Growing Potential Business opportunity for Climate Friendly Goods and Technologies in Asia since 1997

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2018

Potential Business of Climate Friendly Goods and Technologies in Asia

8.1 Introduction

Newly Industrial Countries (NIC) in East Asian nations like Taiwan, South Korea, and Hong Kong are experienced in trade led growth in last quarter of the 20th century. Their exports were increased rapidly following imports of updated technologies from developed countries, which might reduce technological restrictions or limitations. They import new technologies through foreign collaborations and produce better quality of goods at comparatively low cost (due to available cheap labour) and finally export quality products embedded with upgraded technologies at competitive price. Trade model of East Asia is adopted by neighbouring and other Asian countries. Several Asian economies are emerging with trade diversity. Truly, import trade meet domestic demand as well as it also fulfil requirement for creation of export opportunities in emerging Asia in this 21st century. CFGT import might reduce technological restrictions of under developed countries. Availability and effective adaptation of use of CFGT is essential to mitigate global climate change. CFGT export increased slowly in the period of 1996 – 2003; however, CFGT export rose rapidly after 2003 and it over took CFGT import growth in Asia during 2004-2006. Share of CFGT export in total world export increased from 2.48% in 2002 to 2.71% in 2008 and slightly down to 2.68% in 2009, while world import of CFGT share rose from 2.4% in 2002 to 2.6% in 2008 (Dinda 2014). CFGT trade share was low (around 7.5% of world merchandise export); however, it takes momentum after 2009.

Reporter country's export turns to be import of its partners. Asia's CFGT exports increase gradually with intraregional and interregional trade during 2002-2008. Intraregional demand was nearly 51% and only 49% for interregional demand of CFGT in 2008. It is true that internal demand within Asia is very high for CFGT, and it increases with economic development over time.

This chapter investigates stable empirical relationships (Learner and Levinson 1995) and estimate of bilateral trade flows applying the gravity model in Asia. The gravity model is used in this empirical analysis for determinants of the distribution of goods or production factors across space and economic size. Truly, the gravity model explains the role of

economic size and resource endowments, distance between trading partners, membership of regional and multilateral agreements, among others on trade of such CFGT. In this chapter, this gravity model is used in several cross sectional data analysis for estimating CFGT import and export in different times. Initially we examine the gravity equation considering the bilateral total trade of CFGT import for the year 2006 and later investigate CFGT exports for the year 2005 and finally analyse CFGT export and import in 2008. Economic growth momentum gained considerably in 2005 – 2006 and reached at maximum in 2008. The gravity model analysis is useful to explain determinants of imports and exports potential of CFGT for Asian countries within the region, and interregional such as in the North America and the European Union (EU).

In our regression analysis, we have used the log values of all the variables except for dummies. In original version of Tinbergen (1962), the model is expressed in a log-log form. So the parameters are elasticity of the trade flow with respect to the explanatory variables.The least square econometric technique is used for the gravity equation (6) is estimated for analysis purpose. Trade gap is measured the differences between estimated and actual bilateral trade flows. Untapped trade gap is identified as potential trade opportunity which may rise with reducing restrictions.

8.2 Empirical Findings and Analysis

Initially, we discuss on CFGT import in Asia in 2006. Model 1 is a basic CFGT import gravity model consists of reporter country's GDP, partners' GDP, per capita GDP of reporting and partners, distance between pair countries, and weighted tariffs. Country characteristics dummy variables are added to model 2. Policy, Infrastructure and FDI are incorporated in gravity model 3, 4 and 5, respectively. Infrastructure and policy are the score Indies which are calculated on the basis of available information. Model 6 combines all variables.

Table 8.1 provides above said six different estimated gravity models of import of CFGT in Asia in 2006. In model 1, coefficients of reporter country's GDP, GDP partner, geographical distance between two countries, and constant term are statistically significant at 1% level. Import elasticity of CFGT in 2006 with respect to reporting country's GDP is 0.847 which is inelastic. It suggests that import of CFGT might

increase by 0.847% if income of the reporting country increases by 1%. Import elasticity of CFGT with respect to the partner country's GDP is elastic (1.03), which suggests that if the partner country's GDP increases by 1%, import of CFGT increases by 1.03% (which is more than 1%).

Table 8.1: Estimated gravity model for Import of CFGT in Asia in 2006

Variables	1	2	3	4	5	6	7
Constant	-29.467*** (-8.94)	-32.2*** (-9.93)	-37.382*** (-10.78)	-33.812*** (-10.6)	-32.114*** (-9.36)	-32.46*** (-7.45)	-32.734*** (-6.65)
lnGDP_Reporter	0.847*** (9.86)	0.911*** (10.85)	0.977*** (10.83)	1.004*** (11.45)	1.019*** (11.6)	0.819*** (4.7)	0.935*** (4.21)
lnGDP_Partner	1.03*** (13.61)	0.999*** (13.39)	1.096*** (14.35)	1.037*** (15.14)	0.983*** (13.27)	1.089*** (9.31)	1.101*** (10.14)
lnpcgdp_reporter	0.131 (1.54)	0.161** (1.97)	0.0949 (1.11)	0.031 (0.35)	0.038 (0.42)	0.137 (1.54)	0.041 (0.46)
lnpcgdp_partner	0.156** (1.97)	0.245*** (3.01)	0.024 (0.25)	-0.4287*** (-3.57)	-0.482*** (-3.94)	0.275*** (3.16)	-0.453*** (-3.66)
lnDistance	-0.814*** (-6.59)	-0.762*** (-6.1)	-0.892*** (-6.85)	-0.872*** (-7.14)	-0.869*** (-7.03)	-0.772*** (-6.09)	-0.858*** (-6.92)
lnTarifwt	-0.037 (-0.87)	-0.022 (-0.54)	0.005 (0.13)	0.019 (0.45)	0.0126 (0.31)	-0.002 (-0.03)	0.207 (0.43)
D Contiguous		0.204 (0.43)	0.193 (0.42)	0.215 (0.49)	0.291 (0.67)	0.221 (0.46)	0.339 (0.78)
DCommonofficial language		1.16*** (4.69)	0.704*** (2.67)	0.668*** (2.82)	0.81*** (3.25)	1.242*** (4.71)	0.955*** (3.59)
D Colony		-0.63 (-1.11)	-0.609 (-1.1)	-0.46 (-0.88)	-0.455 (-0.88)	-0.605 (-1.06)	-0.436 (-0.84)
DRegionalAgreement		0.936* (1.92)	0.643 (1.33)	0.442 (0.97)	0.409 (0.9)	0.852* (1.73)	0.340 (0.74)
lnPolicy_Score _Reporter			1.222** (2.26)		0.76 (1.12)		0.899 (1.2)
lnPolicy_Score _Partner			1.959*** (3.83)		-1.358* (-1.88)		-1.471** (-2.03)
lnInfrastructure_score Reporter				1.34** (2.53)	0.726 (1.03)		0.388 (0.42)
lnInfrastructure_score Partner				3.267*** (7.16)	4.245*** (6.21)		4.366*** (6.35)
ln FDI Reporter						0.159 (0.65)	0.126 (0.44)
ln FDI Partner						-0.128 (-0.99)	-0.179 (-1.51)
R^2	0.5559	0.5965	0.6221	0.6653	0.6714	0.5987	0.6745
Adj R^2	0.5461	0.5814	0.6050	0.6502	0.6540	0.5806	0.6546
Root MSE	1.5446	1.4833	1.4409	1.356	1.3486	1.4848	1.3475
N	279	279	279	279	279	279	279

Note: Figures in parenthesis are t-values. '***', '**' and '*' denote the statistical level of significant at 1%,

5% and 10%, respectively.

Coefficient of partners' per capita GDP is significant at 5% level. Import elasticity of CFGT with respect to per capita GDP (development index) of partner country is inelastic (0.156). CFGT import increased by 0.156% as 1% per capita GDP increased in partner country. It is clear from these findings that import of CFGT increases with level of economic activities of both countries and development of partner. Coefficient of geographical distance between country pair is -0.814, which is negative as it is expected in the gravity model. Import reduces with increasing distance between trade partners. Coefficient of weighted tariffs is negative as expected, however, it is statistically insignificant[1], and we left it without any comments. The constant term is statistically highly significant which suggests that certain explanatory variables are needed to explain the model. Considering only statistically significant coefficients of *base model 1* the estimated CFGT import determinants in Asia in 2006 is

$$\ln M_{ij} = -29.467 + 0.847 \ln GDP_i + 1.03 \ln GDP_j + 1.56 \ln pcgdp_j - 0.814 \ln DT_{ij}$$

Several dummy variables related to country characteristics and regional agreements are added to the base model 1 for forming model 2, which represents a standard practice of the gravity model. In model 2, among additional variables (compared to model 1) coefficients of common official language and regional agreement are significant at 1% and 10% level, respectively. On the basis of statistically significant coefficients of *model 2* the estimated CFGT import determinants in Asia in 2006 is

$$\ln M_{ij} = -32.2 + 0.911 \ln GDP_i + 0.999 \ln GDP_j + 0.161 \ln pcgdp_i + 0.245 \ln pcgdp_j - 0.762 \ln DT_{ij} + 1.16 D_{Com\_Office\_Lang} + 0.936 D_{RegionalAgreement}$$

This study consider important three major variables such as infrastructure, policy, and FDI, which are added in model 3, model 4 and model 6, respectively.Policy score is measured on the basis of information available related to number of economic reform policy take place and adopted in reporter and partner countries. Similarly infrastructure score is also calculated for both reporter and partner countries. Individually policy and infrastructure (of both report and partner countries) are positive and statistically highly

[1]It remains insignificant in all six models (see Table 8.1).

significant in model 3 and model 4. Observing only statistically significant coefficients of *model 3* the estimated CFGT import determinants in Asia in 2006 is

$$\ln M_{ij} = -37.382 + 0.977 \ln GDP_i + 1.096 \ln GDP_j - 0.892 \ln DT_{ij} + 0.704 D_{Com\_Office\_Lang} + 1.222 \ln Policy\,Score_i + 1.959 \ln Policy\,Score_j$$

Policy score is positive and highly responsive in both trading (reporter and partner) countries. Policy score is elastic in both reporting and partner nations. It also suggests that trading nations' economic policy reforms directly increase the import of CFGT in Asia. To capture the open economy market share Asian nations build up infrastructure which has positive and direct impact on trade of both trading countries. Results indicate that infrastructure is highly elastic in both trading partners. Considering only statistically significant coefficients of *model 4* the estimated CFGT import determinants in Asia in 2006 is

$$\ln M_{ij} = -33.812 + 1.004 \ln GDP_i + 1.037 \ln GDP_j - 0.4287 \ln pcgdp_j - 0.872 \ln DT_{ij} + 0.668 D_{Com\_Office\_Lang} + 1.34 \ln Infrastructure\,Score_i + 3.267 \ln Infrastructure\,Score_j$$

In model 5, coefficient of partner's infrastructure is positive and highly significant at 1% level, while policy is significant at 10% level with a negative coefficient. It is noted that infrastructure of partner nation is significantly positive; it suggests that import of CFGT in Asia directly depends on partner's infrastructure. Findings of model 6 and 7 suggest that FDI in Asia has no role to explain CFGT import in 2006. Coefficient of partner's policy score is negative and highly significant at 5% level; however, coefficient of infrastructure of partner is positive and highly significant in model 7. As per model fitting criteria both R^2 and adjusted R^2 of model 7 are higher than other models. Root Mean Square of Error (RMSE) is the least in model 5 and very close to model 7. However, model 7 is the best fitted model considering R^2 and adjusted R^2 and RMSE. Considering only statistically significant coefficients of *model 7* the estimated CFGT import determinants in Asia in 2006 is

$$\ln M_{ij} = -32.73 + 0.93 \ln GDP_i + 1.1 \ln GDP_j - 0.45 \ln pcgdp_j - 0.86 \ln DT_{ij} + 0.95 D_{Com\_Office\_Lang} - 1.47 \ln Policy_j + 4.37 \ln Infrastructure_j$$

Partners' countries economic position, infrastructure and policy reforms are major determinants of overall CFGT import in Asia in 2006. Do these determinants vary or remain same for subcategories of CFGT in Asia in 2006? Now we investigate determinants of import of major four (SPVS, CCT, EEL and WE) sub-categories of

CFGT in Asia in 2006. Table 8.2 shows the estimated results of the gravity equation for import of CFGT sub categories such as SPVS, CCT, EEL and WE in Asia in 2006. From Table 8.2 we find that the coefficients of GDP of partner and reporting countries, partner's per capita GDP, distance, common official language, policy of both countries, partner's infrastructure, and FDI inflow to reporting country are significant determinants of import of SPVS in Asia in 2006. Considering only significant coefficients the estimated SPVS import determinants in Asia in 2006 is

$$\ln M_{ij} = -38.03 + 0.645 \ln GDP_i + 1.181 \ln GDP_j - 0.666 \ln pcgdp_j - 1.19 \ln DT_{ij} + 1.31 D_{Com\_Office\_Lang} + 2.86 \ln Policy_i - 1.882 \ln Policy_j + 5.794 \ln Infrastructure_j + 1.07 \ln FDI_i$$

Table 8.2: Estimated gravity model for the import of sub-categories of CFGT like SPVS, CCT, EEL and WE in Asia in 2006

Variables	**Solar Photovoltaic System (SPVS)**	**Clean Coal Technology (CCT)**	**Energy Efficient Lighting (EEL)**	**Wind Energy (WE)**
Constant	**-38.03*** **(-5.11)**	**-16.8** **(-2.43)**	**-34.56*** **(-6.7)**	**-33.4185*** **(-6.14)**
lnGDP_Reporter	**0.645*** **(1.94)**	0.38 (1.22)	**1.074*** **(4.56)**	**0.8384*** **(3.41)**
lnGDP_Partner	**1.181*** **(7.08)**	**0.834*** **(5.36)**	**1.133*** **(12.26)**	**1.151*** **(10.16)**
lnpcgdp_reporter	0.17 (1.17)	**-0.227** **(-1.97)**	-0.038 (-0.29)	-0.01588 (-0.16)
lnpcgdp_partner	**-0.666*** **(-3.49)**	**-0.307*** **(-1.78)**	**-0.321** **(-2.53)**	-0.17919 (-1.35)
lnTarifwt	0.018 (0.26)	-0.06 (0.88)	0.0698 (1.3)	0.004676 (0.09)
lnDistance	**-1.19*** **(-6.26)**	**-0.866*** **(-3.84)**	**-1.248*** **(-7.18)**	**-0.757*** **(-5.52)**
D Contiguous	0.297 (0.44)	0.576 (1.21)	-0.094 (-0.19)	-0.093 (-0.2)
D_CommonOfficial language	**1.31*** **(3.2)**	0.163 (0.48)	**0.535** **(2.06)**	**0.769*** **(2.69)**
D_Colony	-0.437 (-0.55)	-0.42 (-0.87)	-0.174 (-.35)	-0.45 (-0.82)
D_Regional Agreement	0.844 (1.2)	-0.211 (-0.31)	0.119 (0.23)	0.436 (0.83)
lnPolicy Reporter	**2.86** **(2.48)**	0.473 (0.5)	0.779 (1.0)	-0.2415 (-0.3)
lnPolicy Partner	**-1.882*** **(-1.69)**	**-1.597*** **(-1.66)**	-0.834 (-1.1)	-0.833 (-1.05)
ln Infra Reporter	-1.896 (-1.32)	1.219 (0.99)	**2.291** **(2.11)**	1.36 (1.37)
ln Infra Partner	**5.794*** **(5.49)**	**3.367*** **(3.57)**	**3.044*** **(4.2)**	**2.976*** **(3.92)**
ln FDI Reporter	**1.07** **(2.44)**	**0.864** **(2.15)**	0.031 (0.10)	0.1604 (0.5)

ln FDI Partner	-0.037 (-0.20)	0.024 (0.15)	-0.193 (-1.61)	-0.158 (-1.24)
N	279	128	172	259
R^2	0.6044	0.6549	0.7613	0.6316
Adj R^2	0.5803	0.6052	0.7366	0.6073
Root MSE	2.0707	1.1837	1.0673	1.4229

Note: Figures in parenthesis are t-values. '***', '**' and '*' denote the statistical level of significant at 1%, 5% and 10%, respectively

Significant determinants of CCT import in Asia are GDP of partner country, per capita GDP of reporter and partner, distance, partner's policy and infrastructure, and FDI inflow to reporter country. Considering only significant coefficients the estimated CCT import determinants in Asia in 2006 is

$$\ln M_{ij} = -16.8 + 0.834 \ln GDP_j - 0.227 \ln pcgdp_i - 0.307 \ln pcgdp_j - 0.866 \ln DT_{ij} - 1.597 \ln Policy_j + 3.367 \ln Infrastructure_j + 0.864 \ln FDI_i$$

Similarly, the estimated import of EELdeterminants in Asia in 2006 is

$$\ln M_{ij} = -34.56 + 1.074 \ln GDP_i + 1.133 \ln GDP_j - 0.321 \ln pcgdp_j - 1.248 \ln DT_{ij} + 0.535 D_{Com\_Office\_Lang} + 2.291 \ln Infrastructure_i + 3.044 \ln Infrastructure_j$$

and the estimated wind energyimport determinants in Asia in 2006 is

$$\ln M_{ij} = -33.4185 + 0.8384 \ln GDP_i + 1.151 \ln GDP_j - 0.757 \ln DT_{ij} + 0.769 D_{Com\_Office\_Lang} + 2.976 \ln Infrastructure_j$$

Determinants of EEL import in Asia are GDP of partner and reporter countries, partner's per capita GDP, distance, common official language, and infrastructure of reporter and partner; while WE import are determined by GDP of partner and reporter countries, distance, common official language, and infrastructure of partner. Partner's GDP is common significant determinant for all subcategories of CFGT import. Coefficient of GDP of reporter country is statistically highly significant for import of EEL and WE; while it is significant at low (10%) level in SPVS import and insignificant in case of CCT import, i.e., CCT import does not depend on importing country's income level. Income of reporting country is important determinant for import of energy efficient lighting and wind energy in Asia in 2006.

Coefficient of geographical distance between pair countries is negative and statistically significant in four major subcategories (SPVS, CCT, EEL and WE) as per expected in the gravity model. Distance is highly sensitive (or elastic) in import of SPVS and EEL while it is less sensitive (or inelastic) in case of import of CCT and wind energy. Common

official language is significant all sub-categories except CCT. Common official language is a good indicator for easy communication between pair of trading countries. Coefficient of reporter's policy is statistically significant only for SPVS imports; while partner's policy is significant for SPVS and CCT imports. SPVS import depends on both traders' policy reforms. Coefficient of FDI inflow to reporter country was statistically significant only for import of SPVS and CCT. So, FDI inflow played an important role for importing SPVS and CCT in Asia. Coefficient of reporting country's infrastructure is statistically significant only for import of EEL; while coefficient of partner's infrastructure is for SPVS, CCT, EEL and WE. So,all major sub-categories of CFGT imports depend on infrastructure of trading partners. Overall imports of SPVS, CCT, EEL and WE depends on traders' income level, partner's economic development and infrastructure. However, imports of SPVS and CCT depend directly on FDI inflow in Asia. So, SPVS and CCT entered in Asia in 2006 through FDI channel.

Table 8.1 and Table 8.2 suggest that imports of CFGT and its sub-categories in Asia are determined by income of both reporter and partner countries, economic development of partners associated with their policy reforms and infrastructure, and common official language. So, import of CFGT in Asia crucially depends on economic positions of trading partners, infrastructure setup, policy reformsand common communicating language.

Imports generally boost up exports in emerging and developing economies in the follow up periods. Now we investigate CFGT export determining factors in pre and post CFGT import in Asia in 2006. For the said purpose we examine CFGT export in 2005 and 2008.

Table 8.3 presents the estimated results of the gravity equation for CFGT exportin Asia in 2005 and 2008. Column 2-4 and column 5-7 of Table 8.3 provide results of CFGT export in 2005 and 2008, respectively. Row-wise Table 8.3 has three parts displaying estimated gravity equation of CFGT export in Asia in 2005 and 2008, their ANOVA in middle part and regression statistics at bottom part. We discuss first the fitting criteria, analysis of variance (ANOVA) and lastly estimated results. Overall fitting of the gravity equation is good in the cross sectional data analysis (multiple R is 0.68257 in 2005 and 0.67924 in 2008; for more details, see, bottom part of Table 8.3). R^2 is a fitting criterion that provides strength of association between actual and estimated dependent variables. In

2005, R^2 value of 0.4659 means that only 46.59% of the variations in CFGTs export is explained by the variables used in the equation; while R^2 value of 0.4745 suggests that variables used in the equation explained only 47.45% of the variations in CFGT exports in Asia in 2008.Adjusted R^2 (after adjustment with DF) is 0.4631 in 2005 while it is 0.4708 in 2008. Both F statistics (164.53 in 2005 and 128.97 in 2008) in ANOVA are statistically highly significant. Table 8.3 shows point estimation of coefficients with their corresponding statistical significance level marked with stars (as significance levels at 1%, 5% and 10%).

In 2005, the coefficients of reporter country's GDP, GDP partner, per capita GDP of reporter, geographical distance between two countries, and constant term are statistically significant at 1% level. The coefficient of dummy for small country group is significant at 5% level and coefficient of dummy for country group of contiguity is significant at a 10% level. Considering only statistically significant coefficients the estimated CFGT export determinants in Asia in 2005 is

$$\ln X_{ij} = -43.24 + 1.5267 \ln GDP_i + 0.8825 \ln GDP_j - 0.195 \ln pcgdp_i - 1.2852 \ln DT_{ij} + 0.7472 D_{contiguity} + 1.5052 D_{smctry} \quad (8)$$

CFGT export elasticity with respect to GDP of the reporting country in 2005 is elastic which suggests that export of CFGT would increase by more than 1.5% if income of the reporting country increases by 1%. CFGTexport elasticity with respect to the partner country's GDP is inelastic (0.88), which suggests that if the partner country's GDP increases by 1%, the export of CFGT increases by 0.88% (<1%) in the reporter country's GDP. From this, one can guess that one part of partner country's internal demand is fulfilled by their production of CFGT. CFGT export elasticity with respect to per capita GDP (development index) of the reporting country is inelastic (-0.195). CFGT export decreases by 0.195% as 1% per capita GDP increases in reporting country. It is clear from these findings that export of CFGT increases with GDP while declines with per capita GDP (proxy of economic development). It is possibly due to the increase in internal demand of CFGT due to raising awareness of global climate change and related policies, and further provides the opportunity to produce CFGT in Asia. It indicates that opportunity of green business in Asia grows in 2005, and business of CFGT expands.

The coefficient of distance between country pair is negative as it is expected in the gravity model. Here, CFGT export elasticity with respect to distance was elastic (i.e., estimated coefficient of distance variable is -1.285) in 2005 and highly sensitive with distance[2]. The estimated coefficient of contiguity dummy variable is 0.747. CFGT exports are likely to be more in contiguous countries than others. Overall, CFGT exports are statistically significant in small countries in Asia in 2005. The constant term is statistically highly significant.

In 2008, the coefficients of GDP of reporter and partner, coefficient of per capita GDP of partner, distance between two countries, and common colony are statistically significant at 1% level. The coefficient of dummy variable for contiguity and colony are statistically significant at a 5% and 10% level, respectively.

Table 8.3: Estimated gravity equation of CFGT export of Asia in 2005 and 2008

	Export 2005			***Export 2008***		
Variables	*Coefficients*	*Standard Error*	*t Stat*	*Coefficients*	*Standard Error*	*t Stat*
Intercept	**-43.24*** **	1.5323	-28.22	**-48.688*** **	1.765	-27.78
lnGDP_reporter	**1.5267*** **	0.0419	36.46	**1.407*** **	0.0471	24.86
lnGDP_partner	**0.8825*** **	0.0336	26.27	**0.904*** **	0.0366	24.68
lnpcgdp_reporter	**-0.195*** **	0.0467	-4.18	0.097	0.060	1.62
lnpcgdp_partner	-0.0620	0.047	-1.32	**-0.188*** **	0.0528	-3.56
lndistw	**-1.2852*** **	0.0985	-13.04	**-0.538*** **	0.1077	-5.00
contiguity	**0.7472***	0.3931	1.90	**1.007** **	0.419	2.40
comlang_office	0.3459	0.3423	1.01	0.334	0.535	0.62
comlang_ethno	0.3117	0.304	1.025	0.242	0.501	0.48
colony	0.4533	0.7223	0.63	**1.458***	0.756	1.93
Common colony	0.2170	0.228	0.95	**1.362*** **	0.2465	5.52
col45	1.0892	0.8791	1.24	0.283	0.9176	0.31
smctry	**1.5052** **	0.7361	2.045	0.7768	0.91	0.85
ANOVA						
	Sum of Square	*Mean Sum of Square*	*F Stat*	*Sum of Square*	*Mean Sum of Square*	*F Stat*
Regression	19629.26	1509.943	164.531	11874.475	989.54	128.97
Residual	22502.62	9.177253		13150.923	7.6726	
Total	42131.88			25025.398		
Regression Statistics						
Multiple R	0.6826			0.6792		
R^2	0.4659			0.4745		
Adjusted R^2	0.4631			0.4708		

[2]An increase in bilateral trade is explained as transportation cost decreases.

Standard Error	3.0294	2.77
Observations	2466	1727

Note: Figures in parenthesis are t-values.'***', '**' and '*' denote the statistical level of significant at 1%, 5% and 10%, respectively.

Considering only statistically significant coefficients the estimated export of CFGT determinants in Asia in 2008 is

$$\ln X_{ij} = -48.688 + 1.407 \ln GDP_i + 0.904 \ln GDP_j - 0.188 \ln pcgdp_j - 0.538 \ln DT_{ij} + 1.007 D_{Contiguity} + 1.362 D_{Comcol} + 1.458 D_{Col} \quad (9)$$

CFGT export elasticity in 2008 with respect to GDP of reporting country is elastic (1.407) which suggests that CFGT export would increase by more than 1.4% if income of the reporting country increases by 1%. CFGT export elasticity with respect to the partner country's GDP is inelastic (0.904), which suggests that the reporter country's CFGT export increases by 0.904% if the partner country's GDP increases by 1%, in 2008. From these findings, one can guess that one part of partner country's internal demand is fulfilled by their CFGT production. CFGT export elasticity with respect to per capita GDP (development) of partner country is negative and inelastic (-0.188). CFGT export decreases by 0.188% as 1% per capita GDP increases in partner country in 2008. It is clear from these findings that CFGT export increases with GDP while declines with per capita GDP or economic development. It is possibly due to the increase in internal demand of CFGT due to raising awareness of global climate change and related policies, and further provides the opportunity to produce CFGT in Asia. It indicates that opportunity of green business in Asia grows, and expands CFGT business in 2008 in Asia.

The coefficient of distance between reporter and partner countries is negative and highly significant. Here, CFGT export with respect to distance[3] is inelastic (i.e., -0.538). There is a negative association between geographical distance and trade, i.e., bilateral trade rises with reducing transportation cost. CFGT exports are more among contiguity, common colonies and colony countries compared to others; it may be due to probably common administrative system and similar infrastructure in common colonial countries. It should be noted that estimated several coefficients of CFGT export in 2008 are different from that of in 2005. Country characteristic variables like colony and common colony are

[3]Literature[3] (Disdier and Head 2008, Balassa 1966, Balassa and Bauwens 1987) supports these observations.

significant in 2008 where as these are insignificant in 2005. Contiguity is highly significant in 2008 and significant at low level in 2005. Small country dummy is significant in 2005, however, it insignificant in 2008. Magnitude of coefficient of distance reduces from -1.285 in 2005 to -0.538 in 2008. This suggests that probably cost of CFGT trade declines in 2008 compared to 2005. Coefficient of per capita GDP of reporter is significantly negative in 2005 and that of partner in 2008. Constant term is highly statistically significant which might not capture other unknown factors.

Considering per capita GDP as development index, results of Table 8.3 suggest that CFGT export reduced in 2005 with reporting country's development, while it declined in 2008 with development of partner country. It indicates that reporting country might absorb more CFGT and reduced its export in 2005; however, it was completely opposite picture in 2008. With partner's development reporting country's export declined in CFGT which is directly connected with import of trading partners in 2008. So, we have to examine import determinants of CFGT in 2008. Once again we examine import determinants of CFGT with the parity of export determinants in 2008. Table 8.4 provides the estimated results of gravity equation of CFGT import in Asia in 2008.

Table 8.4: Estimated Results of the gravity model of CFGT import in Asia in 2008

Variables	*Coefficients*	*Standard Error*	*t Stat*
Intercept	-36.57***	1.819	-20.1
lnGDP_reporter	0.542***	0.047	11.48
lnGDP_partner	1.226***	0.041	29.83
lnpcgdp_reporter	0.354***	0.059	6.03
lnpcgdp_partner	0.666***	0.058	11.42
lndistw	-1.416***	0.111	-12.74
contiguous	0.924**	0.405	2.28
comlang_office	1.508***	0.499	3.02
comlang_ethno	-0.324	0.47	-0.69
colony	-1.863***	0.658	-2.83
comcol	0.245	0.289	0.85
curcol	-7.052**	2.821	-2.5
col45	2.685***	0.821	3.27
smctry	0.054	0.776	0.07
R^2	0.6022		
Adjusted R^2	0.5984		
RMSE	2.6341		
Observations	1367		

Note: '***', '**' and '*' denote the statistical significant level at 1%, 5% and 10%, respectively.

Considering only statistically significant and estimated CFGT import gravity model for Asia in 2008 is

$$\ln M_{ij} = -36.57 + 0.542 \ln GDP_i + 1.226 \ln GDP_j + 0.354 \ln pcgdp_i + 0.666 \ln pcgdp_j - 1.416 \ln DT_{ij} + 0.924 D_{Contiguous} + 1.508 D_{Col\ OfficialLang} - 1.86 D_{Col} + 2.685 D_{Col45} - 7.052 D_{CurCol} \quad (10)$$

Overall, determinants of CFGT import in Asia in 2008 are directly related to their income levels (Reporter's GDP and Partner's GDP), development positions (Reporter's per capita GDP and Partner's per capita GDP), contiguity, common official language, colony45, and inversely related to colony and current colony. Comparing results of CFGT import in Table 8.4 and CFGT export in (right part of) Table 8.3 we observe that CFGT import determinants are different[4] from that of CFGT export in Asia in 2008. These are trade determinants in Asia just before the global financial crisis. Are the trade determinants changed in the crisis period? In this context we also investigate the trade determinants in Asia in 2009.

In the *global financial crisis*, in 2009; the coefficients of reporter's GDP, partner's GDP, distance among pair countries, colony, common colony, common official language are significant at 1% level, while that of contiguous is significant at 10% level. Considering only statistically significant coefficients the estimated export of CFGT determinants in Asia in 2009 is

$$\ln X_{ij} = -44.57 + 1.44 \ln GDP_i + 0.82 \ln GDP_j - 0.97 \ln DT_{ij} + 0.67 D_{Contig} + 1.48 D_{Col} + 1.06 D_{Com\,col} + 0.86 D_{Col\ Off\ Lang} \quad (11)$$

CFGT export elasticity with respect to GDP of reporting country in 2009 is 1.44 which is elastic, while it is inelastic (0.82) with respect to partner's GDP. Country features are significant determinants of CFGT exports in 2009. More or less major determinants are remained same, however, magnitudes change.

Potential Trade Gap

Using the estimated export gravity equation (9), we predict the estimated CFGT export value of the reporting country with its trade partners in 2008. In this context we define potential CFGT export gap as difference between actual and predicted export value.

[4] Export and import trading partners could be different.

Potential trade gap in CFGT indicates possible scope of raising CFGT trade with its partner (see Dinda 2014). For example, in 2008, the estimated CFGT export in Asia was nearly $32.6 billion US dollar (USD), however, actual CFGT export was around $23.4 billion USD, hence, the export gap was approximately $9.2 billion USD in 2008 (it is different from Dinda 2014). So, trade opportunity value of CFGT export was around $9.2 billion USD in Asia in 2008. It indicates under performance of CFGT export of several Asian nations in 2008. This trade gap also suggests that those under performing countries could raise their CFGT export value around $9.2 billion USD with their existing trade partners in 2008. In other word, potential trade opportunity was nearly $9.2 billion USD in CFGT export in Asia in 2008. India was on top having potential untapped CFGT export of around $5 billion USD in 2008, and other countries were followed by Russia, Pakistan, and Hong Kong etc. These major countries have huge untapped potential trade of CFGT. Intra and inter region groupings are done according to the partner country belonging to Asia, the EU, America, etc., and it identifies individual trade partners of the reporting country.

Intraregional demand for CFGT was also very high. Asia was net CFGT importer during 2002-2008 that reflected high demand for CFGT. Actual CFGT import within Asia was around $61 billion USD in 2008, and the potential CFGT import gap within Asia was approximately $20 billion USD, which was higher than CFGT export gap (see World Bank 2008, Dinda 2014). Within Asia total potential CFGT (export and import) trade was around $30 billion USD in 2008. Truly, several nations were unable to meet their CFGT import demand in the period of global crisis started at the end of 2008; however, those countries were capable to raise CFGT import value of approximately $20 billion USD within Asia in 2008. Top potential CFGT importing country was South Korea and its potential import value was around $15 billion USD in 2008, and next was Pakistan ($3 billion USD).

Variation in the potential trade gap is observed among Asian nations. One of the major reasons is the variation of tariff rates of CFGT among Asian countries, regional trade agreements, etc. Other reasons may be lack of awareness and knowledge, insufficient technology, lack of skilled labour for production of CFGT, lack of trade facilities and infrastructure etc.

8.3 Conclusion

This chapter examines the gravity equations considering the bilateral trade of CFGT export and import in the pre-global financial crisis period like 2005 and 2006; and focuses mainly on CFGT trade in 2008. The gravity model is used to explain determinants of exports potential of CFGT for Asian nations within Asia, and outside Asia such as in the North America and the European Union. This chapter estimates bilateral trade flows of CFGT and also its sub-categories like SPVS, CCT, WE and EEL applying the gravity model in Asia and observes its determinants. Income level, geographical distance, and developmental position of both trading partners, and country characteristics, economic policy reforms and available infrastructure are important determinants of CFGT trade and its sub-categories.

Potential trade gap is measured as the difference between predicted and actual trade among trading partners. Using the gravity model, this chapter measures the *potential export and import trade gap of Climate Friendly Goods and Technologies* in Asia in 2008. Through trade gap, this chapter estimates the value of trade opportunity of CFGT in Asia, identifies potential trading partners, and also suggests CFGT trade among the trade partners. The total estimated potential export of CFGT within Asia was nearly $32 billion US dollar (USD) in 2008. This study contributes in the empirical measurement of potential trade opportunity of CFGT for an individual country and also quantifies it for every trade partner. Trade opportunity of CFGT was more among Asian trading partners than outside Asia in 2008. It assists policy makers and governments in formulating appropriate trade and economic policy. It also helps negotiate trade in the right direction to tap the potential opportunity of CFGT export. It may stimulate CFGT export-led growth in Asia and also mitigates climate change issues.

There is a huge variation in the potential trade gap in CFGT among nations in Asia. One of the major reasons is the variation of trade restriction in Asian countries. Other reasons may be socio- political conditions and economic development policies which vary widely among Asian countries. The reasons for untapped potential export gap in CFGTs may be lack of awareness, unavailability of technology, lack of skilled labour for production of CFGT, unfavourable business environment, weak governance, inappropriate government

policy towards CFGTs, lack of trade facilitations, etc. A more in-depth study of sub-regions is needed to explore these in detail. Next chapter focuses on South Asia region and highlights its possible potential trade opportunity.

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Appendix

Appendix Table I: List of 64 Climate Friendly Goods and Technology

SERIAL No.	HS CODES6 DIGIT(2002)	DEFINITION
1	380210	Activated carbon
2	392690	Articles of plastics & arts. ofoth. mats. of 39.01-39.14, n.e.s. in Ch.39
3	392010	PVC or polyethylene plastic membrane systems to provide an impermeable base for landfill sites and protect soil under gas stations, oil refineries, etc. from infiltration by pollutants and for reinforcement of soil.
4	560314	Nonwovens, whether or not impregnated, coated, covered or laminated: of manmade filaments; weighing more than 150 g/m2 for filtering wastewater.
5	701931	Thin sheets (voiles), webs, mats, mattresses, boards, and similar nonwoven products.
6	730820	Towers and lattice masts for wind turbine.
7	730900	Containers of any material, of any form, for liquid or solid waste, including for municipal or dangerous waste.
8	732111	Solar driven stoves, ranges, grates, cookers (including those with subsidiary boilers for central heating), barbecues, braziers, gas-rings, plate warmers and similar non-electric domestic appliances, and parts thereof, of iron or steel.
9	732190	Stoves, ranges, grates, cookers (including those with subsidiary boilers for central heating), barbecues, braziers, gas-rings, plate warmers and similar non-electric domestic appliances, and parts thereof, of iron or steel.
10	732490	Water saving shower.
11	761100	Aluminum reservoirs, tanks, vats and similar containers for any material (specifically tanks or vats for anaerobic digesters for biomass gasification).
12	761290	Containers of any material, of any form, for liquid or solid waste, including for municipal or dangerous waste.
13	840219	Vapor generating boilers, not elsewhere specified or included hybrid.
14	840290	Super-heated water boilers and parts of steam generating boilers.
15	840410	Auxiliary plant for steam, water, and central boiler.
16	840490	Parts for auxiliary plant for boilers, condensers for steam, vapor power unit.
17	840510	Producer gas or water gas generators, with or without purifiers.
18	840681	Turbines, steam and other vapor, over 40 MW, not elsewhere specified or included.
19	841011	Hydraulic turbines and water wheels of a power not exceeding 1,000 kW.
20	841090	Hydraulic turbines and water wheels; parts, including regulators.

21	841181	Gas turbines of a power not exceeding 5,000 kW.
22	841182	Gas turbines of a power exceeding 5,000 kW.
23	841581	Compression type refrigerating, freezing equipment incorporating a valve for reversal of cooling/heating cycles (reverse heat pumps).
24	841861	Compression type refrigerating, freezing equipment incorporating a valve for reversal of cooling/heating cycles (reverse heat pumps).
25	841869	Compression type refrigerating, freezing equipment incorporating a valve for reversal of cooling/heating cycles (reverse heat pumps).
26	841919	Solar boiler (water heater).
27	841940	Distilling or rectifying plant.
28	841950	Solar collector and solar system controller, heat exchanger.
29	841989	Machinery, plant or laboratory equipment whether or not electrically heated (excluding furnaces, ovens etc.) for treatment of materials by a process involving a change of temperature.
30	841990	Medical, surgical or laboratory stabilizers.
31	848340	Gears and gearing and other speed changers (specifically for wind turbines).
32	848360	Clutches and universal joints (specifically for wind turbines).
33	850161	AC generators not exceeding 75 kVA (specifically for all electricity generating renewable energy plants).
34	850162	AC generators exceeding 75 kVA but not 375 kVA (specifically for all electricity generating renewable energy plants).
35	850163	AC generators not exceeding 375 kVA but not 750 kVA (specifically for all electricity generating renewable energy plants).
36	850164	AC generators exceeding 750 kVA (specifically for all electricity generating renewable energy plants).
37	850231	Electric generating sets and rotary converters; wind-powered.
38	850680	Fuel cells use hydrogen or hydrogen-containing fuels such as methane to produce an electric current, through an electrochemical process rather than combustion.
39	850720	Other lead acid accumulators.
40	853710	Photovoltaic system controller.
41	853931	Discharge lamps, (ex ultraviolet), fluorescent.
42	854140	Photosensitive semiconductor devices, including photovoltaic cells whether or not assembled in modules or made up into panels; light-emitting diodes.
43	900190	Mirrors of other than glass (specifically for solar concentrator systems).
44	900290	Mirrors of glass (specifically for solar concentrator systems).
45	903210	Thermostats.
46	903220	Manostats.
47	700800	Multiple-walled insulating units of glass
48	730431	Tubes, pipes & hollow profiles (excl. of 7304.10-7304.29), seamless, of circular cross-section, of cold-drawn/cold-rolled (cold-reduced) steel
49	730441	Tubes, pipes & hollow profiles (excl. of 7304.10-7304.39), seamless, of circular cross-section, of stainless steel, cold-drawn/cold-rolled (cold-reduced)
50	730451	Tubes, pipes & hollow profiles (excl. of 7304.10-7304.49), seamless, of circular cross-section, of alloy steel other than stainless steel, cold-drawn/cold-rolled (cold-reduced)

51	840682	Steam turbines &oth. vapour turbines (excl. for marine propulsion), of an output not >40MW
52	841012	Hydraulic turbines & water wheels, of a power >1000kW but not >10000kW
53	841013	Hydraulic turbines & water wheels, of a power >10000kW
54	850239	Electric generating sets n.e.s. in 85.02
55	850300	Parts suit. for use solely/princ. with the machines of 85.01/85.02
56	850440	Static converters
57	902830	Electricity meters, incl. calibrating meters therefor
58	903020	Cathode-ray oscilloscopes & cathode-ray oscillographs
59	903031	Multimeters
60	903039	Instruments & app. for meas./checking voltage/current/resistance/power (excl. of 9030.31), without a recording device
61	890790	Floating structures other than inflatable rafts (e.g., rafts (excl. inflatable), tanks, coffer-dams, landing-stages, buoys & beacons)
62	847989	Machines & mech. appls. having individual functions, n.e.s./incl. in Ch.84
63	842129	Filtering/purifying mach. & app. for liquids (excl. of 8421.21-8421.23)
64	842139	Filtering/purifying mach. & app. for gases, other than intake air filters for int. comb. engines