

Brunei Darussalam's Trade Potential and ASEAN Economic Integration: A Gravity Model Approach

Wee Chian Koh

Research Department, Centre for Strategic and Policy Studies,

Buau, Brunei Darussalam

Corresponding author: wc.koh@anu.edu.au

Abstract

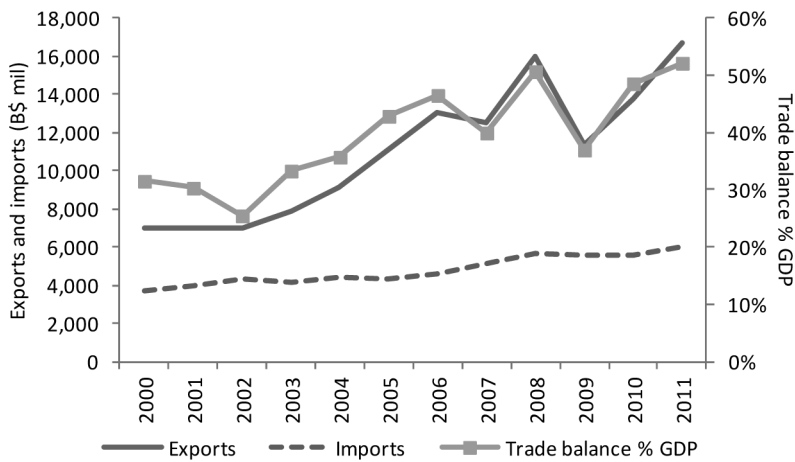
This article uses an augmented gravity model estimated using panel data and stochastic frontier methods to investigate the determinants of Brunei Darussalam's trade from 2000 to 2011 and also estimate its trade potential. We find that GDP, population, colonial relationship and trade agreements have positive effects on the level of trade, while distance affects trade negatively. We also find that Brunei's trade potential is relatively low, indicating the presence of significant 'behind the border' inefficiencies, but these inefficiencies have been decreasing over time. In addition, we investigated whether AFTA is trade creating or trade diverting. Based on data from 1987 to 2011, we find positive and significant trade creation effects. Results from the stochastic frontier gravity model also suggest that 'behind the border' inefficiencies for ASEAN as a whole have decreased over time.

Keywords: Gravity Model, Stochastic Frontier, Brunei Darussalam, AFTA

Introduction

Brunei Darussalam is endowed with an abundance of oil and gas, which has accounted for more than half of its GDP and more than 90 per cent of exports and government revenue over the past two decades. The accumulated wealth earned primarily from hydrocarbon exports has allowed the Government to fund a large public sector, maintain an extensive welfare system and invest heavily in health, education and infrastructure to ensure a high standard of living. International trade therefore plays an important role in Brunei’s economic growth and development as a small open economy. Brunei’s major trading partners are ASEAN-5¹, China, India, Japan, Korea, United Kingdom and United States, which comprised about 96 per cent of total exports and 89 per cent of total imports in the past two decades. Typical of resource rich nations, exports are volatile and fluctuate with global price movements. Despite declining oil production and increased imports, Brunei has managed to achieve a healthy current account surplus due largely to high oil and gas prices. Figure 1 displays key trade statistics.

Figure 1: Brunei Darussalam’s trade performance, 2000-2011



Source: Department of Economic Planning and Development (2012).

1 ASEAN is the acronym for Association of Southeast Asian Nations; ASEAN-5 refers to Indonesia, Malaysia, Philippines, Singapore and Thailand.

Resource abundance can be both a blessing and a curse². Economic diversification has generally not been successful in Brunei despite decades of development planning programmes aimed at creating a vibrant private sector to stimulate economic growth, which has averaged only 1.7 per cent over the past two decades, and is the lowest among ASEAN countries. Several studies have identified the causes of low growth such as the large public sector crowding out the labour market (Crosby 2007) and weaknesses in the enabling environment (Bhaskaran 2010). The Government has taken serious steps in removing institutional impediments and the results are reflected in Brunei's improved rankings in the World Competitiveness Index³ (WCI) from 39th in 2008 to 28th in 2012 (World Economic Forum 2012), and also in the Ease of Doing Business⁴ (EODB) rankings from 94th in 2009 to 79th in 2013 (World Bank 2013).

Given the importance of trade and institutional factors in economic performance, it is indeed surprising that there are very few, if any, papers in the literature on evaluation of Brunei's trade performance. To the best of my knowledge, this paper is the first to investigate the determinants and estimate the potential of Brunei's trade, including the extent of 'behind the border' trade barriers, by using both an augmented version of the standard gravity model (see Anderson & van Wincoop 2003) and a stochastic frontier gravity model suggested by Kalirajan and Findlay (2005) and Armstrong (2007).

Brunei takes on the chair of the ASEAN in 2013 and with the ASEAN Economic Community (AEC) deadline in 2015 looming, it is perhaps timely to also investigate how successful ASEAN has been in terms of economic integration since the formation of the ASEAN Free Trade Area (AFTA) in 1992 when Brunei, Indonesia, Malaysia, Philippines, Singapore and Thailand agreed to enhance ASEAN's competitiveness through the Common Effective Preferential Tariff (CEPT) scheme to lower intra-regional tariffs to 0-5 per cent

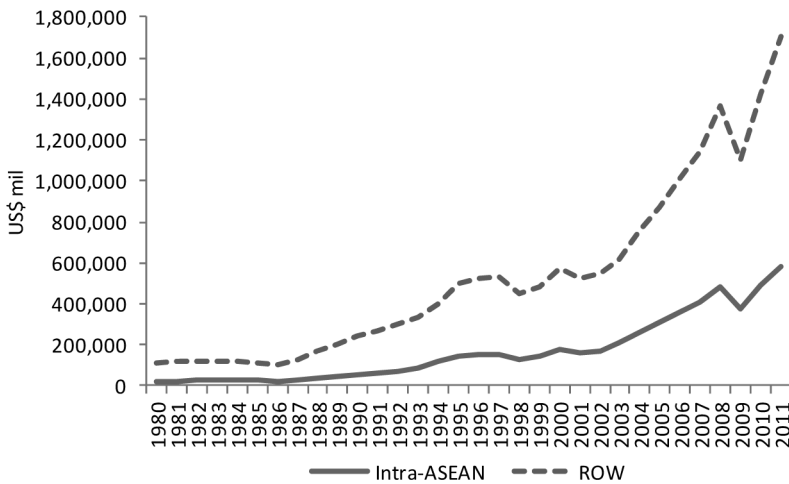
2 For a survey of the literature on resource curse, see van der Ploeg (2011).

3 WCI looks at a country's competitiveness based on twelve pillars, which include health, education, infrastructure and market efficiency.

4 EODB ranking methodology involves a distance-to-frontier measure of a country's business regulatory practices converging towards highly efficient high-income economies.

within a fifteen year period starting from 1993. Vietnam joined AFTA in 1995, Laos and Myanmar in 1997, and Cambodia in 1999. Both intra-ASEAN trade and trade with the rest of the world (ROW) have increased substantially since the later part of the 1980's, with strongest sustained growth in the periods from 1987-1996 and from 2002-2008. The Asian financial crisis in 1997 took a major toll on the region's trade, and so did the dot com bubble burst in 2000 and the 2008 global financial crisis (GFC). ASEAN's total trade has rebounded since and surpassed US\$2 billion in 2011. Figure 2 below displays trends in ASEAN trade.

There are several studies in the literature that applies the gravity model framework in determining whether AFTA leads to trade creation or trade diversion; however, the conclusions are mixed. Frankel (1997), Elliott and Ikemoto (2004), Nguyen and Hashimoto (2005) and Urata and Okabe (2007) found significant positive effects for AFTA, in contrast to the findings by Endoh (2000), Solaga and Winters (2001) and Hapsari and Mangunsong (2006). It is difficult to reconcile the contrasting results from these studies due to differences in time periods, sample size, data type (aggregated or disaggregated), estimation type (cross-sectional or panel), econometric method (ordinary least squares (OLS), fixed effects, random effects, generalized method of moments (GMM), Hausman-Taylor) and model specifications. Nevertheless, this paper will add to the debate by employing both panel data and stochastic frontier methods, supplemented by shift-share analysis. The novelty in this paper will be the use of a more recent dataset from 1987 to 2011 and the application of a stochastic frontier gravity model to better understand whether trade inefficiencies for ASEAN as a group have increased or reduced over the years.

Figure 2: ASEAN trade, 1980-2011 (US\$ millions)

Source: IMF (2012).

The rest of the paper is organised as follows. Section 2 provides a brief literature review of the gravity model and the stochastic frontier approach. Data and methodology used in estimating Brunei's trade potential and AFTA trade effects are presented in Section 3, along with a discussion of the empirical results. Section 4 concludes.

2. Literature Review on Gravity Model and Stochastic Frontier

Since the seminal work of Tinbergen (1962), the gravity model has been applied extensively in analysis of bilateral international trade flows. In its basic form, by analogy with Newton's "Law of Universal Gravitation", the gravity trade equation postulates that the size of bilateral trade flows between two countries (X_{ij}) is proportional to the economic sizes ($Y_i Y_j$) of the two countries, proxied by gross domestic product (GDP), and inversely proportional to their economic distance (D_{ij}), usually represented by physical distance:

$$X_{ij} = K(Y_i Y_j / D_{ij}) \quad (1)$$

However, early criticisms point to the lack of theoretical foundations in the gravity model. Anderson (1979) was the first attempt to provide a theoretical basis for the gravity equation based on a demand function with

constant elasticity of substitution (Armington preferences) where goods were differentiated by country of origin. Bergstrand (1985, 1989) showed that the gravity model can be derived following a trade model based on monopolistic competition. Most applied work based on theoretically-grounded gravity models pay tribute to an important paper by Anderson and van Wincoop (2003), where they showed that controlling for relative trade costs is vital for a well-specified gravity model. By excluding their so-called “multilateral resistance” terms which are correlated with trade costs, they argued that the model will suffer from omitted variables bias and hence OLS will produce biased and inconsistent coefficient estimates. A possible method to resolve this is the use of county-specific fixed effects; however, a major restriction is that time-invariant variables cannot be included in the model as they are perfectly collinear with the fixed effects.

Baldwin and Taglioni (2006) summarises the errors frequently encountered in applied work. The “gold medal error” is the omission of the “multilateral resistance” terms mentioned above; the “silver medal error” refers to incorrect averaging of bilateral trade — taking the log of average trade flows instead of the average of the logs; the “bronze medal error” occurs when trade values are wrongly deflated using an inappropriate price index. Other important issues are endogeneity, the zeros problem and heteroscedasticity. Endogeneity issues often arise in estimating the impact of trade policies as the causal link between trade policies and trade flows can proceed in either directions. Unfortunately, this is difficult to solve; instrument variables and GMM techniques have been used but they suffer from selecting an appropriate instrument and the number of lags, respectively. The problem of zero trade flows is more pertinent when using disaggregated data, where there is significant presence of either no trade or missing information. Two approaches have been used to correct for this — sample selection correction by Heckman (1979) and Poisson pseudo-maximum likelihood estimator by Santos Silva and Tenreiro (2006). The imprecision in model specification by not capturing economic distance between countries properly leads to heteroscedasticity, though fixed effects models (FEM) can tackle this issue. However, Kalirajan (2008) pointed out that FEM are not formulated based on economic theory and proposed the use of stochastic frontier approach to capture country-specific constraints that

are not explicitly modelled in standard gravity equations, which have typically included only physical distance and not social-political and institutional factors.

Stochastic frontier analysis was developed independently by Aigner et al. (1977) and Meeusen and van den Broeck (1977), recognising that technical inefficiencies exist in firms' production. Hence realised output falls short of its potential on the production frontier, and they showed that the error term can be decomposed into a non-negative term which captures the production inefficiencies and a random term reflecting measurement errors and exogenous shocks.

Kalirajan and Singh (2008) highlighted that trade flows are constrained by three factors: (i) natural constraints, such as population, income, geographical distance and transport costs; (ii) 'behind the border' constraints, which are institutional and infrastructural rigidities in the exporting country; and (iii) 'beyond the border' constraints, which consist of explicit constraints which can be modelled explicitly such as import tariffs, and implicit ones stemming from institutional and infrastructural rigidities in the importing country, which are difficult to measure. The stochastic frontier gravity model combines the gravity model and the stochastic frontier approach, with the non-negative error term representing 'behind the border' inefficiencies in the exporting country that prevents it from reaching its trade frontier, and the random term captures all other disturbances including 'implicit beyond the border'.

The stochastic frontier gravity model takes on the following form:

$$X_{ijt} = f(Z_{ijt}, \beta) \exp(v_{ijt} - u_{ijt}) \quad (2)$$

where X_{ijt} are trade flows from country i to country j at time t , $f(Z_{ijt}, \beta)$ is a function of a vector of trade determinants and a vector of parameters to be estimated, v_{ijt} is an independently and identically distributed (iid) error term with a Normal distribution of mean zero and variance σ_v^2 , and u_{ijt} is a non-negative iid term with a truncated half-Normal distribution with mean μ and variance σ_u^2 .

As the stochastic frontier approach allows measurement of distance from the frontier, the framework is therefore ideal in measuring trade potential

as the maximum possible using the most efficient trade policies observed. This is more desirable compared to the estimation of trade potential in conventional gravity models where the average values are used. For example, in estimating Australia's trade potential, Rahman (2009) applied a gravity model on cross-section data for 2001 and 2005 using OLS and found that Australia has overtraded⁵ with more than half of its trading partners. In contrast, Miankhel et al. (2009) used a stochastic frontier gravity model for data from 2006 to 2008 and found overtrading in less than 10 per cent of its trading partners.

3. Data and Methodology

The basic gravity model in equation (1) can be represented in log-linear form and we can augment the model by adding other variables. In addition to GDP and distance, we include population, absolute value of per capita GDP differentials between exporter and importer, importer's mean tariff rate on primary products⁶, bilateral real exchange rate and dummy variables for language, colony and trade agreements.

Countries with smaller populations tend to trade more due to the insufficient supply of the domestic market to meet demand. Therefore we expect a negative coefficient for the population variable. However, it is also possible that a larger population creates more opportunities for trade in a wider variety of goods; hence the coefficient will be positive in this case. Per capita GDP differential is a test of the Linder (1961) hypothesis which suggests that trade will be higher for countries with similar levels of income. However, according to the Heckscher-Ohlin theory, trade will be higher if there are larger differences in factor endowments in the two countries. Therefore, according to the Linder hypothesis we should expect a negative coefficient, but a positive one based on Heckscher-Ohlin theory.

The importer's tariff rate can have an effect on export flows. If import tariffs are reduced, exports are expected to increase hence we expect a negative

⁵ Overtrade means that actual trade is higher than estimated potential trade.

⁶ Importer's mean tariff rate on primary products is used since more than 90 per cent of Brunei's exports are oil and gas. This is preferable instead of using the mean tariff rate of all imported products.

coefficient for tariffs. Depreciation of the exporter's currency is expected to increase exports and likewise, appreciation of the importer's currency will likely lead to increased imports. Therefore we expect the coefficient of the real exchange rate to be positive for exports and negative for imports. In addition to physical distance as a potential impediment to trade, cultural and language differences might also hinder trade. We expect countries that share the same language to trade more. Likewise, we also expect countries that have had colonial links or relationships to have higher trade and therefore positive coefficients for both the language and colony dummy variables. If both exporting and importing countries belong to a trade agreement, we expect higher trade and hence a positive coefficient for the trade agreement dummy variable.

Data on bilateral exports and imports are from IMF (2012). GDP, per capita GDP, importer's mean tariff rate on primary products, official exchange rate and consumer price index (CPI) are obtained from World Development Indicators (WDI)⁷. The bilateral nominal exchange rate is calculated by dividing the domestic country's official exchange rate by the partner country's official exchange rate since the official exchange rate in WDI is expressed as domestic currency per US dollar. The bilateral real exchange rate is then calculated by multiplying the bilateral nominal exchange rate with the ratio of the domestic country's CPI to the partner's CPI. Therefore a fall in the real exchange rate represents currency appreciation for the domestic country. Geodesic distance and dummy variables for border, language and colony are taken from the CEPII dataset⁸. The language dummy is set to one if both countries share either the same official language and or a language spoken by at least nine per cent of the populations in the two countries. For instance, the official language of Brunei is Bahasa Melayu while that of Indonesia is Bahasa Indonesia, but both languages are in fact very similar; hence the construction of this language dummy variable to reflect cultural and language barriers. Colony is set to one if both exporter and importer have had a colonial link or relationship, reflecting similarities in either the political or legal systems which can have positive effects on trade facilitation. A dummy variable for

⁷ <http://data.worldbank.org/data-catalog/world-development-indicators>

⁸ http://www.cepii.fr/CEPII/en/bdd_modele/bdd.asp

trade agreement is set to one if it is in existence for both exporter and importer at time t .

3.1 Estimation of Brunei's exports

Brunei's exports to its top 40 export partners which make up 99.9 per cent of total exports from 2000 to 2011 are modelled as:

$$\log(X_{ijt}) = \beta_0 + \beta_1 \log(GDP_{it}) + \beta_2 \log(GDP_{jt}) + \beta_3 \log(POP_{it}) + \beta_4 \log(POP_{jt}) + \beta_5 \log(PCGDPD_{ijt}) + \beta_6 \log(DIST_{ij}) + \beta_7 \log(1 + TARIFF_{jit}) + \beta_8 \log(RER_{ijt}) + \beta_9 LANG_{ij} + \beta_{10} COL_{ij} + \beta_{11} RTA_{ijt} \quad (3)$$

where X_{ijt} = exports from Brunei to country j in year t ,

GDP_{it} (GDP_{jt}) = Brunei's GDP (country j 's GDP) in year t ,

POP_{it} (POP_{jt}) = Brunei's population (country j 's population) in year t ,

$PCGDPD_{ijt}$ = absolute value of per capita differential of Brunei and country j in year t ,

$DIST_{ij}$ = distance between Brunei and country j ,

$TARIFF_{jit}$ = country j 's mean tariff rate on primary products in year t ,

RER_{ijt} = bilateral real exchange rate between Brunei and country j in year t ,

$LANG_{ij}$ = common language of Brunei and country j (dummy variable),

COL_{ij} = colonial link or relationship of Brunei with country j (dummy variable),

RTA_{ijt} = trade agreement of Brunei with country j in year t (dummy variable).

The augmented gravity model for Brunei's exports is estimated using pooled OLS, fixed effects model (FEM), random effects model (REM) and the stochastic frontier approach (SFA). The results are reported in Table 1 in the Appendix.

As discussed in Section 2 above, OLS will likely produce biased and inconsistent estimates due to heterogeneity across countries, but the results are included in Table 1 as a reference. Panel data methods can mitigate this bias and the decision to use either FEM or REM is based on Hausman test. Results in Table 1 show that the test does not reject the null hypothesis that there are substantial differences between fixed and random effects, hence

REM is preferred. We also conduct the Breusch-Pagan Lagrange Multiplier (LM) test and conclude that there are random effects, hence pooled OLS is inappropriate. Based on the REM, importer's GDP and population, distance, colony and RTA are significant and have the expected signs. Exporter's GDP and population, per capita differential, language and import tariff are not significant. The bilateral real exchange rate is significant but has the incorrect sign. A possible explanation is that oil and gas demand, which make up predominantly Brunei's exports, is both price and exchange rate inelastic since there is usually excess demand from Brunei's trading partners who are net importers of oil and gas. This is supported by Cooper (2003) where he found that the short and long-run price demand elasticities for major economies to be highly inelastic using data for 1979-2000. Dargay et al. (2007) also came to the same conclusion for OECD countries using data for 1971-2006. Although De Schryder and Peersman (2012) found that oil demand is more responsive to exchange rate movements than price movements, their findings confirm that exchange rate sensitivity has declined over time for the 1971-2008 sample period.

The results for SFA are similar to that of REM, except that Brunei's population is significant but importer's population is no longer significant. Gamma (γ) is large and highly significant, which means that country-specific 'behind the border' factors are responsible for a large portion of the total variation in the model, justifying the use of a stochastic frontier model to estimate export potential. Eta (η) is positive and also highly significant, suggesting that these country-specific constraints have been decreasing over time, in support of Brunei's improvement in the WCI and EODB rankings as mentioned in Section 1. Using the SFA coefficients to estimate Brunei's potential exports, we find that on average, Brunei has achieved only 25 per cent of its export potential over the twelve-year period from 2000 to 2011. The results are reported in Table 2 in the Appendix.

3.2 Estimation of Brunei's imports

Using a similar specification, Brunei's imports from its top 40 import partners which make up 99.8 per cent of total imports from 2000 to 2011 are modelled as:

$$\log(M_{ijt}) = \beta_0 + \beta_1 \log(GDP_{it}) + \beta_2 \log(GDP_{jt}) + \beta_3 \log(POP_{it}) + \beta_4 \log(POP_{jt}) + \beta_5 \log(PCGDPD_{ijt}) + \beta_6 \log(DIST_{ij}) + \beta_7 \log(RER_{ijt}) + \beta_8 LANG_{ij} + \beta_9 COL_{ij} + \beta_{10} RTA_{ijt} \quad (4)$$

where M_{ijt} = imports from Brunei to country j in year t , and the other variables are as defined in Section 3.1 above. Results are summarised in Table 3 in the Appendix.

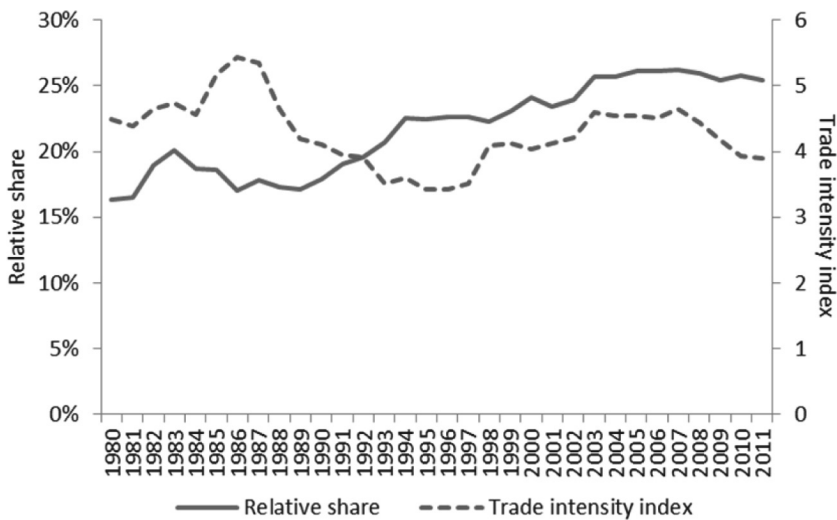
Based on both the LM and Hausman tests, REM is the preferred model. GDP and population for both Brunei and its partner countries, distance, colony and RTA are significant and have the expected signs. Per capita GDP differential, language and bilateral real exchange rate are found to be insignificant. Under the SFA model, in addition to the significant variables under REM, language and bilateral real exchange rate are also significant. However, the real exchange rate has the opposite sign, but the coefficient is very small and is only significant at the 10 per cent level. Using the SFA to estimate Brunei's import potential, we find that Brunei has achieved 56 per cent of its potential over the time period from 2000 to 2011, more than twice that of exports. Consistent with the results for exports in Section 3.1, both gamma and eta are highly significant suggesting the presence of 'behind the border' inefficiencies but also reinforcing the improvement in these country-specific inefficiencies over time. In sharp contrast to exports, Brunei's imports from its main trading partners are high relative to its potential, reaching an average of 81 per cent of its potential. Results are reported in Table 4 in the Appendix. A possible reason for the difference in potential between exports and imports is the relatively wider variation (refer to notes in Tables 2 and 4) and higher concentration of exports to Brunei's main trading partners (see Section 1). However, the most important inference to draw out from these potential estimates is that country-specific inefficiencies exist and are large but are decreasing over time.

3.3 ASEAN Economic Integration

As shown in Figure 2 above, intra-ASEAN trade has increased substantially since the formation of AFTA in 1992. Two simple measures in the trade literature, relative share (RS) and trade intensity index (TII), are

used to show the impact AFTA has on intra-regional trade. RS is the share of ASEAN countries' trade in their overall trade and is calculated as $RS = A_{ii} / A_{ij}$; TII measures the intensification of ASEAN members' relationship and is calculated as $TII = (A_{ii} / A_{ij}) / (A_{ij} / A_{jj})$, where A_{ii} = intra-ASEAN trade, A_{ij} = ASEAN's trade with the rest of the world and A_{jj} = total world trade.

Figure 3: ASEAN relative share and trade intensity index, 1980-2011



Source: Calculated using data from IMF (2012).

As seen in Figure 3, RS increased from 18 per cent in the 1980s to 25 per cent in 2011. TII was high in the early to mid-1980s and then fell until AFTA was formed, which then began to increase until the 2008 GFC impacted global trade, but is still high at around 4. Both RS and TII therefore indicate strong trade relationships among members. However, from these measures we cannot make any conclusions as to whether AFTA is trade-creating or trade-diverting. The gravity model is a useful tool to investigate this question. We use a similar specification as in Section 3.2 for ASEAN imports and add two dummy variables indicating whether both countries i and j are in AFTA at time t (bothAFTA_{ijt}) or whether only the importer is in AFTA at time t but not the exporter (oneAFTA_{ijt}). If post AFTA formation, country i imports more from country j (where i and j are in AFTA) but imports less from non-AFTA

country k , this suggest trade diversion. On the other hand, if i imports more from both j and k , trade creation is likely. We therefore model ASEAN imports (Q_{ijt}) from its top 50 import partners which make up 94.8 per cent of total imports from 1987 to 2011 as:

$$\begin{aligned} \log(Q_{ijt}) = & \beta_0 + \beta_1 \log(GDP_{it}) + \beta_2 \log(GDP_{jt}) + \beta_3 \log(PCGDP_{it}) + \\ & \beta_4 \log(PCGDP_{jt}) + \beta_5 \log(PCGDPD_{ijt}) + \beta_6 \log(DIST_{ij}) + \beta_7 \log(RER_{ijt}) + \\ & \beta_8 LANG_{ij} + \beta_9 COL_{ij} + \beta_{10} oneAFTA_{ijt} + \beta_{11} bothAFTA_{ijt} \end{aligned} \quad (5)$$

If both the coefficients for *oneAFTA* and *bothAFTA* are positive and significant, then we say there has been trade creation. If *oneAFTA* is positive but *bothAFTA* is negative, then it is likely that there is trade diversion. Results are in Table 5 in the Appendix.

The LM test suggests using REM but the Hausman test suggests that FEM is preferred. Under FEM, all variables are significant except for Brunei's population and the real bilateral exchange rate. Under REM, all variables are highly significant and have the expected signs. Per capita GDP differential is positive in both models, which supports the Heckscher-Ohlin theory instead of the Linder hypothesis. What is crucial is that in both models, the two AFTA dummy variables are positive and highly significant, providing evidence of trade creation. All results from the SFA are the same as REM's, lending further support for AFTA trade creation effects. Gamma is large and highly significant; hence 'behind the border' effects are very important for ASEAN as a whole. Eta is positive and also highly significant, suggesting improvements in "behind the border" constraints, though the value of eta is small.

We provide another complementary measure of AFTA trade creation by a simple shift-share analysis following Cabalu and Alfonso (2007). The base years before the formation of AFTA are chosen as 1987-1989 to calculate the import shares of ASEAN countries. Based on this fixed share, we then calculate the hypothetical imports of ASEAN countries after the formation of AFTA, and the difference between the actual and hypothetical imports will be the shift. If the increase in imports among ASEAN countries comes at the expense of imports from the rest of the world, this indicates trade diversion. If imports increase for both intra-ASEAN and with the rest of the world (ROW),

then this is indication of trade creation. Table 6 below displays the results. We see clearly that imports have increased both for ASEAN and ROW, providing another piece of evidence of AFTA trade creation.

Table 6: ASEAN shift-share analysis (US\$ billions)

Year	ASEAN imports	ASEAN exports to ASEAN	ASEAN exports to ASEAN using constant share	Change due to ASEAN share changes	ROW imports	ASEAN exports to ROW	ASEAN exports to ROW using constant share	Change due to ROW share changes
1991	174.32	32.78	32.49	0.29	3,343.09	126.05	103.47	22.58
1996	353.52	84.05	65.89	18.15	4,833.31	242.24	149.59	92.65
2001	317.43	86.33	59.17	27.16	5,813.61	282.25	179.93	102.32
2006	624.94	191.39	116.49	74.90	11,274.14	550.09	348.93	201.16
2011	1,097.32	308.95	204.54	104.41	16,530.92	876.82	511.63	365.19

Source: Calculated using data from IMF (2012).

4. Conclusion

This paper uses an augmented gravity model estimated using both panel data and stochastic frontier methods to investigate the determinants of Brunei Darussalam's exports and imports, as well as estimate the trade potential. GDP, population, colonial relationship and trade agreements positively affect both exports and imports, while distance has a negative impact. Brunei's actual exports and imports have achieved 25 and 56 per cent of their potential, respectively. This therefore implies that country-specific 'behind the border' inefficiencies are large. On a positive note, inefficiencies have been decreasing over time, which is reflected in Brunei's improved rankings in the WEF World Competitiveness Index and the World Bank Ease of Doing Business. However, specific policy recommendations cannot be made as to the factors which have contributed to these improvements, or more importantly the factors which have impeded higher gains, without an elaborate inefficiency model due to data limitations. It is envisaged that as trade facilitation data for Brunei becomes available, which should include port efficiency, customs administration, measures of infrastructure and logistics, and regulatory environment;

it will then possible to estimate both trade potential and inefficiency using a specification framework as suggested by Armstrong (2007).

In this paper, we also investigated the extent of AFTA economic integration, in particular, whether AFTA is trade creating or trade diverting. Using data from 1987 to 2011, we find positive and significant trade creation effects. This is further supported by a shift-share analysis indicating that both intra-ASEAN trade and trade with the rest of the world have increased after the formation of AFTA. In addition, using a stochastic frontier approach, we find that 'behind the border' inefficiencies for ASEAN as a whole have decreased over time. It is important to note that this does not imply country-specific inefficiencies have declined for all ASEAN members, though this is the case for Brunei.

References

- Aigner, D, Knox Lovell, CA & Schmidt, P 1977, 'Formulation and Estimation of Stochastic Frontier Production Function Models', *Journal of Econometrics*, vol. 6, no. 1, pp. 21-37.
- Anderson, JE 1979, 'A Theoretical Foundation for the Gravity Equation', *American Economic Review*, vol. 69, no. 1, pp. 106-116.
- Anderson, JE & van Wincoop, E 2003, 'Gravity with Gravitas: A Solution to the Border Puzzle', *American Economic Review*, vol. 93, no. 1, pp. 170-192.
- Armstrong, S 2007, 'Measuring Trade and Trade Potential: A Survey', *Asia Pacific Economic Papers*, no. 368.
- Baldwin, R & Taglioni, D 2006, 'Gravity for Dummies and Dummies for Gravity Equations', NBER Working Paper, no. 12516, National Bureau of Economic Research, Cambridge MA.
- Bergstrand, JH 1985, 'The Gravity Equation in International Trade: Some Microeconomic Foundations and Empirical Evidence', *Review of Economics and Statistics*, vol. 67, no. 3, pp. 474-481.
- 1989, 'The Generalized Gravity Equation, Monopolistic Competition, and the Factor-Proportions Theory in International Trade', *Review of Economics and Statistics*, vol. 71, no. 1, pp. 143-153.
- Bhaskaran, M 2010, 'Economic Diversification in Brunei Darussalam', *CSPS Strategy and Policy Journal*, vol. 1, pp. 1-12.

- Cabalu, H & Alfonso, C 2007, 'Does AFTA Create or Divert Trade?', *Global Economy Journal*, vol. 7, no. 4, article 6.
- Cooper, J 2003, 'Price Elasticity of Demand for Crude Oil: Estimates for 23 Countries', *OPEC Review*, vol. 27, no. 1, pp. 1-8.
- Crosby, M 2007, *Economic Diversification*, Centre for Strategic and Policy Studies, Bandar Seri Begawan.
- Dargay, J, Gately, D & Huntington, H 2007, 'Price and Income Responsiveness of World Oil Demand, by Product', EMF Occasional Paper, no. 61, Energy Modeling Forum, Stanford University, Stanford CA.
- De Schryder, S & Peersman, G 2012, 'The U.S. Dollar Exchange Rate and the Demand for Oil', CESifo Working Paper, no. 4126, CESifo Group Munich, Munich.
- Department of Economic Planning and Development 2012, Brunei Darussalam Statistical Yearbook 2012, Government of Brunei Darussalam, Bandar Seri Begawan.
- Elliott, R & Ikemoto, K 2004, 'AFTA and the Asian Crisis: Help or Hindrance to ASEAN Intra-regional Trade?', *Asian Economic Journal*, vol. 18, no. 1, pp. 1-23.
- Endoh, M 2000, 'The Transition of Postwar Asia-Pacific Trade Relations', *Journal of Asian Economics*, vol. 10, pp. 571-589.
- Frankel, JA 1997, *Regional Trading Blocs in the World Economic System*, Institute for International Economics, Washington DC.
- Hapsari, I & Mangunsong, C 2006, 'Determinants of AFTA Members' Trade Flows and Potential for Trade Diversion', ARTNeT Working Paper Series, no. 21, United Nations Economic and Social Commission for Asia and the Pacific, Bangkok.
- Heckman, J 1979, 'Sample Selection Bias as a Specification Error', *Econometrica*, vol. 47, no. 1, pp. 153-161.
- International Monetary Fund, see IMF
- IMF 2012, Direction of Trade Statistics, International Monetary Fund, Washington DC.
- Kalirajan, K 2008, 'Gravity Model Specification and Estimation: Revisited', *Applied Economic Letters*, vol. 15, pp. 1037-1039.
- & Findlay, C 2005, 'Estimating Potential Trade Using Gravity Model: A Suggested Approach', Foundation for Advanced Studies on International Development, Tokyo.

- _____ & Singh, K 2008, 'A Comparative Analysis of China's and India's Recent Export Performances', *Asian Economic Papers*, vol. 7, no. 1, pp. 1-28.
- Linder, SB 1961, *An Essay on Trade and Transformation*, John Wiley, New York.
- Meeusen, W and van den Broeck, J 1977, 'Efficiency Estimation from Cobb-Douglas Production Functions with Composed Error', *International Economic Review*, vol. 18, no. 2, pp. 435-444.
- Miankel, AK, Thangavelu, S & Kalirajan, K 2009, 'On Modeling and Measuring Potential Trade', Quantitative Approaches to Public Policy Conference in Honour of Professor Krishna Kumar, Bangalore, August 9-12.
- Nguyen, TK & Hashimoto, Y 2005, 'Economic Analysis of ASEAN Free Trade Area; by a Country Panel Data', Discussion Papers in Economics and Business, no. 05-12, Osaka School of International Public Policy, Osaka.
- Rahman, M 2009, 'Australia's Global Trade Potential: Evidence from the Gravity Model Analysis', Oxford Business & Economics Conference, Oxford, June 24-26.
- Santos Silva, J & Tenreyro, S 2006, 'The Log of Gravity', *Review of Economics and Statistics*, vol. 88, no. 4, pp. 641-658.
- Solaga, I & Winters, A 2001, 'Regionalism in the Nineties: What Effect on Trade?', *North American Journal of Economics and Finance*, vol. 12, pp. 1-29.
- Tinbergen, J 1962, *Shaping the World Economy: Suggestions for an International Economic Policy*, The Twentieth Century Fund, New York.
- Urata, S & Okabe, M 2007, 'The Impacts of Free Trade Agreements on Trade Flows: An Application of the Gravity Model Approach', RIETI Discussion Paper Series, no. 07-E-052, Research Institute of Economy, Trade and Industry, Tokyo.
- van der Ploeg, F 2011, 'Natural Resources: Curse or Blessing?', *Journal of Economic Literature*, vol. 49, no. 2, pp. 366-420.
- World Bank 2013, *Doing Business 2013*, The World Bank, Washington DC.
- World Economic Forum 2012, *The Global Competitiveness Report 2012-2013*, World Economic Forum, Geneva.

Appendix

Table 1: Estimation results of Brunei's exports

Dependent variable log(X)	OLS	FEM	REM	SFA
log(GDP _i)	-0.181 (0.961)	-0.459 (0.715)	-0.203 (0.672)	-0.218 (0.658)
log(GDP _j)	1.852*** (0.148)	2.021** (0.872)	1.765*** (0.296)	1.767*** (0.282)
log(POP _i)	-5.078 (5.157)	-4.267 (4.116)	-4.574 (3.632)	-16.114*** (5.314)
log(POP _j)	-0.680*** (0.150)	-2.308 (2.152)	-0.517* (0.304)	-0.347 (0.246)
log(PCGDP)	0.063 (0.177)	-0.298 (0.187)	-0.176 (0.166)	-0.126 (0.159)
log(DIST)	-1.394*** (0.298)		-1.956*** (0.595)	-1.960*** (0.523)
log(TARIFF)	7.477** (3.106)	-3.200 (2.630)	-1.845 (2.489)	-1.211 (2.550)
log(RER)	-0.410*** (0.074)	0.754 (1.121)	-0.413** (0.170)	-0.531*** (0.140)
LANG	-0.457 (0.508)		-0.204 (1.511)	-0.173 (1.243)
COL	2.521*** (0.264)		2.463*** (0.740)	3.075*** (0.567)
RTA	2.622*** (0.529)	0.809* (0.485)	1.051** (0.459)	1.774*** (0.483)
constant	-14.697 (14.316)	-12.485 (14.740)	-5.604 (11.229)	-14.727 (11.404)
No. of observations	420	420	420	420
R-squared	0.586	0.825	0.560	
LM test			505.77	
Hausman test			12.44	
mu (μ)				2.885*** (0.948)
eta (η)				0.055*** (0.015)
sigma-square (σ ²)				5.034*** (0.904)
gamma (γ)				0.459*** (0.098)

Note: ***, ** and * represent significance levels at 1, 5 and 10 per cent respectively. Figures in parenthesis are the standard errors of the coefficients.

Table 2: Results of Brunei's potential exports, 2000-2011 average
(US\$ millions)

Country	Actual exports	Potential exports	Ratio of actual to potential	Country	Actual exports	Potential exports	Ratio of actual to potential
Australia	639.42	1,818.56	35.2%	Korea, Republic	890.26	5,793.65	15.4%
Bahrain	0.86	1.39	62.1%	Lebanon	1.30	2.25	57.6%
Bangladesh	0.62	246.56	0.3%	Malaysia	49.80	6,733.26	0.7%
Belgium-Luxembourg	0.09	5.91	1.5%	Nepal	0.28	0.36	76.8%
Brazil	1.35	7.97	17.0%	Netherlands	1.00	13.27	7.5%
Cambodia	0.20	86.3	0.2%	New Zealand	178.67	114.51	156.0%
Canada	2.60	451.62	0.6%	Nigeria	1.40	46.92	3.0%
China	246.79	2,238.05	11.0%	Oman	0.25	0.22	113.2%
Czech Republic	0.10	5.31	1.8%	Pakistan	1.22	191.35	0.6%
Denmark	0.34	11.13	3.0%	Philippines	10.55	1,182.27	0.9%
Dominican Republic	0.09	0.23	40.5%	Saudi Arabia	0.34	11.90	2.8%
Egypt	1.31	33.15	3.9%	Singapore	162.96	17,711.71	0.9%
France	0.67	70.94	0.9%	Slovak Republic	0.45	2.52	17.8%
Germany	2.13	116.37	1.8%	Spain	1.18	24.23	4.9%
Hong Kong	1.75	6,079.76	0.03%	Switzerland	4.25	8.36	50.9%
Hungary	0.41	9.90	4.1%	Thailand	232.74	1,213.65	19.2%
India	173.26	4,899.92	3.5%	United Arab Emirates	1.57	150.59	1.0%
Indonesia	752.21	49,045.01	1.5%	United Kingdom	44.88	1,325.92	3.4%
Italy	0.32	64.31	0.5%	United States	283.12	13,615.58	2.1%
Japan	2,519.89	31,162.10	8.1%	Vietnam	15.16	2,172.69	0.7%

Note: Mean and standard deviation of actual exports are US\$155.6 million and US\$436.7 million, respectively.

Table 3: Estimation results of Brunei's imports

Dependent variable log(M)	OLS	FEM	REM	SFA
log(GDP _i)	0.762* (0.393)	0.834** (0.342)	0.736** (0.321)	0.741** (0.316)
log(GDP _j)	1.713*** (0.065)	1.130*** (0.354)	1.581*** (0.134)	1.520*** (0.122)
log(POP _i)	-6.028*** (2.223)	-3.222 (1.995)	-4.878*** (1.724)	-8.779*** (2.092)
log(POP _j)	-0.510*** (0.049)	-1.438 (1.578)	-0.440*** (0.122)	-0.405*** (0.112)
log(PCGDP)	0.071 (0.059)	0.111 (0.089)	0.082 (0.079)	0.104 (0.072)
log(DIST)	-2.038*** (0.129)		-2.180*** (0.270)	-1.912*** (0.252)
log(RER)	0.029 (0.028)	0.609* (0.351)	0.061 (0.071)	0.094* (0.054)
LANG	0.806*** (0.225)		0.987 (0.625)	0.925** (0.466)
COL	0.986*** (0.126)		0.881*** (0.298)	0.419* (0.245)
RTA	1.012*** (0.232)	0.446* (0.236)	0.534** (0.223)	0.786*** (0.232)
constant	-14.956** (6.178)	-18.878** (8.161)	-10.791** (5.354)	-15.276*** (5.349)
No. of observations	455	455	455	455
R-squared	0.807	0.896	0.804	
LM test			361.42	
Hausman test			8.14	
mu (μ)				0.632 (0.456)
eta (η)				0.064*** (0.022)
sigma-square (σ^2)				1.125*** (0.269)
gamma (γ)				0.399*** (0.144)

Note: ***, ** and * represent significance levels at 1, 5 and 10 per cent respectively. Figures in parenthesis are the standard errors of the coefficients.

Table 4: Results of Brunei's potential imports, 2000-2011 average
(US\$ millions)

Country	Actual imports	Potential imports	Ratio of actual to potential	Country	Actual imports	Potential imports	Ratio of actual to potential
Argentina	0.42	1.15	36.9%	Malaysia	396.06	721.21	54.9%
Australia	31.98	105.76	30.2%	Netherlands	13.25	15.45	85.8%
Austria	1.76	7.47	23.5%	New Zealand	8.45	5.98	141.3%
Bangladesh	0.46	2.11	21.9%	Norway	2.14	8.87	24.2%
Belgium-Luxembourg	7.22	9.25	78.1%	Pakistan	1.58	2.02	78.5%
Brazil	0.46	2.11	21.9%	Philippines	6.01	65.34	9.2%
Canada	4.83	23.55	20.5%	Portugal	0.37	2.08	17.9%
China	165.71	343.87	48.2%	Saudi Arabia	2.12	8.14	26.0%
Czech Republic	0.42	1.51	27.9%	Singapore	739.16	886.30	83.4%
Denmark	1.97	5.88	33.6%	Slovak Republic	0.82	0.61	134.5%
France	12.98	49.24	26.4%	South Africa	1.85	2.79	66.3%
Germany	92.15	73.09	126.1%	Spain	3.67	16.25	22.6%
Hong Kong	41.65	112.70	37.0%	Sweden	2.54	8.70	29.2%
India	95.44	35.74	267.0%	Switzerland	5.97	11.19	53.4%
Indonesia	49.40	212.02	23.3%	Thailand	89.11	72.69	122.6%
Iran	1.01	1.59	63.4%	Turkey	1.13	7.40	15.3%
Ireland	1.93	5.94	32.4%	United Arab Emirates	4.95	16.45	30.1%
Italy	18.36	38.73	47.4%	United Kingdom	120.91	82.62	146.3%
Japan	149.38	718.21	20.8%	United States	113.33	381.99	29.7%
Korea, Republic	92.48	67.78	136.4%	Vietnam	2.96	6.03	49.1%

Note: Mean and standard deviation of actual imports are US\$57.2 million and US\$133.0 million, respectively.

Table 5: Estimation results of ASEAN's imports

Dependent variable log(M)	OLS	FEM	REM	SFA
log(GDP _i)	1.526*** (0.020)	0.293*** (0.037)	0.454*** (0.030)	0.271*** (0.041)
log(GDP _j)	1.256*** (0.025)	0.683*** (0.047)	0.667*** (0.038)	0.565*** (0.048)
log(POP _i)	-0.180*** (0.020)	-0.309 (0.193)	0.455*** (0.050)	0.566*** (0.079)
log(POP _j)	-0.229*** (0.022)	1.467*** (0.155)	0.300*** (0.054)	0.469*** (0.076)
log(PCGDP)	-0.134*** (0.020)	0.093*** (0.025)	0.084*** (0.025)	0.084*** (0.025)
log(DIST)	-1.559*** (0.035)		-0.746*** (0.103)	-0.905*** (0.160)
log(RER)	0.011** (0.005)	-0.009 (0.012)	-0.040*** (0.010)	-0.026** (0.011)
LANG	0.973*** (0.054)		2.379*** (0.275)	1.942*** (0.441)
COL	0.296*** (0.063)		0.741*** (0.224)	0.688*** (0.262)
oneAFTA	-0.831*** (0.060)	0.307*** (0.041)	0.168*** (0.038)	0.117*** (0.043)
bothAFTA	-0.288*** (0.085)	0.305*** (0.064)	0.358*** (0.064)	0.324*** (0.065)
constant	-10.879*** (0.345)	-12.225*** (0.412)	-6.145*** (0.875)	2.941* (1.712)
No. of observations	7623	7623	7623	7623
R-squared	0.690	0.822	0.539	
LM test			19529.34	
Hausman test			490.25	
mu (μ)				5.081*** (0.374)
eta (η)				0.004*** (0.001)
sigma-square (σ^2)				6.631*** (0.546)
gamma (γ)				0.873*** (0.011)

Note: ***, ** and * represent significance levels at 1, 5 and 10 per cent respectively. Figures in parenthesis are the standard errors of the coefficients.