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Abstract

This paper investigates the impact of cross-border road infrastructure on trade and foreign direct investment in the Greater Mekong Subregion using panel data from 1981 to 2003. Empirical analysis based on a gravity-model approach suggests that the development of cross-border road infrastructure has had a positive effect on intra-regional trade in major commodities with its elasticity in the range of 0.6-1.4. When the impact of domestic road infrastructure is assessed separately, it has been associated with increased trade. When cross-border and domestic road infrastructure are considered together, the former has had a positive and the latter has had a negative association, respectively, with trade. Results regarding the impact of road infrastructure on FDI flows are ambiguous, although data limitations appear to have attributed to the poor performance of these estimates.

Keywords: cross-border transport infrastructure, regional public goods, economic integration.
JEL classification: F15, H54, H87

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I. Introduction

This paper investigates the impact of cross-border road infrastructure on the economies of the Greater Mekong Sub-region (GMS).[1] Cross-border and domestic road infrastructure together can reduce transport costs and lead directly to increased trade. Reduced transport costs can also raise indirectly foreign direct investment (FDI) by reducing transaction costs involved in intra-firm vertical integration structured to exploit varied comparative advantages across countries. Increases in FDI, in turn, can further increase regional trade, and add to the direct effect of reduced transport costs achieved through improvements in the road infrastructure in border areas. If true, this would define a virtuous cycle of cross-border infrastructure development, trade, and investment that fosters increased trade and economic growth. Despite the many initiatives of economic integration in practice in the GMS, there has been only limited empirical research (e.g., Poncet, 2006), and to our knowledge, none on the role of cross-border road infrastructure. This paper helps fill this gap. [2]

We estimate trade creation and investment facilitation effects of cross-border road infrastructure in the GMS though econometric examination of historical data. In particular, following the approach of Limao and Venables (2001), we estimate gravity model equations for trade and FDI flows between each pair of the six (pre-2005) GMS economies. The gravity approach has been widely applied in empirical studies of bilateral trade since its introduction by Tinbergen (1962) and Poyhonen (1963). "In most cases, the basic gravity model has been employed to capture statistically the bulk of trade variation to discern the marginal explanatory power of free trade pacts and/or exchange rate variability with an aim to test one theory or another" (Bergstrand, 1998, p.27-28). Our principal interest in applying the gravity model in this paper is to use it to establish expected levels of trade between GMS economies from which we can quantify the marginal or incremental effect of cross-border (border-area) road infrastructure on trade in GMS relative to the effect of general domestic (non-border area) road infrastructure.

Despite data limitations associated with the relatively small number of economies included in our analysis and shortcomings in reliable reporting of FDI and other key data in some of the GMS economies, our estimates are able to explain much of the variation in trade flows, although they are less successful in explaining FDI flows. Our results show that the quality of road infrastructure in the border area between economies has a positive and statistically significant relationship with trade flows between them, and that this relationship is particularly strong when both cross-border and general domestic road infrastructure are included in the estimates. This result is important to policy as governments and international development organizations seek effective mechanisms for promoting regional trade and broader economic growth in the GMS.

Section II of the paper discusses the relevant literature we reviewed and Section III sets out the research questions we consider. Section IV presents the analytical approach and estimation models we applied. Section V discusses characteristics of the data we used in our analysis. Section VI presents our estimation procedures and Section VII discusses our results and implications. Finally, Section VIII provides concluding remarks.

II. Relevant Literature

This paper draws from two broad strands of recent economic literature. First, the economic geography literature that has flourished since the 1990s makes increasingly clear the importance of geography in explaining patterns of trade and economic development. For example, access to sea and distance to major markets have been shown to have strong effects on shipping costs, which in turn, strongly influence trade flows in manufactured goods (e.g., Limao and Venables, 2001). Economies suffering multiple geographical handicaps such as landlocked status, an absence of navigable rivers and lakes, or tropical or desert ecology, tend to be among the poorest in the world (e.g., Radelet and Sachs, 1998; Redding and Venables, 2004). These papers have documented a strong negative empirical relationship between transport costs and economic growth controlling for the other variables expected to influence growth. In the context of the GMS, the relative poverty of Lao PDR has long been understood as at least a partial result of the country's landlocked status and geographic characteristics. Empirical evidence in this literature suggests there is much potential for cross-border road infrastructure and associated institutional arrangements to benefit economies that are not endowed with favorable geographic characteristics.

Second, one branch of the recent trade literature has focused on trade and FDI linkages (the so-called "trade-FDI nexus") in explaining patterns of trade and, ultimately, patterns of economic development. Empirical analyses in the area have found that multinational firms can gain from intra-firm trade by integrating production processes across economies with different areas of comparative advantage. When such gains are present, this reduces tendencies towards production agglomeration, and if the advantages of production integration across economies outweigh those from agglomeration, then reductions in transport costs would make FDI complementary to trade. The literature on the trade-FDI nexus shares an understanding that one of the common threads in the economic successes of the "East Asian Miracle" has been the openness of these economies to FDI and their time-limited and targeted use of protectionist measures, which enabled their economies to overcome late-comer disadvantage and to reap the benefits of leaning by doing and network presence in their manufactured exports. Researchers have asserted that in the case of some East Asian economies, this led to a virtuous cycle of increased trade, economic growth, and FDI, and fueled their emergence as export-oriented manufacturing-based economies.[3] The experience of East Asian economies and the potential gains from trade (and capital transfers) between economies in the GMS suggest the latter has the potential to benefit from a similar trade-FDI nexus and greater regional economic integration enabled by improved cross-border road infrastructure.

III. Research Questions

Our interest extends to a few empirical questions considered to be of importance in the context of ongoing road infrastructure development in the GMS.

- What is the empirical relationship between the level of development of cross-border road infrastructure, and trade and FDI flows between GMS economies, historically?
- Can positive marginal effects of cross-border road infrastructure development on trade flows be found empirically, and if found, what is the magnitude of such effects?
- Has the development of cross-border road infrastructure been associated with increased FDI flows, and if so, to what extent can trade creation be attributed to increased FDI?

IV. Analytical Approach and Estimation Models

Our analytical approach is adapted from Limao and Venables (2001) and applies a gravity model to predict bilateral trade and FDI flows for each pair of GMS economies. However, departing from Limao and Venables, we omit estimation of an explicit transport cost equation due to data limitations. The lack of reliable measures of transport costs within the GMS and their proxies is discussed in Section V. Instead, we proceed by using an instrument for transport costs (distance) and include this directly in our trade and FDI equations. Also, departing from the existing empirical literature on the trade-FDI nexus, data limitations prevented us from estimating indirect impacts that come through trade and FDI.[4] Estimation parameters of our particular interest are the responses of trade and FDI to various transport cost factors including cross-border road infrastructure.[5] Accordingly, our empirical analysis centers on the following two functional relationships:

1. <u>Trade equation</u>: $X_{ij} = X(\boldsymbol{E}_i, \boldsymbol{E}_j, \boldsymbol{R}_{ij}, \boldsymbol{R}_{ji}, D_{ij}, F_{ij}, \omega_{ij})$

- X_{ij} : exports of economy *i* to economy *j*,
- $\boldsymbol{E}_i$, $\boldsymbol{E}_j$: vector of characteristics of economy *i (j)* related to trade such as economy size (GDP), population, land area, trade barriers, and other variables typically used in gravity model estimates,
- $\boldsymbol{R}_{ij}$, $\boldsymbol{R}_{ji}$: vector of variables measuring road infrastructure in border areas and non-border (domestic) areas in economy *i* (*j*) with respect to economy *j (i)*,
- D_{ij}: distance between economies *i* and *j*,
- F_{ij} : economy *i*'s foreign direct investment from economy *j*, and
- ω_{ij} : other factors not accounted for (model error).

The trade equation incorporates standard variables used in gravity models plus variables of our particular interest in this research (i.e., measures of cross-border and domestic road infrastructure, and FDI from the trading partners). Economy's GDP is considered a key variable in the base gravity model because larger economies are expected to engage in greater trade (*ceteris paribus*). Trade is expected to be positively influenced by the economic mass of the trading partners and negatively affected by the distance between them. Our focus in this paper is on how road infrastructure is related to bilateral trade in the GMS. Specifically, we envision that bilateral trade between GMS economies is a function of the quality of road infrastructure generally in each economy and particularly the quality of road infrastructure in border areas. Other factors seen as important in driving levels of bilateral trade are differences in price levels between economies, tariff rates, and a broad characterization of the export/import environment in the economies.

Gravity models are often estimated with a few other variables to characterize the geographic characteristics and proximity of economies besides distance (e.g., sharing land border, landlocked status, small island status) or cultural-historical ties (e.g., shared language, dominance by common colonial power), however, these variables are not included in our estimates because there is insufficient heterogeneity in these variables and insufficient degrees of freedom in our small sample of GMS economies.

2. FDI equation: $F_{ij} = F(\boldsymbol{E}_i, \boldsymbol{E}_j, \boldsymbol{R}_{ij}, \boldsymbol{R}_{ji}, D_{ij}, X_{ij}, \boldsymbol{z}_i, \varepsilon_{ij})$

- F_{ij} : economy i's foreign direct investment received from economy j,
- $\boldsymbol{E}_i$, $\boldsymbol{E}_j$, $\boldsymbol{R}_{ij}$, $\boldsymbol{R}_{ji}$, D_{ij}, X_{ij} : same as in the trade equation,
- $\boldsymbol{z}_i$: vector of other characteristics related to economy *i*'s investment climate, and
- ε_{ij} : other factors not accounted for (model error).

The FDI equation specifies that FDI flows are determined by several factors common to the trade equation (e.g., economy size and resources, inflation rate, tariff rates). Of our particular interest, again, is in the relative marginal contributions of cross-border and domestic road infrastructure to FDI flows between the GMS economies. In addition, FDI is viewed as being influenced by various other factors related to the investment climate of the recipient economy.

Following the empirical approach common to gravity models of trade, our base models use two specifications for the above functional relationships:

$$X_{ijt} = AY_{it}^{\alpha_E} Y_{jt}^{\alpha_M} H_i^{\beta_E} H_j^{\beta_M} N_{it}^{\gamma_E} N_{jt}^{\gamma_M} D_{ij}^{\theta} (\varepsilon_{ijt} u_{ij})$$

or $$X_{ijt} = A(Y_{it} Y_{jt})^{\alpha} (H_i H_j)^{\beta} (N_{it} N_{jt})^{\gamma} D_{ij}^{\theta} (\varepsilon_{ijt} u_{ij})$$

where X_{ijt} : are exports from economy *i* to economy *j* in time *t,*

Y_{it}, Y_{jt} : are the gross domestic products of economies *i* and *j* in year *t*,

H_i, H_j : are the geographic sizes of economies *i* and *j*,

N_{it} , N_{jt} : are the populations of economies *i* and *j* in year *t*,

D_{ij} : is the distance between (the capitals of) economies *i* and *j*,

ε_{ijt} : is the regular error term,

u_{ij} : is an error component specific to economy-pair i-j,

A : is a constant,

with the following signs generally expected for the estimation parameters:

α_E ,α_M , α , β_E, β_M , β > 0; and γ_E , γ_M , γ , θ < 0.

In logarithmic form, we have:

$ln\ X_{ijt}=ln\ A+\alpha_E\ ln\ Y_{it}+\alpha_M\ ln\ Y_{jt}+\beta_E\ ln\ H_i+\beta_M\ ln\ H_j+\gamma_E\ lnN_{it},+\gamma_M\ N_{jt}+\theta lnD_{ij}+ln\ \varepsilon_{ijt}+\ ln\ u_{ij},$

or $ln\ X_{ijt}=lnA+\alpha\ (lnY_{it}+lnY_{jt})+\beta(\ lnH_i+\ lnH_j)+\gamma(\ lnN_{it},+lnN_{jt})+\theta lnD_{ij}+ln\ \varepsilon_{ijt}+\ ln\ u_{ij},$

(The FDI equation takes the same form and is not presented here to save space.)

The first specification takes a Cobb-Douglas form in which the influences of each trading partner's economic size, population, and geographic area are estimated separately. The second specification enters the characteristics of economies *i* and *j* as products, following more closely the Newtonian form of the gravity equation. The advantage of the first specification is that it allows examination of the effects of variables between exporting and importing economies separately.[6] The second specification offers a more straightforward interpretation and has the additional advantage of reducing the number of estimation parameters, which is helpful when sample size is relatively limited as in our dataset. Using these specifications as our base models, we add variables for road infrastructure and obtain estimates that control for other standard variables treated in the gravity model.

Before discussing the dataset used in our analysis, some comments regarding potential problems with endogeneity between trade flows and the other variables in the model seem warranted. Endogeneity between trade flows and GDP, and between overland trade flows and the quality of road infrastructure in the border areas – in particular – are of concern in this regard. With respect to the former, we note that the widespread use of GDP as a regressor in the vast gravity model literature. Moreover, we use a measure of major goods traded over land (to be explained later) in addition to total bilateral trade as our dependent variable, which would have only a limited endogeneity problem since major goods traded over land represents a smaller share of GDP. Were it the case that cross-border road infrastructure is developed in response to increased demand by traders, then endogeneity between trade and cross border road infrastructure would be a problem. However, the significant lead time required before a planned road is constructed and is available for transporting goods supports treating the extent of road infrastructure as an exogenous variable.

V. Data

Our dataset tracks trade and other variables for each pair of GMS economies over the period of 1981 to 2003. In all, 30 economy pairs can be formed across the 6 GMS economies (i.e., Cambodia-Laos, Cambodia-Myanmar,…,Yunnan-Thailand, and Yunnan-Vietnam). Table 1 summarizes descriptive statistics from the dataset along with details on the data sources and definitions of variables. In the table, "between n" reports the number of reporting economy pairs (maximum 30), "within T(-bar)" the number of data years (maximum 23 years), and "overall N" the total number of observations (maximum $30\times23=690$).

Due to the relatively small number of GMS economies and limited number of years for which most data are available, missing data problems were widespread and created challenges in estimating our models. This is particularly true for data during the initial years of our panel, when many of the GMS economies were suffering prolonged periods of conflict or social unrest and did not have well established national statistical services. In the remainder of this section we discuss details on data collection and the measures we used for key variables.

<u>*Transport cost*</u>

This study required information on overland transport costs because of our focus on road infrastructure. However, gathering reliable measures for these proved difficult. Past studies, including Limao and Venables (2001), used directly observed transport costs data collected from shipping and logistics companies and they mainly capture the costs of transport by sea. We were not able to find reasonable data directly representing observed transport costs over land in the GMS. Then we considered using a commonly employed proxy for transport costs: the ratio of Cost, Insurance, and Freight (CIF) and Free on Board (FOB) prices. The CIF/FOB ratio between two economies provides a proxy for average costs of transporting goods between them weighted by the value of the goods being traded.[7] In the case of the GMS, however, collecting panel data for CIF/FOB proved impractical because: (i) the trade authorities for most GMS economies record export values in FOB only and import values in CIF only; and (ii) FOB import values reported in balance of payment statistics are available only at the economy-aggregate level, but not by individual trading partner. An alternative to finding FOB import values would be to assume the FOB export values equal the FOB import values for corresponding trade partners; however, analysis of these data revealed large discrepancies between the recorded values for exporters and those for corresponding importers. Problems of missing or unreliable trade data reported in GMS economies with weak statistical capacity such as Cambodia, Lao PDR, and Myanmar lead international trade databases including the International Monetary Fund's (IMF) *Direction of Trade Statistics* (DOTS) to adjust the data for these economies based on data of their trading partners such as China and Thailand (for example, in a number of cases, it appeared that an assumed CIF/FOB ratio of 1.08 was used). Other data sources and adjustments to derive transport cost measures were tried, but none proved reliable ultimately. Due to these data problems with transport costs, we had to forgo the estimation of the effects of road infrastructure in two steps – first on transport costs, and then second on trade flows – and instead estimate the determinants of trade (and FDI) flows in one step as described in Section IV.

Trade flows

We employ two measures of trade flows: one based on total bilateral trade reported in the IMF-DOTS database (except for Yunnan Province for which data are taken from Yunnan Statistical Yearbook), and the other based on "major exports" transported via land or river. For the latter measure, the selection of the representative commodities relied on customs data available at selected international crossing points (including river ports) in the GMS. Up to five commodities defined at the four digit level in the UN Harmonized System of Product Categories that are considered largely transported via land (or ferry, where river transport dominates) are identified and their export values reported in the UNCOMTRADE database are summed to form the measure of major exports via land.[8] Use of this measure is preferred to the use of total bilateral trade because cross-border road infrastructure is expected to be more important in determining the volume of overland trade flows than that of total trade, which includes ocean-bound trade and is influenced by a greater variety of factors. However, the use of the preferred measure comes at the cost of data scarcity and some unavoidable subjectivity in the selection of major goods due to sketchiness of customs data at overland points of entry. Therefore, the use of the total bilateral trade would work as a check on the sensitivity of estimates depending on the choice of the trade measures, and it can also gauge the effect of more limited sample size on estimates despite the presumably weaker relationship between total trade and cross-border road infrastructure.

One last issue concerning the trade data used in this study concerns the problem of undocumented trade/smuggling between GMS economies. The limited evidence available regarding the magnitude of smuggling suggests that a significant portion of intra-GMS trade goes unrecorded by government officials. Estimates of the value of smuggled goods generally fall in the broad range of 30 to 50 percent of the value of the recorded trade.[9] However, for the purpose of this paper, we maintain that omission of the value of unrecorded trade is unlikely to significantly influence estimates due to our focus on international crossing points—as opposed to local border crossing points—in deriving the measure of cross-border road infrastructure.[10]

Road infrastructure

We construct two separate measures for road infrastructure based on road density in GMS economies: one characterizing road density in border areas and the other characterizing road density in non-border areas.[11] In this paper "cross-border road infrastructure" is represented by the density of paved roads in the provinces (for Cambodia, Lao PDR, Thailand, and Vietnam), states (for Myanmar) or districts (for Yunnan Province) containing international crossing point(s) to the corresponding GMS pair. "Domestic road infrastructure" is represented by the density of paved roads in the provinces, states or districts that do not border any economy. Figure 1 displays the GMS road network and border crossing points referenced in our dataset. For example, cross-border road infrastructure for Cambodia as an exporter and Lao PDR as an importer is represented by the road density in Stung Treng Province of Cambodia and Champassack Province of Lao PDR, respectively. In Tables 2-4, these variables are represented by "cross-border roads exporter" and "cross-border roads importer," respectively. Similarly the domestic road infrastructure in this case is represented by road density of all the other provinces in these economies and they are represented by "domestic roads exporter" and "domestic roads importer," respectively, in Tables 2-4. Road density is calculated by dividing the total road length in border (non-border) provinces by the total area of the corresponding provinces, states, or districts, with adjustments in a few cases where disaggregated road inventory data are unavailable.[12]

VI. Estimation Procedures

Estimates are carried out using estimators suitable to the panel structure of our data. By panel, we refer to the fact that data consists of variables covering the cross-section of GMS economies over time, which raises concerns of serial correlation in estimation residuals.[13] Depending upon the results of Hausman and Breusch-Pagan Lagrange Multiplier tests, either the random effects estimator or the robust ordinary least squares (OLS) estimator is applied. Robust OLS is the regular OLS estimator with a Huber-White correction, which takes into account the panel-nature of the data in recalculating standard errors. The fixed effects estimator cannot be applied since key variables of concern (e.g., distances, land areas) are fixed over time. The Hausman test indicates whether the fixed or random effects approach is appropriate by testing for omitted variables. A significant result from the Hausman test indicates that strong parametric assumptions of the random effects estimators are not met so this estimator is not suitable. In such cases, we use the robust OLS estimator despite its reduced efficiency. The Breusch-Pagan test evaluates the significance of random effects versus a regular OLS estimator by examining the statistical significance of economy-pair-specific error terms included in the random effects estimator. A significant result from the Breusch-Pagan test implies that the random effects estimator should be used.

Coefficient estimates in random effects estimation reflect a weighted average of the cross-sectional and time-series association between the dependent and independent variables included, with the weighting indicated by the estimation parameter Rho. The statistical significance of coefficient estimates is tested using a z-test that is functionally equivalent to a standard t-test applied in OLS regression. The overall statistical significance of the estimation models is tested using the Wald Chi-square test, which indicates the probability of a false rejection of the null hypotheses that the model has no explanatory power over the dependent variable.

Finally, coefficient estimates in all estimation models can be interpreted as elasticities because they are estimated in logarithmic form.

VII. Estimation Results

Table 2 presents estimation results on total exports between GMS economies. Seven variant specifications of the model are reported. They yield coefficient estimates that are largely consistent with expectations (e.g., a negative association with distance and a positive association with economic size), and conform to gravity model results in several recent papers.[14] All the models except Model 7 show overall goodness of fit with R-squared coefficients in the range of 44 to 63 percent. They are all highly statistically significant according to results of F-test (robust OLS) or Wald Chi-square test (random effects). The results of Hausman test indicate that the robust OLS estimator should be used for all models except Model 3.

The overall results suggest that the gravity model approach provides a strong basis upon which we can judge the marginal effect of additional variables on the level of trade. In particular, Model 1 includes only the gravity model base variables with exporting and importing economies separated. The coefficient estimates have the expected signs and significance, so endorse application of the gravity model to analyze trade flows in the GMS.

In Model 2, cross-border road infrastructure is found to have a positive and statistically significant association with total exports on both the exporter's and importer's sides of the border. According to this estimate, a one percent increase in the stock of roads on each side of the border area are associated with 1.2 and 1.7 percent increases in total trade between the importing and exporting economies, respectively. Model 3 adds measures of domestic road infrastructure, alone, to the base gravity model, and finds a positive but statistically insignificant association between total trade and domestic roads.

Models 4, 5, and 6 add both cross-border and domestic road infrastructure to the base gravity model estimates of total trade. Coefficient estimates for importer's cross border road infrastructure are all positive and statistically significant, and large in magnitude; however, those for exporter's cross border roads are positive but not statistically significant.

In contrast, importers' domestic roads are estimated to have a negative and statistically significant association with total trade in two of these models. Domestic road infrastructure in the exporting economies is estimated to have a positive but insignificant association with total level of trade. These results imply that cross-border road infrastructure on the importer's side of the border promotes greater trade, while the importer's domestic road infrastructure diminishes trade – perhaps by fostering domestic market integration at the expense of foreign trade. The more likely explanation for the very large elasticities, however, is that these are artifacts of high covariance between our measures of cross border and domestic road infrastructure measures.[15] The magnitudes of the trade effects estimated for importer's cross-border and domestic road infrastructure appear unreasonably large given the presumably smaller influence they would have on aggregate trade relative to their influence on major overland trades. But the results could also be explained if our road measures were capturing broader policies determining trade orientation/openness. This would occur if economies more oriented towards foreign trade tended to make greater investments in cross-border infrastructure.

If, as indicated by the results of Models 4 to 6, cross-border and domestic road infrastructure play non-complementary roles in promoting regional trade in the GMS, regional integration would require strategic shifts in road investments toward border areas.

Some of the models in Table 2 include other factors one might expect to influence the total trade flows. For example, Models 4 through 6 include a measure of the relative prices in the two trading partners (captured by the ratio of purchasing parity power parity (PPP) conversion factors). As expected, two of these models show that the higher the ratio (i.e., the greater the cost of goods in the importer vis-à-vis the exporter), the greater the level of total exports. Model 6 includes the average weighted tariff rate of the importer as an explanatory variable. However, this is found to not have a statistically significant effect on trade. Possible explanations for this are that tariff rates averaged across all goods and trading partners poorly reflect the tariff rates between particular GMS economies or that non-tariff barriers are of greater importance than tariff levels in determining trade. Lastly, Model 7 estimates the relationship between FDI on trade by adding measures of bilateral FDI flows to the base gravity model, and finds no statistically significant relation between the two.[16]

Table 3 presents results for the determinants of the major exports over land between GMS economies. The eight models presented report estimated R^2 measures ranging between 47 percent (Model 8) and 74 percent (Model 12), and all models are highly statistically significant as indicated by the results of F-test or Wald Chi-square test. Based on the results of Hausman test, all models except models 9 and 10 use the robust OLS estimator.

Gravity model estimates carried out using the major export measures are less successful in explaining past trade than the estimates using the total export measures. The coefficient estimates on the base variables of the gravity model, except for GDP, failed to yield expected signs and statistical significance consistently. The contrast between the results from estimates using total and major export measures could be due to the limited explanatory power of the gravity model for the latter (i.e., major goods transported over land in the GMS) or to the much reduced sample available in the latter estimates. The distance variable shows either an insignificant or a positive influence on major exports, which is counter to the expectation from gravity model. Perhaps, distance between capitals is a poor indicator for the relevant distance in determining overland trade flows between GMS economies, which would be the case if overland trade tended to focus on markets besides the capital city (e.g., regional markets closer to border areas).

When the cross-border road infrastructure variable is added separately to base variables of the gravity model (Models 9 through 12), we find a positive and statistically significant association with trade levels for both exporter's and importer's sides of cross-border roads. Estimated trade elasticities with respect to cross-border roads range between 0.635 and 1.357. These were generally larger for exporter's side (except in model 10), and were relatively stable across the various model specifications estimated. The trade elasticities with respect to cross-border road infrastructure appear more reasonable in the major export estimates than in the estimate of total exports, which would follow from the expected closer relation between trade in goods selected based on their importance to overland trade as opposed to total trade (which relies more heavily on sea shipment).

Model 13 shows that when our measure of domestic road infrastructure is added separately to the base gravity model, it alone has a significant positive association with the level of major exports—with a elasticity of about 1 for both the exporter and importer. Paralleling our finding from the estimates of total trade, when both cross-border and domestic road infrastructure measures are included in the model (Model 14), we find that cross border roads have a positive and significant effect on majors exports on the exporter's side of the border—with an unrealistically large elasticity—but domestic roads in the exporting economy have negative and significant association with major exports. As discussed in reference to total export estimates, high covariance between cross border and domestic road measures seems to offer the most likely explanation for the magnified elasticities. The result in Model 14 implies that domestic road infrastructure—when separated from roads in frontier areas—mainly promotes the integration of domestic markets and diverts economic activities away from trade in major goods across GMS economies.

Another relationship of our interest is how FDI flows between GMS economies influence trade levels. Model 15 adds a measured bilateral FDI to the base gravity model and suggests that importer-to-exporter FDI flow has a small (0.098) but statistically significant association with major exports, but that exporter-to-importer FDI flow has no significant effect.

This provides some evidence of a positive trade-FDI nexus in which FDI contributes to export growth from the FDI-recipient economies, and would be consistent with the movement of export-oriented assembly and resource extraction activities. Lastly, the result from Model 12 indicates that tariff barriers have no discernible influence on major exports, which was also the case in total exports estimates.

Finally, we are also interested in examining the determinants of FDI flows between GMS economies—particularly the relationship between FDI, trade flows, and development of road infrastructure. Table 4 summarizes FDI inflow estimation results. In general, the gravity model performed poorly in explaining regional FDI flows, although, admittedly, our dataset on FDI flows was small. Calculated R^2 statistics for the models were fairly low, ranging between 0.37 and 0.41, but all models were statistically significant according to F-tests. Few variables except GDP were found to have significant associations with FDI flows. Cross-border road infrastructure was estimated to have a positive but not statistically significant association with FDI in most models, while domestic road infrastructure was found to have a negative but again statistically insignificant association.

VIII. Conclusions

This paper investigates the impact of cross-border and domestic road infrastructure on trade and FDI flows in the GMS during the past two decades. The theoretical underpinnings of the research draw from the recent economic geography and trade literatures, while the paper's empirical approach is based on a gravity model estimation framework. Our main interest is in the marginal effect of cross-border road infrastructure on trade and FDI when domestic road infrastructure and other controls are taken into account. The most notable findings were:

(i) Economy size appears to be a dominant driver of both trade and FDI, and other base variables of the gravity model generally perform as expected (except for the estimates of FDI flows);

(ii) The elasticity of trade in major exports likely to be transported over land between GMS economies with respect to developments in cross-border road infrastructure is estimated to be in the range of 0.6-1.4;

(iii) When the gravity model of total trade is estimated with domestic road infrastructure separately, we find a positive association between the two with an estimated elasticity of about 1.0;

(iv) Estimates including measures of both cross-border and domestic road infrastructure show that cross-border roads have a positive association and domestic roads have a negative association with trade flows (both major exports and total trade); and

(v) Barriers to trade captured by weighted average tariff rates and a trade environment dummy variable failed to yield significant associations with trade flows, which may suggest a relatively greater impact of unmeasured non-tariff barriers or poor measurement of these proxies for trade policy.

From this analysis, we conclude that the development of cross-border road infrastructure in the GMS has had a positive effect on the regional trade. The result that cross-border roads have distinct effects from domestic road infrastructure suggests promotion of regional trade may require deliberate policy shifts toward investments in roads in border areas. In this light, cross-border road infrastructure becomes an important part of a broader effort to encourage regional integration to benefit GMS economies that are less endowed with natural seaports such as Lao PDR.

Nonetheless, sample size constraints associated both with the relatively small number of GMS economies and with missing data problems represent serious challenges in carrying out otherwise more comprehensive regression exercises. Our estimates provide little insight into the determinants of FDI flows between GMS economies, although FDI flows are associated at a statistically significant level with slightly higher trade in major exports.

The modeling framework and empirical estimates in this paper provide a useful beginning in efforts to estimate some of the key empirical relationships between road infrastructure development, trade, and FDI in the context of the GMS. While application of the gravity model to intra-GMS FDI flows appears premature, such application could gain relevance in the future as the flow of investments particularly from Thailand and China toward the other GMS economies increase and the data situation in Cambodia, Lao PDR, Myanmar, and Vietnam improves.

Notes

[1] Current members of GMS are Cambodia, Lao PDR, Myanmar, Thailand, Vietnam, Yunnan Province of China, and Guanxgxi Zhuang Autonomous Region of China. Guangxi Region joined GMS in 2005. Analysis in this paper excluded data for Guangxi Region due to scarcity of detailed data documented (e.g., in Guanxi Statistical Yearbooks), particularly on transport infrastructure. Throughout this paper, we use “economy(ies)” in referring to the members of the GMS.

[2] The motivation and detailed background of this research are discussed in Fujimura (2004).

[3] Trade-FDI nexus in line with the argument here has been well researched in the context of East Asia’s economic integration: e.g., Fukao, Ishido and Ito (2003) and Urata (2001).

[4] The dataset used in this study features too few observations to permit simultaneous estimation of equations (trade and FDI) with a panel structure.

[5] De (2005) applied a gravity model to Asian countries with transport infrastructure variables and transaction costs among the explanatory variables, but does not distinguish cross-border and domestic transport infrastructure as such.

[6] However, caution is warranted in interpreting results when asymmetric coefficients for exporting and importing economies are obtained, since these may to a considerable extent be driven by imbalance in the panel.

[7] CIF = FOB + freight forwarding charge + insurance premium. To the extent that insurance premiums are similar for goods transported between various GMS markets, the CIF/FOB ratio would provide a good measure of transport costs.

[8] For example, for major exports from Lao PDR to Thailand the commodities selected (based on goods transit reported at selected border crossing customs stations in 2004) were: HS2483 (wood of non-coniferous species), HS2472 (sawn logs and veneer logs of non-coniferous species), HS0011 (animals of bovine species), HS2876 (tin ores and concentrates), and HS2842 (wood of coniferous species).

[9] ADB (2004) p.14.

[10] A number of other points can be offered with respect to the issue of unmeasured trade within the GMS and its impact on our findings. Improvement in the availability and quality of roads at borders may reduce incentives for smuggling by increasing relative cost of transport via undocumented channels (by making transport via primary roads through international crossing relatively more cost-efficient vis-à-vis smuggler routes) and by capacitating customs enforcement. Also, to the extent that major international roads are used by smugglers, estimates of trade effects of cross-border road improvement will underestimate true positive effect of the road on trade, so examining official trade figures would offer a conservative test of road improvement's influence on trade flows. Lastly, it is reasonable to assume that the economic incentives for smuggling of some goods between GMS economies have fallen over time as they have lowered tariff rates on many imports from their neighbors, which would be expected to reduce smuggling over time (other things being equal).

[11] Data sources (and data years available) were: Committee for Development of Cambodia (CDC) for Cambodia (1995-2002), Department of Roads, Ministry of Communication, Transport, Post and Construction (MCTPC) for Lao PDR (1992-2003); Department of Highways, Ministry of Transport for Thailand (1994-2003); and transport section of statistical yearbooks for Myanmar (1984-1996), Vietnam (1993-2002) and Yunnan Province (1990-2002), respectively.

[12] For Cambodia, road data by province were available only for 1995. This data was extrapolated to recent years based on the available data on total road length. For Thailand, road inventory data are not recorded by province but by the route of national highways that run through multiple provinces. Therefore, adjustment was made by the estimated provincial shares of road length of each highway based on the GIS-based "Road Inventory of ASEAN Highways" developed by UNESCAP. For Vietnam, road inventory data was available for only 1994. This data was extrapolated based on the available administrative data on freight tonnage and distance carried. Justification for this treatment is that freight carriages reflect to some extent "revealed" quality of roads that are used.

[13] See Greene (2003) or other graduate econometric texts treating panel estimation procedures for further discussion of the estimators and specification tests reviewed briefly here.

[14] For example, our estimation results are generally comparable to those reported in Frankel and Romer (1999), Soloaga and Winters (2001), Clarete et al. (2003), Rose (2004), and Yamarik and Ghosh (2005).

[15] Given high covariance between available measures of domestic and cross-border road infrastructure, coefficient estimates that include both these variables must be interpreted with caution (i.e., multicolinearity problem), which is why we present models that include the cross-border and domestic road variables separately. Unfortunately, no usable instruments for either of our road measures could be identified and other approaches to solving potential problems of mutlicolinearity between these two variables of interest were considered impractical.

[16] In addition to the explanatory variables discussed here, models estimates examined a number variables (e.g., dummy variables characterizing the export, import, and foreign investment environment), but these were not found to have statistically significant effects on trade and FDI under various specification, and are not reported in light of space constraints. Full results are available upon request from the authors.

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