EABER WORKING PAPER SERIES

Paper No.32

ASIAN TRADE STRUCTURES AND TRADE POTENTIAL: AN INITIAL ANALYSIS OF SOUTH AND EAST ASIAN TRADE

SHIRO ARMSTRONG, PETER DRYSDALE AND KALIAPPA KALIRAJAN
CRAWFORD SCHOOL OF ECONOMICS AND GOVERNMENT, AUSTRALIAN NATIONAL UNIVERSITY
SHIRO.ARMSTRONG@ANU.EDU.AU

Asian Trade Structures and Trade Potential: An Initial Analysis of South and East Asian Trade

Shiro Armstrong, Peter Drysdale, and Kaliappa Kalirajan[*]

Crawford School of Economics and Government
Australian National University

Abstract

A frontier of potential trade is constructed for trade flows from a world trade matrix of trade determinants to compare East Asian trade performance with that of South Asia. The results suggest that East Asian trade, led by ASEAN, is outperforming the world while South Asia lags behind significantly. Within East Asia, the transformation of Chian's trade performance is remarkable with its accession to the WTO. Australia is efficiently integrated with East Asia and performing close to its trade frontier. There is scope to lift intraregional trade among the East Asian economies but South Asia has even more unrealised potential, including within its own region.

---

[*] Correspondence to shiro.armstrong@anu.edu.au

Background

East Asian integration and trade performance, both within the region and outside the region, has fast become the model for market-driven economic integration and the benchmark to which other regions like South Asia are inclined to aspire. Starting with Japan in the immediate post war period, later with the newly industrialised economies of East Asia, and more recently with China, outward oriented growth policies and large scale economic reform and liberalisation have lifted the East Asian economies to being among of some of the most prosperous in the world.

By what measure might the trade performance of East Asian economies be judged? How can their performance be compared with the performance of other regions, like South Asia? How can the efficiency of trade integration be measured in both regions? This paper suggests one way of measuring trade performance and trade efficiency both within and between these two regional economies. It uses this measure to assess the performance of the Asian economies and compares South Asian trade performance, both intra regionally and inter regionally, with that of East Asia.

The paper is organised as follows. In the next section the concept and measurement of trade potential and trade performance are explained. The results of the analysis of Asian trade performance are presented and discussed in the section which follows. Regional differences and structures are compared before concluding.

Measuring trade potential

Trade and economic integration is a product of the scale and structure of partner economies, their geographic, political and institutional proximity and the openness of their economies to trade, investment and commercial participation by outsiders (Tinbergen, 1962; Linnemann, 1966; Drysdale and Garnaut, 1982; Harrigan, 2001).

Controlling for the first two elements, we can measure the impact of changes in policies of all kinds on trade potential and trade performance.

The gravity model of trade explains that trade between two economic bodies is determined by their masses and distance they are apart. Over time this model has come to be used extensively in explaining the effects of different policy and other determinants of trade flows with the key variables of economic size and distance always included.

Trade potential is the trade achieved at a *frontier* that estimates a level of trade that might be achieved in the case of the most open and frictionless trade possible given current trade, transport and institutional technologies or practices (Drysdale et al., 2000; Kalirajan, 2000; Armstrong, 2007). Trade performance (also referred to as trade efficiency) is then a measure of actual levels of trade against potential trade and can be estimated statistically using the stochastic frontier gravity model for all trade flows (Kalirajan and Findlay, 2005). This measure is relevant in the present context of examining the impact on trade performance not only of trade policy reforms, but also wider regulatory and economic reform. Trade performance is not only affected by policies which limit or promote exchange across national borders; it is also affected by policies, institutions and regulations that facilitate or inhibit trade and investment and promote openness right across the economy. Drawing on stochastic frontier methodology, trade potential is estimated using the gravity model of trade. Due to the somewhat arbitrary choice of policy variables and determinants of trade that have been included in estimating a gravity model, here we follow Armstrong (2007) and Kalirajan (2007) and make the distinction between natural, or core determinants such as geography, size, and language, and those which are manmade or policy variables which might affect trade such as trade agreements, customs unions and import restrictions. In this study we consider only the first set of determinants.

The stochastic frontier gravity model aims to capture trade resistances beyond the explicit resistances that are usually measured in gravity models of trade. The inclusion of a non-negative unobservable term, u in the stochastic gravity model, captures unobservable and

manmade resistances to trade (Armstrong, 2007) including behind the border resistances and barriers to international integration (Kalirajan, 2007; Imran and Kalirajan, 2007).

The conventional gravity model, which is mostly estimated by the ordinary least squares methods or some variant of this estimation method, estimates the mean effects of the determinants of trade and a bilateral trade flow's performance can be measured using the mean predicted value as a benchmark (Baldwin, 1994). The stochastic frontier version of the model shifts the benchmark, or reference point, to a frontier as measured by world trade flows.

Trade performance here means actual trade relative to potential trade, the realisation of potential trade.

The model used in this study is

$$\ln X_{ijt} = \beta_0 + \beta_1 \ln GDP_{it} + \beta_2 \ln GDP_{jt} + \beta_3 COMP_{ijt} + \beta_4 Dist_{ij} + \beta_5 Border_{ij} + \beta_6 Lang_{ij} + \left(v_{ijt} - u_{ijt} \right)$$

Where X_{ijt} is exports from country i to country j at time t; GDP_{it} is GDP of country i at time t; GDP_{jt} is the GDP of country j at time t; $COMP_{ijt}$ is a complementarity index between country i and country j at time t; $Dist_{ij}$ is the distance between country i and country j; $Border_{ij}$ is a variable equal to one if i and j share a common border; and $Lang_{ij}$ is an index of language similarity between countries i and j. v_{ijt} is normally distributed statistical error term. u_{ijt}, and, as discussed earlier, refers to the unobservable and manmade resistance to trade including behind the border resistances and is non-negative. It is assumed to follow a truncated normal distribution with mean μ and variance σ^2_u, truncated at the mean. The above model can be estimated using any one of the following programs: GAUSS, STATA, LIMDEP, and FRONTIER 4.1. Data sources, explanations of the construction of some variables and specification tests can be found in Appendix A.

Results of the analysis

Regressions were performed for four cross sections starting after the reforms in India in 1991, with values averaged for the periods 1993-95, 1996-98, 1999-01 and 2002-04. The top 68 trading economies world wide are in the sample (Appendix B). Results of the frontier regression by FRONTIER 4.1 are shown in Table 1 and selected trade efficiency results are shown in Tables 2 and 3.

All coefficients are statistically significant at the 1 per cent level and the signs are what as they would be expected to be. The larger two countries are, the more they trade and the further they are apart, the less they trade. Language similarity has a statistically significant effect but has little economic effect. A complementary trade structure with a partner helps explain trade as does sharing a border.

Mean trade performance over the sample years for East Asia, ASEAN, South Asia, EU and the world are shown in Tables 2, 3 and Figure 1.

Table 2 shows intraregional and interregional trade performance. World mean trade efficiency is relatively consistent but trending upwards slightly. Given the reductions in transportation and communications costs and the reduction of barriers to trade, both at the border and beyond the border, reflected in rapidly increasing world trade values, one might expect mean trade performance (efficiency) to be increasing at a faster rate. The nature of stochastic frontier analysis means that the more variation there is in trade performance, given the core determinants of trade, the lower average might be. The best performers push the elasticities higher and the frontier shifts outwards (an improvement in 'trade technology') meaning the average trade relationship has to keep up with the best performers for average to grow. In addition, world trade is becoming more distorted with the proliferation of preferential trade agreements (PTAs) which not only expand trade but also divert it (Viner, 1950), reducing trade efficiency (Garnaut, 2002; Productivity Commission, 2004; Panagariya, 2007; Garnaut and Vines, 2007).

Table 1 Frontier Maximum Likelihood Estimation Results

Dependent variable is log of exports from country i to j

	1993-95	**1996-8**	**1999-01**	**2002-04**
Constant	-17.36	-18.02	-18.92	-20.29
	(-34.6)	(-39)	(-36.7)	(-40)
ln GDPi	0.8	0.82	0.85	0.87
	(60.1)	(64.3)	(63.2)	(66.6)
ln GDPj	0.8	0.8	0.82	0.84
	(66.3)	(66.7)	(68.3)	(70.8)
COMPij	1.95	1.89	1.92	1.74
	(31.8)	(33.1)	(33.1)	(31.7)
Distij	-0.67	-0.68	-0.71	-0.67
	(-25.6)	(-27)	(-27.2)	(-25.7)
Border	0.44	0.35	0.4	0.48
	(3.5)	(2.8)	(3.1)	(3.8)
Languageij	0.0001	0.0001	0.0001	0.0001
	(7.8)	(7.6)	(6.4)	(8.9)
Sigma Squared	8.07	8.48	7.97	7.85
	(12.9)	(14.2)	(13.6)	(13.5)
Gamma	0.89	0.89	0.88	0.87
	(76.6)	(65.3)	(65.6)	(77)
mu	-5.36	-5.5	-5.29	-5.22
	(-8.1)	(-9.1)	(-7.9)	(-8.7)
Log likelihood ratio	-6797	-7010.6	-7181.8	-7233.9
observations	4049	4151	4227	4245

Notes: Numbers in parentheses are t-ratios. All coefficients are highly statistically significant. The number of observations differs because of missing values.
Source: Authors' calculations.

East Asian mean trade efficiency is higher than European mean trade efficiency but there is considerable variability in performance across Asia. ASEAN has extremely high trade efficiency. South Asian nations on the whole are well under the average of other economies for both trade outside the region and especially for trade within the region. These results will be discussed further in the next section.

Table 2 Selected Regional Trade Efficiency Results

Exporting Region	Importing Region	1993-95	1996-98	1999-01	2002-04
World Average		49	48	49	50
East Asia	East Asia	65	64	64	66
East Asia	South Asia	54	53	56	57
East Asia	World	57	57	58	59
World	East Asia	56	54	54	55
APEC	APEC	64	63	63	61
APEC	World	55	55	56	55
World	APEC	49	48	49	50
ASEAN	ASEAN	69	67	68	70
ASEAN	World	57	58	61	62
World	ASEAN	57	55	56	55
EU	EU	49	49	51	50
South Asia	South Asia	37	30	35	27
South Asia	East Asia	50	49	49	48
South Asia	World	44	44	45	45
World	South Asia	48	45	45	44

Source: Authors' calculations.

Table 3 breaks down some of the results for China and India as well as those of South Asia. Performance measures for each bilateral trade flow had been calculated for all periods. A window on the detailed results is provided in Appendix B which shows average export and import performance for each of the 67 countries during the last period.

Table 3 Selected Country Trade Efficiency Results

Exporter	Importer	1993-95	1996-98	1999-01	2002-04
World Average		49	48	49	50
Indian Trade					
India	East Asia	53	53	51	55
India	South Asia	24	25	21	36
India	World	44	44	45	47
East Asia	India	51	49	55	56
South Asia	India	37	37	40	37
World	India	40	39	43	45
Other South Asian Trade					
Sri Lanka	World	50	50	49	50
Pakistan	World	43	44	47	44
Bangladesh	World	39	35	38	38
World	Sri Lanka	55	51	49	49
World	Pakistan	53	50	44	39
World	Bangladesh	43	42	43	42
Chinese Trade					
China	East Asia	60	60	62	65
China	World	55	56	58	61
China	South Asia	50	48	48	56
East Asia	China	59	56	58	61
South Asia	China	30	27	33	42
World	China	50	43	47	53
Australian Trade					
Australia	World	52	53	53	51
World	Australia	48	48	50	49
Australia	East Asia	67	67	65	64
East Asia	Australia	67	67	68	69
Australia	South Asia	60	61	58	58
South Asia	Australia	53	52	51	48
Bilateral Flows					
China	India	47	44	45	51
India	China	29	30	34	46
China	Japan	55	55	55	59
Japan	China	55	54	51	55
India	Pakistan	24	31	25	38
Pakistan	India	44	52	48	36
India	Australia	57	54	51	52
Australia	India	39	42	43	55

Source: Authors' calculations.

Chinese trade and Indian trade

Indian exports to the rest of South Asia are notable for their underperformance against its trade potential. India's trade with East Asia performs better, and better on average than with the world at large. This relative trade performance is clearly affected by distortions in trade infrastructure that inhibits trade with South Asian partners, as well as frictions that are a product of political obstacles to trade. While the India-China relationship is also affected by political distance earlier, it has performed closer to the world average in the last half decade, notably after China's accession to the WTO and its commitment to the global trading regime and a rules based system which gives confidence to traders and investors and fosters trade growth independently of bilateral political difficulties. Most of the tariff and other liberalisations took place leading up to WTO accession but performance lifted significantly afterwards. The WTO effect for China illustrates that reducing subjective trade resistance or psychic distance (Linnemann, 1966; Drysdale and Garnaut, 1982) can lift trade performance (Armstrong, 2007).

Trade from Pakistan to India was performing at roughly the world average until the last period when there is a large drop. This is in direct contrast to China's trade with India.

India's and Pakistan's trade underperformance is also reported in Imran and Kalirajan (2007) who show that most of the trade gains occurred from reform and liberalisation of these economies behind the border, an argument also advanced by Panagariya (World Bank, 2007). Kalirajan and Singh (2007) also demonstrate that India's trade performance lags significantly behind China due to the persistence of both border and behind the border trade barriers.

Complementary Trade

An examination of the sensitivity of these results to the inclusion of the complementarity variable was carried out. Omitting the complementarity variable would lead Indian trade with its South Asian neighbours to perform much closer to its performance in world trade, a significant improvement. This underscores two points, one about India's trade policy and the other about the importance of the complementarity variable. It reveals that

India does not trade as fully as it might with its *natural* trading partners, those with whom it has complementary trade structures and complementary resource endowments. With further liberalisation and reform, both at the border and of institutional and other infrastructure behind the border, India's trade would increase substantially through efficient realization of its comparative advantage (Panagariya, 2008), especially with its South Asian neighbours, more in line with what world trade technologies and their proximity and relative size would suggest.

The importance of the inclusion of the complementarity variable as a determinant of trade (Drysdale, 1967) and in estimating the frontier (Armstrong, 2007) is shown not only in the estimates in Table 1 but with the effect on some relativities in the results[†]. The sensitivity test conducted here does not alter the world benchmarks in the analysis.

Overall, the results in Tables 2 and 3 appear very similar to those obtained without the inclusion of the complementarity variable. But the effects on those countries or trade relationships where policies take them away from their natural comparative advantage are significant. For trade relationships in which there is a high degree of complementarity the estimated potential trade level is higher. This is the case for India-South Asia trade where there is potential for significantly higher levels of trade.

South Asian Trade
Bangladesh and Pakistan's mean trade performance stand out as markedly below world average while Sri Lanka is roughly on par with the world benchmark. None of the South Asian economies has seen any improvement in their overall trade performance − they have not been able to outpace world trade performance, or catch up to it in some cases (Table 3). Given their size, geography, resource structures (represented by the complementarity variable) and language similarities, South Asian trade is not performing as well as it could. It is yet to realise a lot of its trade potential.

[†] Results from the sensitivity tests can be obtained from the corresponding author. They are not included here for parsimony in argument and to economise on space.

Table 2 reveals that South Asian trade with East Asia performed better than South Asian trade to the world. Intra-regional trade in South Asia performed worse than South Asian trade overall. Shared borders do not necessarily facilitate trade in South Asia as they do elsewhere in the world. There are not only, or mainly, political barriers but also a host of institutional barriers to trade in the region. Regionalisation of trade and production networks, such as that which has led to strong trade and output growth in East Asia, is underdeveloped in South Asia.

East Asia has benefited greatly from being able to host international production bases for a large number of manufacturing products and develop sophisticated production networks to cut production costs. Production networks are most prevalent in the electronics and automobile industries. This relatively new phenomenon is importantly a result of East Asian trade investment policies that have attracted international investors to take utilise differences in comparative advantage within the region. There has been strong commitment to regional and global policies that promote trade, investment and cross border links as well domestic reform and deregulation. Most, if not all, economies in the region have been able to participate in the production networks meaning that it is not only competition that is benefiting these economies but also complementarities in production, cooperation and spill overs.

Distance is a significant factor in economic integration with economies of scale and positive technology and human capital spill overs from agglomeration and clustering in economies in the same region (Palacios, 2006). Some regions in India have benefited from this but only on a small scale compared to China and without the breadth or reach that is possible when there are fewer institutional and policy resistances to trade and exchange both domestically and internationally. Such resistances to trade frequently have more to do with regulatory and institutional systems behind the border than they do with barriers at the border and are therefore susceptible only to unilateral national policy initiative (Dee, 2007).

Australia in Asia

Australian export performance worldwide is above the world average whereas import performance is roughly on par with the world average (Table 3). But, Australia exports very efficiently to East Asia, achieving 64 per cent of export potential in the period 2002-04. Although this was down slightly, from 65 per cent in an earlier period, it was still well above world average and similar to trade performance for intra-ASEAN trade (Table 2).

Australian trade integration with East Asia and intra-ASEAN trade are high performing outliers. Australia is also the most Asia-oriented economy in the world defined in terms of its trade share going to, and derived from, Asian economies.

Australia is now realising more of its export potential to South Asia, with exports at 58 per cent of their potential but exports from South Asia to Australia is trending downwards from potential falling below world average from 53 per cent to 48 per cent over the 12 years under study. Australia's trade performance with India is below that with South Asia as a whole except for Australian exports to India trending upwards and jumping remarkably to 55 per cent in the last period of analysis.

Australia's trade and economic reforms and flexible trade policy have seen it lift trade performance sharply over the last two decades and achieve rapid integration with the most dynamic traders and most dynamic regions in the world.

Regional trade and economic potential

There are stark differences between trade performance across regions. The European Union, a currency union with a long history of institution-led integration, and North America, one of the largest free trade areas, fall behind East Asia in terms of trade performance measured not only in average trade but also in intraregional trade.

Figure 1 Intra-regional Potential Trade Realisation
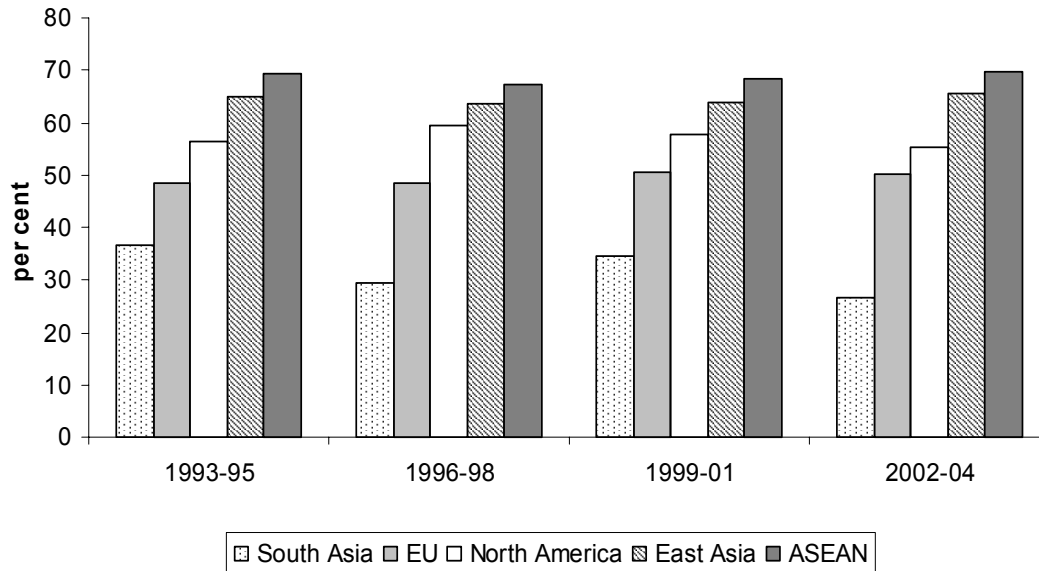
East Asian economies, and economies in APEC, have successfully reduced resistances to trade and are performing closer to their trade potential than countries elsewhere in the world. This performance is led by ASEAN (Figure 1). The target of regional integration strategies within Asia is to lift trade much closer to its potential level.

East Asian trade efficiency is high. Its intra-regional trade has remained steady over the twelve years with average intra East Asian trade achieving roughly 65 per cent of its potential. East Asian export performance rose slowly from 57 per cent to 59 per cent and remained roughly steady for imports around 55 per cent, both higher than world average. This reflects the openness to trade and other economic exchange among the East Asian economies and institutional developments that have supported stronger integration into the global economy. Importantly, trade performance among East Asian economies has remained stronger than trade performance between East Asian economies and the rest of the world.

Higher levels of confidence in trade among East Asian economies, most specifically with China, have played an important role in promoting the realisation of higher trade potential among the East Asian economies. There was a significant lift in China's

14

realisation of its trade potential after its accession to the WTO, both for imports and exports. An in-depth analysis of the impact of various arrangements that sustained and promoted stronger confidence in trade and international integration is the subject for a future study. There is clearly much scope for lifting trade closer to its full potential. The trade performance of some economies within East Asia is considerably higher than that of others.

The performance of intra-ASEAN trade efficiency, for example, is remarkable. In another study by Drysdale (2008), intraregional trade performance in ASEAN for the second half of the 1980s was lower (52%) than the intraregional trade performance in East Asia (59%), but ASEAN came to outperform other East Asian economies in the 1990s, and consistent with this study, climbed to 70 per cent, ahead of the figure of 65 per cent for all East Asia in the early 2000's. Drysdale (2008) uses the same specifications and data but different time periods.

The regional and global integration that has led to the achievement of higher levels of trade potential has also seen a reduction in the variation of trade performance of ASEAN trade among ASEAN economies (Figure 2). ASEAN economies' trade performance has converged towards a higher level. There is less variation evident in the trade performance of ASEAN, measured in this way, than there is among EU economies. A lower level of intra-regional ASEAN trade is often seen as an indicator of less successful integration. When the success of trade integration is measured properly so as to take account of the size, structure and geography of the region, as it is here, ASEAN trade integration emerges as a leading element in East Asian trade integration more broadly.

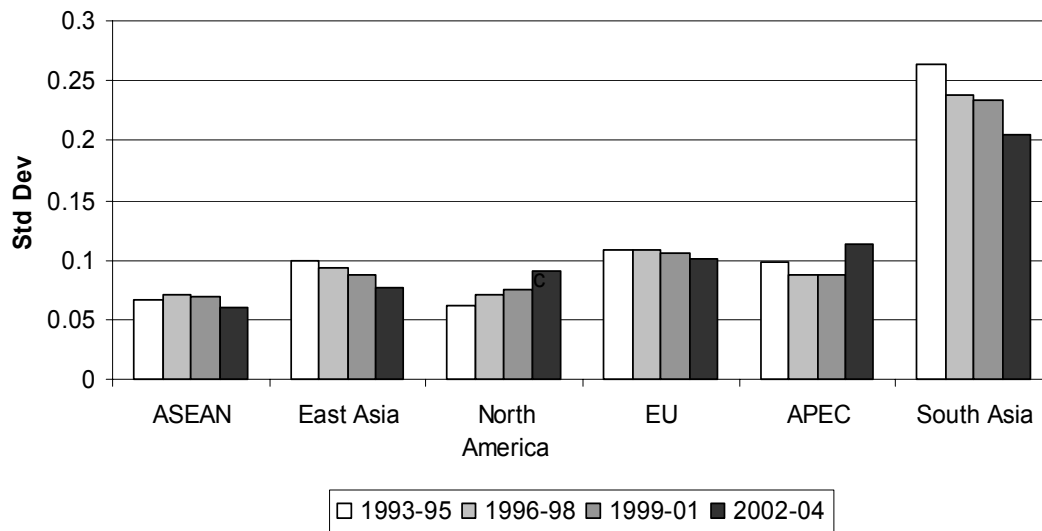**Figure 2 Variation of Trade Performance within Intra Regional Trade**

Figure 2 shows the variation of performance within a region of its members' intra regional trade. While East Asian and ASEAN intra regional trade performance converges among the economies in that region, there is a growing divergence in North America, despite NAFTA, and very little change in the EU. The remarkably high variation of intra regional trade performance in South Asia shows that regionalism in South Asia has been slower to evolve despite the growing convergence.

Note that this analysis does not provide evidence in support for trade policy which would necessarily give priority to the promotion of the South Asian free trade area (FTA). There is contrary evidence here and in other analyses of a similar kind (Productivity Commission, 2004). A preferential and discriminatory arrangement might be a diversion from integration with other dynamic regions such as East Asia. Thus far, India's look East policy has shown the benefits of this interregional orientation. Rather the lesson from East Asia is success of a region with high intraregional trade that has not discriminated against trade inter regionally. It has benefited not from narrow inward-looking regional integration but from global integration underpinned by fuller and fuller participation in the global trade regime. Its biggest single bilateral trade relationship, and one of the biggest in the world, continues to thrive and prospered despite bilateral

political ups and downs because it is now firmly embedded in the global trading system. It continues to depend on trading finished goods outside the region (Athukolara and Yamashita, 2006).

East Asian trade performance is similar to that in the APEC region, which also enjoys trade performance that is consistently higher than the world average. Although there is some evidence that NAFTA has weakened APEC's performance in recent years, trade performance is higher and variation lower among APEC members (even when the later members such as Peru, Mexico, Russia and Chile are included) than among EU countries. Trade performance within East Asia is also markedly higher than trade performance in South Asia, which has yet to catch up to world average potential performance.

Conclusion

Trade potential measured in this study is the trade achieved at a *frontier* that estimates a level of trade that might be achieved in the case of the most open and frictionless trade possible given current trade, transport and institutional technologies or practices. This measure is relevant to examining the impact of not only trade policy reforms, but also much wider infrastructure and institutional reforms, on countries' trade performance of examining the efficaciousness of regional trade integration.

The results in this study show that East Asian trade, led by ASEAN, has outperformed North America and Europe. South Asian trade has started to look east towards China and East Asia but there is still a long way to go in lifting trade performance in general and with East Asia, but especially in its own region. South Asian regionalisation, an important element in efficiency specialisation in the international economy lags well behind that in East Asia..

Some countries have been particularly successful in reducing trade resistances and lifting performance. China's WTO accession and Australia's commitments in East Asia are two important examples.

China's strong trade performance was boosted significantly after its accession to the WTO when it committed to the global economy through rules-based institutions. The fact that China's border trade liberalisation largely took place before its accession shows the importance of confidence in the reliability and strengthening of domestic market institutions in lifting trade performance.

Very high Australian trade performance with East Asia is an outlier along with ASEAN intraregional trade. Both Australia and ASEAN are cases in which broadly based domestic economic reform accompanied trade reform at the boarder, enabling both economies to achieve higher trade potential.

South Asia is yet to realise much of its trade potential, and still is much less efficiently integrated into international markets than the world on average. It is under-performing particularly in relation to East Asia.. Intraregional trade in South Asia is also well below potential compared with other regional groupings.

References

Armstrong, Shiro P. (2007) "Measuring Trade and Trade Potential: A Survey", *Asia Pacific Economic Papers*, No. 368.

Athukorala, Prema-chandra and Nobuaki Yamashita (2006) 'Production fragmentation and trade integration: East Asia in a global context', *The North American Journal of Economics and Finance*, Elsevier, vol. 17(3), pages 233-256, December.

Baldwin, R. (1994). *Towards an Integrated Europe*. London: CEPR.

Drysdale, Peter and Ross Garnaut (1982) 'Trade Intensities and the Analysis of Bilateral Trade Flows in a Many-Country World: A Survey', *Hitotsubashi Journal of Economics* 22(2):62–84.

Drysdale, Peter D. (1967) 'Australian-Japanese Trade', Canberra, Australian National University. Ph D. thesis.

_____ (1988) *International Economic Pluralism: economic policy in East Asia and the Pacific*, Allen and Unwin.

_____ (2008) 'Deepening Asian Integration and Regional Cooperation Arrangements', *EABER Working Paper* No. 30.

Drysdale, Peter D., Yiping Huang and Kaliappa Kalirajan (2000) 'China's Trade Efficiency: Measurement and Determinants', in P. Drysdale, Y. Zhang and L.

Song (eds) *APEC and Liberalisation of the Chinese economy*, Canberra, Asia Pacific Press: 259-71.

Ferrantino, M. (1997) Economic Distance, Cultural Distance, and Openness in International Trade: Empirical Puzzles, *Journal of Economic Integration* 12 (4) 456 - 484)

Garnaut, Ross (2002) "An Australia-United States free trade agreement", *Australian Journal of International Affairs*, Vol. 56, No. 1, pp.123-141.

Garnaut, Ross and David Vines (2007) 'Regional free trade areas: sorting out the tangled spaghetti', *Oxford Review of Economic Policy*, Volume 23, Number 3, 2007, pp.508–527.

Harrigan, J. 2001. 'Specialization and the Volume of Trade: Do the Data Obey the Laws?', National Bureau of Economic Research, NBER Working Papers, 8675.

Imran, Ullah Khan and Kaliappa Kalirajan, (2007) 'The Impact of the Components of Trade Costs on Export Growth: An Empirical Measurement', Foundation for Advanced Studies on International Development, Tokyo.

Kalirajan, Kaliappa. (2000). "Indian Ocean Rim Association for Regional Cooperation (IOR-ARC): Impact on Australia's Trade", Journal of Economic Integration 15: 533-547.

Kalirajan, K. and Findlay, C., (2005). 'Estimating Potential Trade Using Gravity Models: A Suggested Methodology, Foundation for Advanced Studies on International Development, Tokyo.

Kalirajan, Kaliappa and Kanhaiya Singh (2007) 'A Comparative Analysis of China's and India's Recent Export Performances', *Asian Economic Papers*, 2008, vol. 7, issue 1, pages 1-28.

Kalirajan, Kaliappa (2007), "Regional Cooperation and Bilateral Trade Flows: An Empirical Measurement of resistance." *The International Trade Journal*, Vol. XXI, No. 2, Summer 2007.

Kodde, David A. and Franz C. Palm, (1986) 'Wald criteria for jointly testing equality and inequality restrictions', *Econometrica* 54, 1243-1248.

Linnemann, H., (1966) *An Econometric Study of International Trade Flows*, North Holland Publishing Company, Amsterdam.

Palacios, Juan (2007), *Multinational Corporations and the Rise of a Network Economy in the Pacific Rim*, Routledge.

Panagariya, Arvind (2007) 'Trading Choices of South Asia', in World Bank (2007) *South Asia: Growth and Regional Integration*, http://go.worldbank.org/1OP9H7AFQ0

Panagariya, Arvind (2008) *India: The Emerging Giant*, Oxford University Press, USA

Productivity Commission (2004) *Rules of Origin under the Australia - New Zealand Closer Economic Relations Trade Agreement Research Report*, Productivity Commission Working Paper.

Tinbergen, J., (1962) *Shaping the World Economy: Suggestions for an International Economic Policy*, The Twentieth Century Fund, New York.

Viner, J., (1950) *The Customs Union Issue*, Carnegie Endowment for International Peace, New York.

Appendix A

Data and Methodology Details

Trade data are from the IMF's Direction of Trade Statistics (various years) and gaps in the data are filled in from the STARS data base, International Economic Databank (IEDB). Imports were used for all flows[‡]. GDP data are from the World Development Indicators (WDI) and at current prices. The complementarity index used here is from Drysdale (1967) and Drysdale and Garnaut (1982),

$$C_{ij} = \sum_k \left(\frac{X_i^k}{X_i} \cdot \frac{M_w - M_i}{M_w^k - M_i^k} \cdot \frac{M_j^k}{M_j} \right)$$

where X is exports, M is imports, subscripts denote country (i, j and world) and superscript k implies commodity k. The index is calculated at the three digit level from UN Comtrade data at the three digit level for all combinations of countries and years. The index captures the complementarity of trade structures between countries and the higher the index implies a higher degree of complementarity.

The language index is based on Ferrantino (1997) and is an index that takes a value of 0 if none of the population of country i speaks the same language as in country j and a value of 10,000 if all of the population in both countries speak the same language.

Specification tests

Likelihood ratio tests, to determine the specification of the model, were performed to determine the appropriateness of the methodology for the data and the statistical distribution of the non-negative residual.

The first test for $\gamma = 0$ (the alternative is is $\gamma > 0$) to test whether a one sided error is appropriate for the data. Gamma is the proportion of total variation that is explained by variation in the non-negative disturbance and is given by

---

[‡] Importers have less incentive to under-report and imports are a more accurate reflection of trade flow values than reported exports. The exception is European trade where there is tax incentive to under report imports due to the value added tax structure but import flows were used for consistency.

$$\gamma = \frac{\sigma_u^2}{\sigma_u^2 + \sigma_v^2}$$

where σ_v^2 is the variance of v_{ij} and σ_u^2 is the variance of u_{ij}. The results in Table 1 confirm γ is significantly different from zero and suggest between 87 per cent and 89 per cent of the total variation is coming from the non-negative term that captures the influence of unobservable and manmade constraints on trade. The u_{ij} term measures the distance of individual countries/regions from the frontier. For more details, see Kalirajan and Singh (2007).

The second null hypothesis that the mean, $\mu = 0$ (alternative is $\mu \neq 0$) which means that the restricted folded normal distribution is preferred to unrestricted truncated normal distribution. This null is also rejected indicating a truncated normal distribution fits the non-negative error term better than a half normal distribution. This does not impact on the relative sizes of the trade efficiencies greatly but changes the absolute values. It is not the absolute distance of trade performance to the frontier that is important but the distance relative to other trade flows from the frontier.

The likelihood ratio test statistics are given by

$LR = -2[\ln L(\text{restricted}) - \ln L(\text{unrestricted})]$

with a mixed χ^2 distribution reported in Table 1 of Kodde and Palm (1986). Table 4 shows the results of the statistical tests for the last period only as all periods reach the same conclusion.

Table 4 Specification Tests

Null Hypothesis	2002-04 χ^2 statistic	Critical mixed-χ^2 value at 0.01	Decision	Conclusion
$\gamma = 0$	201.52	8.273	Reject null	The composite error specification is appropriate
$\mu = 0$	67.144	6.635	Reject null	The truncated normal distribution fits the data better than the special half normal distribution

Appendix B

Table 5 Average Export and Import Performance for All Countries, 1992-2004

	Exports	Imports		Exports	Imports
Argentina	47	40	Jordan	38	54
Australia	52	49	Malaysia	65	60
Austria	44	44	Malta	48	53
Bangladesh	38	43	Mexico	41	48
Belgium	55	59	MUS	42	53
Brazil	53	47	Netherlands	55	59
Bulgaria	53	50	New Zealand	57	49
Canada	48	54	Nicaragua	41	53
Chile	57	51	Nigeria	50	47
China	57	48	North Korea	45	45
Colombia	46	43	Norway	50	45
Costa Rica	52	45	Pakistan	45	46
Cyprus	40	48	Panama	59	40
Denmark	51	45	Paraguay	39	44
Dominican Rep	30	43	Peru	46	45
Ecuador	55	45	Philippines	49	51
Egypt	35	44	Poland	44	49
El Salvador	32	43	Portugal	41	52
Finland	52	48	Russia	54	40
France	47	50	Singapore	66	66
Germany	52	54	South Africa	59	55
Ghana	46	55	South Korea	58	56
Greece	33	45	Spain	45	52
Honduras	46	49	Sri Lanka	50	51
Hong Kong	61	59	Sweden	54	49
Hungary	46	50	Switzerland	53	46
India	45	42	Taiwan	50	65
Indonesia	60	49	Thailand	60	58
Iran	47	46	Turkey	43	51
Ireland	55	48	UK	50	53
Israel	51	50	Uruguay	51	46
Italy	49	51	USA	49	54
Jamaica	39	48	Venezuela	46	39
Japan	52	42	Vietnam	57	49
	49	**49**	**World Average**	**49**	**49**

Source: Authors' calculations