<td>0.378</td>
</tr>
<tr>
<td>Mean dependent var</td>
<td>0.297</td>
<td>0.245</td>
</tr>
<tr>
<td>S.D. dependent var</td>
<td>0.378</td>
<td>0.378</td>
</tr>
<tr>
<td>Sum squared residual</td>
<td>38.925</td>
<td>40.064</td>
</tr>
</tbody>
</table>

*** shows significance at 1 percent level ** shows significance at 5 percent level and * shows significance at 10 percent level.

Source: Author’s estimations

Macroeconomic and infrastructural risk factors do not seem to be major considerations in China’s international trade engagement with Africa.

From this study’s results, there exists a positive association between trade flows and inflation, which suggests that China’s trade engagement proceeds amidst increases in inflation risk among African countries.\(^{11}\) Also, infrastructure availability

\(^{11}\) Positive association between inflation risk in an African country and China’s trade engagement with that country may be explained by the fact that, compared to developed countries, China may have an
is not significant in the model, even though it has the expected sign. The residual term is significant and has a negative sign, meaning that errors are corrected in this pooled model over a one year period. A test for serial correlation using the Jacque-Berra Statistic fails to reject the null hypothesis of no serial correlation in our estimation (see Appendix Chart A1).

5. SUMMARY AND CONCLUSIONS

Trade flows between China and Africa have grown significantly within the last two decades and China currently ranks as Africa’s second largest trading partner, behind the United States and ahead of France and Britain. This study analyzed the factors that motivate China’s international trade engagement with Africa. The fixed effects vector decomposition procedure is applied on a panel of 38 African countries for the period 1995 to 2009. This procedure has the unique advantage of accommodating estimation of time-variant factors (such as market size, macroeconomic risk, infrastructural risk and bilateral trade cooperation) as well as time-invariant factors (such as natural resource availability), an advantage that makes the present study a unique addition to the empirical literature on China-Africa trade partnership.

Results from the study indicate that China’s trade engagement with African countries is driven mainly by market size, natural resource availability and previous bilateral trade cooperation with China. Macroeconomic and infrastructural risk factors do not emerge from estimations as major considerations in this international trade engagement. On the one hand, minimal importance of African countries’ macroeconomic and institutional conditions in China’s trade relationship with the continent highlights the realism of what scholars such as Cheung et al. (2012) refer to as the consequences of China’s “no-interference policy,” which provides little motivation for African countries to improve their macroeconomic and institutional structures to benefit from trade. On the other hand, the importance of factors such as market size, previous bilateral trade cooperation and natural resource availability in this study’s regressions highlights considerations that must be at the core of national and sub-regional strategies that aim at deriving full developmental benefits from the growing trade partnership that China presents to the African continent.

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advantage in dealing with countries with high inflation risk, due to China’s own experience with persistent institutional constraints. Several studies use inflation risk as a measure of institutional quality. For example, both Claessens et al. (2007) and Fried (2013) identified inflation as one of several measures of domestic institutional constraints (e.g. fiscal burden, capital account openness, and quality of democratic institutions).
REFERENCES


Table A1: Correlation Matrix of Variables

<table>
<thead>
<tr>
<th></th>
<th>LNTTRADE</th>
<th>LNKGD</th>
<th>LNINF</th>
<th>LNEXCH</th>
<th>LNTEL100</th>
<th>NRE</th>
</tr>
</thead>
<tbody>
<tr>
<td>LNTTRADE</td>
<td>1.00</td>
<td>0.70</td>
<td>0.13</td>
<td>-0.04</td>
<td>0.08</td>
<td>0.28</td>
</tr>
<tr>
<td>LNKGD</td>
<td>0.70</td>
<td>1.00</td>
<td>0.16</td>
<td>-0.16</td>
<td>0.04</td>
<td>0.33</td>
</tr>
<tr>
<td>LNINF</td>
<td>0.13</td>
<td>0.16</td>
<td>1.00</td>
<td>-0.28</td>
<td>-0.08</td>
<td>0.02</td>
</tr>
<tr>
<td>LNEXCH</td>
<td>-0.04</td>
<td>-0.16</td>
<td>-0.28</td>
<td>1.00</td>
<td>-0.44</td>
<td>0.09</td>
</tr>
<tr>
<td>LNTEL100</td>
<td>0.08</td>
<td>0.04</td>
<td>-0.08</td>
<td>-0.44</td>
<td>1.00</td>
<td>-0.15</td>
</tr>
<tr>
<td>NRE</td>
<td>0.28</td>
<td>0.33</td>
<td>0.02</td>
<td>0.09</td>
<td>-0.15</td>
<td>1.00</td>
</tr>
</tbody>
</table>

Table A2: Results of Granger Causality Tests

Pairwise Granger Causality Tests
Date: 07/28/10   Time: 11:26
Sample: 1995 2009
Lags: 4

Null Hypothesis: Obs F-Statistic Prob.
LNKGDP does not Granger Cause LNTTRADE 418 2.2789 0.0602
LNTTRADE does not Granger Cause LNKGDP 418 2.1037 0.0796
LNINF does not Granger Cause LNTTRADE 276 4.0321 0.0034
LNTTRADE does not Granger Cause LNINF 276 1.0437 0.3851
LNEXCH does not Granger Cause LNTTRADE 418 0.5062 0.7312
LNTTRADE does not Granger Cause LNEXCH 418 0.4227 0.7923
LNTEL100 does not Granger Cause LNTTRADE 418 1.1235 0.3449
LNTTRADE does not Granger Cause LNTEL100 418 1.8246 0.1232
NRE does not Granger Cause LNTTRADE 418 na na
LNTTRADE does not Granger Cause NRE 418 na na
Table A3: Panel Unit Root Test Results for Variables

Null Hypothesis: Unit root (individual unit root process)
Sample: 1995 2009
Exogenous variables: Individual effects
User specified lags at: 1
Cross-sections included: 38

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Chi Sq.</td>
<td>P-value</td>
<td>Chi Sq.</td>
</tr>
<tr>
<td>log trade</td>
<td>36.9022</td>
<td>1.0000</td>
<td>213.756</td>
</tr>
<tr>
<td>log kgdp</td>
<td>48.3214</td>
<td>0.9945</td>
<td>167.599</td>
</tr>
<tr>
<td>log inf</td>
<td>102.288</td>
<td>0.0071</td>
<td>na</td>
</tr>
<tr>
<td>log exch</td>
<td>98.1640</td>
<td>0.0445</td>
<td>na</td>
</tr>
<tr>
<td>logtel100</td>
<td>92.4001</td>
<td>0.0971</td>
<td>na</td>
</tr>
</tbody>
</table>

** Probabilities for ADF Fisher tests are computed using an asymptotic Chi

Chart A1: Results of Serial Correlation Test

<table>
<thead>
<tr>
<th>Series: Standardized Residuals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample 1999 2009</td>
</tr>
<tr>
<td>Observations 322</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Statistics</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>0.015438</td>
</tr>
<tr>
<td>Median</td>
<td>0.057236</td>
</tr>
<tr>
<td>Maximum</td>
<td>0.964161</td>
</tr>
<tr>
<td>Minimum</td>
<td>-0.791062</td>
</tr>
<tr>
<td>Std. Dev.</td>
<td>0.347882</td>
</tr>
<tr>
<td>Skewness</td>
<td>-0.112950</td>
</tr>
<tr>
<td>Kurtosis</td>
<td>2.728720</td>
</tr>
<tr>
<td>Jarque-Bera</td>
<td>1.672031</td>
</tr>
<tr>
<td>Probability</td>
<td>0.433434</td>
</tr>
</tbody>
</table>
Table A4: Estimation Output for Pooled Model with time variant, time invariant and error terms

Dependent Variable: D(LNTTRADE)
Method: Panel EGLS (Cross-section weights)
Sample (adjusted): 1999 2009
Periods included: 11
Cross-sections included: 38
Total panel (unbalanced) observations: 322
Linear estimation after one-step weighting matrix
White period standard errors & covariance (d.f. corrected)

<table>
<thead>
<tr>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>D(LNTTRADE(-3))</td>
<td>0.073806</td>
<td>0.039249</td>
<td>1.880459</td>
</tr>
<tr>
<td>D(LNKGDP(-2))</td>
<td>0.629819</td>
<td>0.312779</td>
<td>2.013620</td>
</tr>
<tr>
<td>LNINF</td>
<td>0.051621</td>
<td>0.012893</td>
<td>4.003737</td>
</tr>
<tr>
<td>LNEXCH</td>
<td>0.006010</td>
<td>0.004508</td>
<td>1.333073</td>
</tr>
<tr>
<td>LNTEL100</td>
<td>0.002732</td>
<td>0.008829</td>
<td>0.309435</td>
</tr>
<tr>
<td>NRE</td>
<td>0.073462</td>
<td>0.027268</td>
<td>2.694061</td>
</tr>
<tr>
<td>FPRESID2(-1)</td>
<td>-0.205088</td>
<td>0.061893</td>
<td>-3.313607</td>
</tr>
</tbody>
</table>

Weighted Statistics

| R-squared | Mean dependent var | 0.297310 |
| Adjusted R-squared | 0.065552 | S.D. dependent var | 0.378017 |
| S.E. of regression | 0.351527 | Sum squared resid | 38.92483 |
| Durbin-Watson stat | 1.792779 | |

Unweighted Statistics

| R-squared | Mean dependent var | 0.245479 |
| Sum squared resid | 40.06413 | Durbin-Watson stat | 1.946019 |