Trade Facilitation and Economic Development: A New Approach to Quantifying the Impact

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This article analyzes the relationship between trade facilitation and trade flows in the Asia-Pacific region. Country-specific data for port efficiency, customs environment, regulatory environment, and e-business usage are used to construct indicators for measuring trade facilitation. The relationship between these indicators and trade flows is estimated using a gravity model that includes tariffs and other standard variables. Enhanced port efficiency has a large and positive effect on trade flows. Regulatory barriers deter trade. Improvements in customs and greater e-business use significantly expand trade but to a lesser degree than improvements in ports or regulations. The benefits of specific trade facilitation efforts are estimated by quantifying differential improvements in these four areas among members of the Asia Pacific Economic Cooperation (APEC). A scenario in which APEC members with below-average indicators improve capacity halfway to the average for all members shows that intra-APEC trade could increase by $254 billion, or 21 percent of intra-APEC trade flows. About half the increase is derived from improved port efficiency.

Economic theory suggests a relatively direct and simple chain of causality: human development is enhanced through income growth; income growth is greater with more cross-border trade; trade is increased through trade facilitation efforts. Recent empirical work has focused on quantifying each of these links. The human development index is positively related to gross domestic product (GDP) per capita, and countries with a growing income have a higher GDP per capita. Though the positive relationship between trade and growth has come under scrutiny recently, there is no evidence that increased cross-border trade reduces income growth. The focus of this article is on the last (or perhaps first) link in the chain—the empirical relationship between trade facilitation and trade flows.

Trade facilitation most often implies improving efficiency in administration and procedures, along with improving logistics at ports and customs. A broader

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definition includes streamlining regulatory environments, deepening harmonization of standards, and conforming to international regulations (Woo and Wilson 2000). Emphasizing broader concepts of trade facilitation is particularly important given the increasing volume of global trade, the time sensitivity of intermediate goods trade (Hummels 2001), reductions in protective tariff rates, and increased availability of modern technology that can improve the management of cross-border trade. This article examines the empirical relationship between relatively broad concepts of trade facilitation and trade flows. It also compares trade facilitation initiatives with reductions in traditional trade barriers (such as tariffs and quotas) for their impact on trade flows and considers complementarities between them.

As part of individual development strategies, some countries, with or without donor assistance or private funding and partnerships, are considering whether to engage in unilateral trade facilitation efforts. They also confront the challenge of priorities within a broad range of trade facilitation measures. At the 1996 Singapore Ministerial Conference of the World Trade Organization (WTO) trade facilitation was added to the new basket of trade issues. Discussions continue on priorities in trade facilitation in the WTO Doha Development Agenda. Decisions on modalities for negotiations on trade facilitation, including customs procedures, were on the agenda for the WTO Ministerial Conference in Mexico in September 2003. Debate also continues on such issues as whether to extend the Information Technology Agreement to nontariff measures and standards, as well as whether international standards should be mandated in national regulations. The lack of empirical measures of trade facilitation and of their impact on international commerce limits informed debate.

At least three challenges are apparent in empirical research on trade facilitation: defining and measuring trade facilitation, choosing a modeling methodology to estimate the importance of trade facilitation for trade flows, and designing a scenario to estimate the effect of improved trade facilitation on trade flows. The research approach taken here contributes to a deeper understanding in each of these areas. The article explores these topics for trade among members of the Asia Pacific Economic Cooperation (APEC), which accounts for about 57 percent of world GDP and about 47 percent of global trade.

First, trade facilitation is defined and measured using four indicators (port efficiency, customs environment, regulatory environment, and e-business usage) rather than a single parameter to proxy trade facilitation, such as import prices, international transport costs, or productivity of the transport sector. Second, a gravity model of bilateral trade flows rather than a computable general equilibrium (CGE) approach is used to model cross-border trade and to estimate the effect of trade facilitation on trade. Third, the scenarios explored to determine the benefits of trade facilitation do not assume that all countries improve capacity by the same amount to support trade flows. The simulations acknowledge that some countries have farther to go to reach best practice in regulatory reform or port efficiency, for example, than do others.

Section I reviews definitions of trade facilitation and previous efforts to measure the impact on trade. Sections II and III discuss the data, methodology,

and results from the empirical model used to estimate the relationship between bilateral trade flows and country-specific trade facilitation measures. Section IV presents simulation exercises exploring the consequences of improving trade facilitation measures for APEC as a whole, for individual countries as exporters to APEC, and for individual countries as importers from APEC.

I. Overview of Previous Work on Measuring the Impact of Trade Facilitation

There is no standard definition of trade facilitation. In a narrow sense, trade facilitation simply addresses the logistics of moving goods through ports or customs at the border. A broader definition includes the environment in which trade transactions take place, including the transparency of regulatory environments, harmonization of standards, and conformance to international or regional regulations. The focus has now moved behind the border to domestic policies and institutional structures, where capacity building plays an important role. In addition, the rapid integration of networked information technology into trade means that service sector infrastructure that supports technology use is also relevant. The definition of trade facilitation used here incorporates such border elements as port efficiency and customs administration and such behind-the-border elements as the domestic regulatory environment and the infrastructure to enable e-business.

The empirical literature on trade facilitation is limited. Maskus and others (2001) address some of the more important empirical methods and challenges in quantifying the gains of trade facilitation in the area of harmonized regulations. The Asia Pacific Foundation of Canada (1999) outlines the relative importance of three kinds of trade facilitation measures (customs, standards and regulatory conformance, and business mobility) for APEC business but does not assess the impact on APEC trade of trade facilitation improvements. The Australian Department of Foreign Affairs and Trade and Chinese Ministry of Foreign Trade and Economic Cooperation (2001) suggest that moving to electronic documentation for APEC trade would yield a cost savings of some 1.5 to 15 percent of the landed cost of an imported item. Applying a simple average of a 3 percent reduction in landed costs from electronic documentation for intra-APEC merchandise trade yields gross savings of US$60 billion. The Organisation for Economic Co-operation and Development (OECD 2001) summarizes other studies, but most use a limited definition of trade facilitation or old data.

Several recent studies use CGE models to quantify the benefits of improved trade facilitation. In CGE models an improvement in trade facilitation can be modeled equivalently as a reduction in the costs of international trade or as an improvement in the productivity of the international transport sector. Because this sector is already included in the CGE model, the effect of improved trade facilitation comes from "shocking" the sector by an appropriate amount. The United Nations Conference on Trade and Development (UNCTAD 2001) uses CGE analysis to consider trade facilitation in the broader context of creating an environment conducive to developing e-commerce. The objective of the CGE

analysis is to consider the relationship between a given size shock to productivity growth, applied equally to all members of the group, on the GDP of regional groups of countries. The results show that a 1 percent reduction in the cost of maritime and air transport could increase Asian GDP some $3.3 billion. If trade facilitation is considered in a broader sense to include an improvement in wholesale and retail trade services, a 1 percent improvement in the productivity of that sector could increase GDP an additional $3.6 billion.

APEC (1999) also uses CGE analysis. The shock reduction in trade costs from trade facilitation efforts differs among members of the group, with a 1 percent reduction in import prices for the industrial countries and the newly industrializing economies (the Republic of Korea, Singapore, and Taiwan, China) and 2 percent for the other developing economies. APEC (1999) estimates that APEC merchandise exports would increase by 3.3 percent from the trade facilitation effort to reduce costs. In comparison, the model estimates a long-run increase of 7.9 percent in APEC merchandise exports from completing Uruguay Round commitments.

Hertel and others (2001) use CGE analysis to quantify the impact on trade of harmonizing standards for e-business and automating customs procedures between Japan and Singapore. They find that these reforms will increase trade flows between these countries as well as with the rest of the world.

Other research addresses specific aspects of the trade facilitation agenda and uses gravity model analysis. Freund and Weinhold (2000) find that a 10 percent increase in the relative number of Web hosts in one country would have increased trade flows by 1 percent in 1998 and 1999. Fink and others (2002b) find that a 10 percent decrease in communication costs is associated with an 8 percent increase in bilateral trade. Moenius (2000) finds that bilaterally shared standards can promote trade. Otsuki and others (2001b), looking at food safety standards, find that a 10 percent tighter EU standard on aflatoxin contamination levels would reduce African exports by 4.3 percent for cereals and 11 percent for nuts and dried fruit. The study reported here uses a gravity model of bilateral trade in the region and incorporates a richer set of indicators of trade facilitation in the analysis. The model also includes tariffs to determine which of these factors might have a greater effect on trade flows within APEC.

II. Data for Measuring Trade Facilitation and Trade Flows

The greatest challenge to new research on trade facilitation is to find conceptually distinct measures of trade facilitation to meet policymakers' needs for specificity. Should policymakers focus scarce resources on port modernization, customs reform, regulatory harmonization, or e-commerce infrastructure? There are clearly synergies among these reforms. Limited resources, however, mean that not all reforms can be addressed simultaneously. Previous efforts to proxy trade facilitation using import prices or transportation costs are not adequate for informing policy priorities.

This analysis includes four indicators that measure four different categories of trade facilitation effort:

- *Port efficiency*, designed to measure the quality of infrastructure of ports and airports.
- *Customs environment*, designed to measure direct customs costs as well as administrative transparency of customs and border crossings.
- *Regulatory environment*, designed to measure the economy's approach to regulations.
- *E-business usage*, designed to measure the extent to which an economy has the necessary domestic infrastructure (telecommunications, financial intermediaries, logistics firms) and is using networked information to improve efficiency and transform activities to enhance economic activity.[1]

Each indicator is generated from data specific to each APEC economy. The indicators alone can help policymakers judge how their economy rates relative to APEC's best practice in each of these areas. Self-assessments against best practice and estimation results on the effect of indicators on trade flows provide useful information to policymakers about what might be the most fruitful direction for reform, capacity building, and negotiation.

Survey data were used to generate the four indicators because no other empirical data are available on a consistent basis for all the APEC members. Although some APEC members have done empirical studies of, for example, improvements in customs costs or release times from customs warehouses, the gains obtained by a country (such as Singapore) cannot be assumed to apply equally to other countries. The objective of the research for this study is to distinguish one country from another in the need for capacity building or pilot projects in the various trade facilitation areas.

In addition, the data available on the conceptual basis relevant for the trade facilitation analysis are also limited. Consistent and country-specific assessments are needed for port efficiency, customs environment, regulatory environment, and e-business usage. Survey data are used in the analysis because they are available for the range of trade facilitation indictors to be examined. Although the data must be used with caution and checked across alternative sources for similar proxies, they offer the potential for cross-country qualitative and quantitative analysis to inform policy discussion and debate.

Generating Trade Facilitation Indicators

Each of the four trade facilitation indicators is constructed with multiple data inputs (oversampling) to reduce dependence on any one survey response. The

1. For further discussion of the relationship between domestic infrastructure and e-commerce, see Mann and and others (2000).

inputs can be analyzed to gain even greater information about trade facilitation measures for individual economies and across APEC. Because some of the data are actual values and some come from surveys with different response ranges (1 to 7, 1 to 10, and so on), the raw data need to be put on a comparable basis. Each APEC-specific observation of a raw series is indexed to the average of all the APEC members' value for the raw series, yielding an indexed input.[2]

Next, the indexed inputs into the four specific trade facilitation indicators are averaged. For greater transparency—and because there is no specific argument (theoretical or statistical) for choosing a different aggregation method—a simple average is used.[3] Details of the sources and survey questions underpinning each of the indexed inputs are in the appendix.

Examining the indexed inputs that are averaged to generate the indicators is informative for several reasons. First, summary statistics on the indexed inputs and the aggregated indicators identify where countries fall in the range from best practice to worst practice (table 1). Knowing the range and where countries are in the range is important for building the scenarios on the benefits of trade facilitation and for considering which areas of trade facilitation might be most fruitful for a country or for APEC as a whole. Second, correlation matrixes of the indexed inputs into the averages help determine how well the oversampling of surveys works to reduce dependency on a single raw data input while still measuring the relevant trade facilitation concept. Within each trade facilitation indicator the correlation of the indexed inputs is high—above 0.85—suggesting robustness of the trade facilitation indicator with respect to the source of the data. But the fact that the correlations are not 1 indicates that the use of multiple inputs for each trade facilitation indicator is valid.

Trade Flows and Other Variables

Trade data are bilateral trade flows of manufactured goods among APEC member nations from 1989 to 2000. The data come from the Commodity and Trade Database (COMTRADE) of the United Nations Statistics Division. Manufactured goods are defined as commodities in categories 5 to 8 at the one-digit level of the Standard International Trade Classification (Revision 1) except those in category 68 (nonferrous metals), which are at the two-digit level. Trade flow data

2. So an indexed input for APEC member $J(J = 1, 2, 19)^2$ is constructed as: $\overline{II}_J = II_J/(\sum_{J=1}^{19} II_J/19)$ where II_J denotes the raw data for APEC member J, where II_J denotes the raw data for APEC member J.

3. The statistical properties of the trade facilitation indicators may require further consideration. The raw data come from different metrics (percent, survey ranges from 1 to 7 or 1 to 10, numbers of users). So the standard deviations around the mean of each of these indicators will differ from the standard deviation of the indexed inputs that they become. When averaged into the trade facilitation indicator, the standard deviation of the final product and its relationship to the standard deviation of the original data are unclear. What implication this has for using the trade facilitation indicators for estimation in the gravity model is also unclear.

TABLE 1. Summary Statistics for Values of Trade Facilitation Indicators

Indicator and indexed inputs	Source	SD	Min	Economy	Max	Economy
Port efficiency						
Port Efficiency Index (higher is better)	Clark and others 2002	0.284	0.612	Philippines	1.482	Singapore
Ports (higher is better)	World Econ. Forum 2000	0.264	0.617	Philippines, Vietnam	1.447	Singapore
Air transport (higher is better)	World Econ. Forum 2000	0.216	0.688	Peru, Vietnam	1.319	Singapore
Aggregate index		0.248	0.658	Philippines	1.416	Singapore
Customs environment						
Irregular payments (higher is fewer)	World Econ. Forum 2000	0.324	0.464	Russia	1.372	New Zealand
Import fees (higher is fewer fees)	World Econ. Forum 2000	0.359	0.569	Russia	1.821	Singapore
Hidden import barriers (higher is fewer barriers)	World Econ. Forum 2000	0.267	0.461	Indonesia	1.384	Hong Kong, China
Improper practices (higher is better administration)	IMD 2000	0.566	0.142	Russia	1.779	Singapore
Corruption Perceptions Index (higher is less corruption)	Transparency Int'l 2001	0.467	0.343	Indonesia	1.694	New Zealand
Aggregate index		0.375	0.456	Russia	1.590	Singapore
Regulatory environment						
Effectiveness of regulations	World Econ. Forum 2000	0.190	0.748	Vietnam	1.402	Singapore
Regulatory standards	World Econ. Forum 2000	0.235	0.628	Vietnam	1.342	United States
Compliance with agreements	World Econ. Forum 2000	0.183	0.683	Peru	1.256	Singapore
Enforcement of regulations	World Econ. Forum 2000	0.250	0.638	Philippines	1.448	Singapore
Aggregate index		0.207	0.735	Philippines	1.335	Singapore
E-business						
E-commerce (% business use)	World Econ. Forum 2000	0.305	0.461	Russia	1.683	United States
Aggregate index		0.306	0.460	Russia	1.680	United States

Note: Mean equals 1.0. SD, standard deviation; Min, minimum; Max, maximum.

Source: Authors' computations based on data from indicated sources.

over a decade are used to ensure that data points exist for all the study countries because trade flow data can be sparse for some years for some countries.

The data for gross national product (GNP) and per capita GNP come from the World Bank's *World Development Indicators* (World Bank various years). Tariff data were derived from the Trade Analysis and Information System (TRAINS) of UNCTAD. Average applied tariff rates are used, weighted by the values of bilateral trade. The applied tariff rates are the most favored nation (MFN) tariff rates when MFN status applies or preferential rates, if available, when there are preferential trading agreements between two countries. For years when no data are available on preferential rates, the MFN rate is applied. Applied tariff records are sparse. To avoid a significant loss of observations, the applied rates are linearly interpolated or extrapolated over the period 1989–2000 for a given pair of importing and exporting countries when records for at least two years are available.

III. The Econometric Model and Results

Developed by Tinbergen (1962) and Pöyhönen (1963) to explain bilateral trade flows by trading partners' GNP and geographic distance between countries, the gravity model is a common approach to modeling bilateral trade flows. Recent theoretical and empirical work supporting this modeling approach includes Evenett and Keller (1998), Feenstra and others (1998), and Frankel (1997). Besides GDP and distance, other factors relevant for bilateral trade may include population, GDP per capita (to account for intraindustry trade effects that may be associated with countries of similar incomes but varied tastes), regional trade arrangements, and language or ethnic similarities.

Some studies add additional structural elements to the gravity model to better reflect real-world observations. These concern mainly the heterogeneity of traded goods in quality and price by origin and price differentials associated with border and transportation costs. Anderson (1979) develops a gravity model in line with a general equilibrium framework, incorporating consumer preferences for goods differentiated by region of origin, assuming a constant elasticity of substitution structure on consumer preferences. Anderson and von Wincoop (2001) additionally introduce border costs as premiums on the export prices. Balistreri and Hillberry (2001) further extend those results to estimate transport and border costs separately by distinguishing consumer and producer price indices. Using a standard specification of the gravity model, Otsuki and others (2001a, 2001b) control for differences in the prices and unobservable factors that are specific to exporting countries by allowing fixed effects for exporting countries. Though somewhat crude, such a model is less data demanding and more applicable for developing economies whose price data are less reliable and complete.

The model reported here uses the key economic variables of the gravity model, such as GNP and the geographic distance between corresponding pairs of importing and exporting countries, and augments the standard gravity model

specification with the various indicators of trade facilitation. In the general specification of the gravity model, the log of bilateral trade flows in real value is regressed on logs of GNP of exporters and importers, geographic distance between each pair of importers and exporters, and other variables that can account for the rest of the variation (Maskus and others 2001). The model used here employs the specification of the exporter-specific fixed effects developed in Otsuki and others (2001a).

The Gravity Model Analysis

The basic structure of the specific gravity equation is:

$$
\begin{aligned}
(1)\quad \ln(V_{IJ}^t) = {} & b_1 \ln(100 + TARIFF_{IJ}^t) + b_2 \ln PE_I + b_3 \ln CE_I + b_4 \ln RE_I \\
& + b_5 \ln EB_I + b_6 \ln(GNP_I^t) + b_7 \ln(GNP_J^t) + b_8 \ln(GNPPC_I^t) \\
& + b_9 \ln(GNPPC_J^t) + b_{10} \ln(DIST_{IJ}) + b_{11} D_{NAFTA} + b_{12} D_{ASEAN} \\
& + b_{13} D_{LAIA} + b_{14} D_{ENG} + b_{15} D_{CHN} + b_{16} D_{SPN} + b_{17} D_{ADJ} + e_{JI}^t
\end{aligned}
$$

where the b terms are coefficients, I is the importer and J the exporter, and t denotes trading years ($t = 1989, \ldots 2000$). The value of manufactures exports from country J to country I is denoted as V_{IJ}. The term $TARIFF_{IJ}^t$ denotes the applied ad valorem tariff specific to trading partners I and J in year t. The inclusion of the tariff variable is useful for reducing omitted variable biases. It is particularly important for APEC because, unlike the EU's harmonized tariffs, applied tariff rates generally vary across member countries and possibly across their exporting partners.

The terms PE_I, CE_I, RE_I, and EB_I denote importing country I's indicators of port efficiency, customs environment, regulatory environment, and e-business usage. These indicators were constructed from data sources with base year either 1999 or 2000. A time series for these indicators is not available. Positive signs are expected for *PE, CE*, and *EB*, but the sign for *RE* is ambiguous because of counteracting effects—the increased transparency of importer's regulations tend to encourage trade, but more stringent regulations might discourage trade.

The terms *GNP* and per capita GNP, *GNPPC*, are both expressed in 1995 U.S. dollars. Geographic distance between capital cities I and J is denoted as DIST_{IJ}. Dummy variables capture the effect of preferential trade arrangements, language similarity, and adjacency. Dummy variables are included for three trade arrangements: North American Free Trade Agreement (D_{NAFTA}), Association of Southeast Asian Nations (D_{ASEAN}), and Latin American Integration Association (D_{LAIA}). The language dummy variables include English (D_{ENG}), Chinese (D_{CHN}), and Spanish (D_{SPN}). The dummy variables for trade arrangements and language assume a value of 1 if both countries are part of the same agreement or both speak the same language. The adjacency dummy variable, D_{ADJ}, takes the value of 1 if country I shares a land border with country J and 0 otherwise.

The error term e_{JI}^{t} is defined as

$$e_{JI}^{t} = \alpha_J + \gamma^t + \varepsilon_{JI}^{t} \tag{2}$$

a composite of exporting country fixed effects, α_j, such as variations in trade flows due to the unobserved difference in quality of goods, domestic policies, and trade facilitation measures in exporting countries; time-specific fixed effects, γ^t; and the random error term, $\varepsilon_{JI}{}^{t}$, which is assumed to be normally distributed with mean 0. A complete specification would include fixed effects for both exporters and importers (see Moenius 2000, for example). However, incorporation of fixed effects causes a technical problem when at least one of the explanatory variables is invariant within groups for which a cross-section panel is formed (Wooldridge 2002). Importer-specific fixed effects are not included in the model because for a given importing country the trade facilitation measures are invariant over exporting partners and years. The problems associated with the time invariance of these measures is will be discussed shortly.

Regression Results

The regression results indicate that the approach used here—generating a set of distinct trade facilitation indicators and deploying them in a gravity model of trade—is generally successful (table 2). In the first specification (Model I) the coefficients for the four trade facilitation measures are generally significant, and all are of the expected sign. The remaining results reported in table 2 explore the sensitivity of the estimated coefficients to the definition of the trade facilitation indicators and to the functional form of the gravity equation.

Alternative Specifications

Model II relaxes the normalization of raw inputs to mean of 1, because this transformation results in different ranges across the indexed inputs (table 2). The ranges of the values of raw inputs are identically set, and the values of the raw inputs are adjusted for the new range and then added without normalization. This revised approach affects the customs indicator the most, because the raw inputs come from three sources. The signs and significance of the coefficients are generally maintained, but notable changes are observed on the coefficient for customs environment. This implies that the inputs to the customs environment indicator are sensitive to the relative ranges of their values.

Models III and IV examine alternative functional forms. The double-log specification is consistent with the typical specification of gravity models, but this transformation can stretch the scale of a raw input at the bottom and compress it at the top. Model III estimates a linear relationship between trade flows and the explanatory variables and yields the elasticities of trade flow with respect to the explanatory variables (except for the dummy variables). The signs and significance

TABLE 2. Gravity Model Results for Regression of Trade Flows on Trade Facilitation Indicators and Other Standard Variables

Variable	Model I Coefficient	Model II Coefficient	Model III Elasticity	Model IV Elasticity
Constant	−81.790***	−96.401***		
	(8.465)	(7.898)		
Tariff	−0.749**	−0.028**	−1.975***	−0.037***
	(0.375)	(0.014)	(0.713)	(0.008)
Port efficiency	4.200***	4.924***	1.344***	2.613***
	(0.219)	(0.254)	(0.465)	(0.128)
Customs environment	0.422**	−0.222	1.946***	0.388***
	(0.169)	(0.319)	(0.458)	(0.098)
Regulatory environment	−1.562***	−0.888***	−5.913***	−1.601***
	(0.308)	(0.317)	(0.601)	(0.182)
E-business	0.631***	1.363***	1.225***	0.515***
	(0.094)	(0.174)	(0.225)	(0.054)
GNP of importing country	0.846***	0.801***	19.589***	9.021***
	(0.021)	(0.022)	(1.509)	(0.192)
GNP of exporting country	3.870***	3.950***	−7.550	33.362***
	(0.521)	(0.517)	(28.374)	(4.688)
Per capita GNP of importing country	−0.376***	−0.346***	0.395	−0.519***
	(0.041)	(0.039)	(0.762)	(0.057)
Per capita GNP of exporting country	−1.906***	−1.962***	13.574	−2.422**
	(0.679)	(0.678)	(12.186)	(1.001)
Geographic distance	−0.687***	−0.671***	−2.375***	−1.051***
	(0.027)	(0.027)	(0.477)	(0.039)
NAFTA membership dummy variable	0.794***	0.784***	7.657***	1.104***
	(0.164)	(0.165)	(0.377)	(0.112)
ASEAN membership dummy variable	0.712***	0.695***	−0.292	0.414***
	(0.096)	(0.096)	(0.217)	(0.066)
LAIA membership dummy variable	1.624***	1.726***	−0.333	0.957***
	(0.279)	(0.279)	(0.639)	(0.191)
English language dummy variable	0.290***	0.244***	0.168	0.163***
	(0.075)	(0.076)	(0.174)	(0.052)
Chinese language dummy variable	1.138***	1.105***	0.589	0.945***
	(0.189)	(0.190)	(0.427)	(0.130)
Spanish language dummy variable	2.284***	2.339***	0.689*	1.506***
	(0.168)	(0.169)	(0.390)	(0.115)
Adjacency dummy variable	0.162	0.186	3.343***	0.353***
	(0.128)	(0.128)	(0.293)	(0.088)
Box-Cox parameter				0.089
Number of observations	3,304	3,304	3,304	3,304
Adjusted R^2	0.865	0.866	0.536	0.888

*Significant at the 10 percent level.

**Significant at the 5 percent level.

***Significant at the 1 percent level.

Note: A fixed-effects model with respect to exporting countries and years is used for all models. Numbers in parentheses are standard errors. Model I is log-log with normalized indicators; model II is log-log with unnormalized indicators; model III is nonlog with normalized indicators; and model IV is Box-Cox transformation with normalized indicators.

Source: Authors' computations based on survey data for trade facilitation indicators, COMTRADE for trade flows, UNCTAD TRAINS for tariffs, and World Bank *World Development Indicators* for GNP.

are consistent with those from the double-log specification for the trade facilitation indicators, but the magnitudes of coefficients are very different.

Model IV explores functional form further, using the more flexible Box-Cox transformation, which allows a nonlinear intermediate specification between linearity and logarithm. The Box-Cox estimated relationship is found to be sufficiently close to the double-log form as the Box-Cox parameter is estimated to be 0.089.[4] The estimated elasticities are also found to be similar to those for the double-log. Thus, although these results imply that functional form matters, the estimates associated with the specification in equation 1 are acceptable compared with the alternative specification.

In model I, the preferred specification, the estimated coefficients differ for the different trade facilitation indicators. From a policy perspective, these differences in estimated elasticities of trade flows with respect to the trade facilitation indicators implies that different approaches to trade facilitation will differentially affect exports of individual countries and of the APEC region as a whole.

Overall, the analysis reveals that trade facilitation involves more than reducing the cost of transportation, although this factor is important. The results indicate that other empirical research on quantifying the benefits of trade facilitation that used transport costs as a proxy for trade facilitation likely underestimated the elasticity of trade with respect to broad trade facilitation efforts. This is an important first consideration for policymakers as they identify trade and development priorities in the future. As expected, tariffs have a significant and negative effect on intra-APEC manufactures, as does distance. The coefficients on these two variables are both about 0.7 (slightly higher for customs and slightly lower for distance).

Port efficiency has the largest elasticity among the trade facilitation indicators, at approximately 4.2, suggesting that the greatest gains to intra-APEC manufactures trade would come from improvements in this area. Such a high elasticity of trade with respect to port functions is supported by internal analyses reported by Hong Kong (China) and Japan at a Trade Facilitation Seminar in Bangkok, Thailand (APEC 2002). Fink and others (2002a) also support this finding in the context of maritime-based trade. In sum, the fact that trade is more elastic with respect to direct border costs than to indirect costs appears reasonable.

Customs environment is positively associated with intra-APEC manufactures trade. The coefficient is not large (0.42) relative to the port efficiency parameter. Equal-sized improvements in the customs environment will complement port improvement, but the additional effect would be relatively small overall. On the other hand, improvements in customs can make up for less improvement in tariff barriers. Moreover, the range of potential for country performance in the area of customs is large (for example, see Russia and Indonesia in table 1), suggesting

4. A common Box-Cox parameter is used for the dependent and trade facilitation variables. See Greene (1993:39) for the specification and properties of the Box-Cox transformation.

opportunities in some countries for great improvements in this area compared with improvements in the ports indicator. This potential should raise the profile of this trade facilitation indicator in policy discussion in those countries.

Regulatory environment has a negative and significant effect on intra-APEC manufactures trade with a coefficient of −1.56. To the extent that regulations are used as border barriers, reducing these regulations will be positively associated with increased trade flows. The relatively large coefficient suggests the costly consequences for trade of nonmarket barriers to trade. The large absolute value of the coefficient points out that tightening regulations can offset improvements in other trade facilitation measures.

E-business usage has a positive and significant effect on intra-APEC manufactures trade, with a coefficient of 0.63. This result is consistent with the findings in Fink and others (2002b) and in Freund and Weinhold (2000) that good telecommunications and greater access to the Internet could increase bilateral trade flows. The range of performance among APEC members on this measure of trade facilitation is the largest among the trade facilitation indicators (table 1). So the opportunities for increased trade from improvements in this indicator are large. These results would tend to support efforts within APEC to enhance e-commerce usage through the e-APEC Strategy and Paperless Trading initiatives.

Caveats and Robustness of the Specifications

Certain caveats should be noted, however. The analytic approach applied here is designed to overcome limited data availability. For trade flows, tariffs, and GDP 12 years of data were used to overcome the sparse availability of trade flow and tariff data for the studied countries, whereas the trade facilitation indicators are available only for a single year. This mismatch creates measurement errors, because the values of these indicators have probably changed over time. Accordingly, the estimated coefficients are less likely to represent true elasticities of trade flow for the earlier period. The use of interpolated tariff rates for the years in which data are not available may also result in measurement errors if tariff changes were not linear. The estimated coefficients also may be subject to specification bias because observations with zero trade are omitted from the sample.

The robustness of the estimation results is examined by comparing the regression results with alternative specifications (table 3). First, all the time-variant variables (value of trade, tariff, GNP, and per capita GNP of the importing and exporting country) are averaged for 1989–2000 to match these variables to the trade facilitation variables. The signs and significance of the coefficients for the tariff and some of the trade facilitation indicators are different from those in the regressions with unaveraged data. The tariff coefficient is positive and significant, and the coefficients for customs environment and regulatory environment are insignificant (table 3, second column).

Compared with the trade facilitation measures, the 12-year-averaged time-variant variables are still subject to measurement error. To match the time period

TABLE 3. Robustness of the Regression Specification for Trade Flows and Trade Facilitation Indicators

Variable	With averaged data	With data only for 2000	With averaged tariff	With uninterpolated tariff
Constant	−56.196***	−41.473***	−93.291***	−35.334***
	(8.935)	(10.952)	(8.033)	(3.626)
Tariff	5.344***	1.971	0.636	−0.929**
	(1.833)	(2.233)	(0.500)	(0.472)
Port efficiency	2.174**	1.826*	4.178***	3.179***
	(0.889)	(0.994)	(0.220)	(0.273)
Customs environment	0.826	2.629***	0.141	0.581***
	(0.684)	(0.722)	(0.178)	(0.219)
Regulatory environment	−1.295	−3.967***	−1.147***	−1.875***
	(1.236)	(1.322)	(0.325)	(0.413)
E-business	0.761*	0.391	0.719***	0.484***
	(0.053)	(0.428)	(0.097)	(0.117)
GNP of importing country	0.808***	1.026***	0.819***	0.868***
	(0.089)	(0.101)	(0.022)	(0.026)
GNP of exporting country	1.082***	1.120***	4.131***	1.359***
	(0.061)	(0.069)	(0.512)	(0.115)
Per capita GNP of importing country	−0.053	−0.221	−0.307***	−0.312***
	(0.172)	(0.195)	(0.042)	(0.053)
Per capita GNP of exporting country	0.171***	0.033	−2.167***	0.250**
	(0.065)	(0.073)	(0.673)	(0.129)
Geographic distance	−0.790***	−1.119***	−0.631***	−0.650***
	(0.103)	(0.121)	(0.026)	(0.035)
NAFTA membership dummy variable	0.044	0.968	0.786***	1.177***
	(0.661)	(0.805)	(0.163)	(0.205)
ASEAN membership dummy variable	1.702***	1.337***	0.964***	0.246**
	(0.372)	(0.447)	(0.094)	(0.123)
LAIA membership dummy variable	0.386	0.142	1.710***	1.466***
	(1.143)	(1.228)	(0.282)	(0.363)
English language dummy variable	0.503*	0.697**	0.293***	0.312***
	(0.278)	(0.334)	(0.074)	(0.092)
Chinese language dummy variable	1.438***	1.161***	1.063***	1.034***
	(0.317)	(0.369)	(0.167)	(0.244)
Spanish language dummy variable	0.689	0.336	2.395***	2.172***
	(0.674)	(0.728)	(0.170)	(0.222)
Adjacency dummy variable	0.540	0.662	0.147	0.112
	(0.509)	(0.733)	(0.123)	(0.168)
Number of observations	303	279	3413	1949
Adjusted R^2	0.746	0.725	0.864	0.874

Note: A fixed-effects model with respect to exporting countries and years is used for all models. Numbers in parentheses are standard errors.

*Significant at the 10 percent level.

**Significant at the 5 percent level.

***Significant at the 1 percent level.

Source: Authors' computations based on survey data for trade facilitation indicators, COMTRADE for trade flows, UNCTAD TRAINS for tariffs, and World Bank *World Development Indicators* for GNP.

exactly, the specification was run using data only for 2000. Observations are lost for some country pairs, but the measurement error with respect to trade facilitation measures is avoided. These results suggest a greater importance for customs and regulatory environment than in the initial specification reported in table 2. This result appears reasonable, given that many of these countries have undertaken improvements in their port facilities over the 12-year period (third column).

A second robustness check examined measurement error due to interpolation of tariff rates, using two alternative specifications of tariff rates: one with averaged tariff rates instead of interpolated tariff rates over the period 1989–2000 (fourth column) and one with uninterpolated tariff rates (fifth column). With averaged tariff rates the coefficient for tariff rates is positive but insignificant, and coefficients on the trade facilitation variables are of about the same magnitude as in the initial specification in table 2, although the customs variable is not significant. With uninterpolated tariff rates the tariff variable is negative and significant, although the trade facilitation variables remain robust and their coefficients are of approximately the same size as those in the table 2 specification. It is not clear from these results whether the interpolated or averaged tariff rates have introduced measurement error or simply missing data. The results suggest overall, however, that the trade facilitation variables are robust to this change in the tariff specification.

Finally, the estimated coefficients may be biased due to the sample selection bias that results from omitting observations with zero trade (see, for example, Wall 2000). Downward bias is likely for the coefficients on the trade facilitation measures because observations with zero trade caused by poor conditions of trade facilitation, other things being equal, are ignored. The implications of this selection bias could not be examined because the source data do not distinguish zero trade from missing records.

Cross-section regression analysis inevitably involves ambiguous causal relationships. In addition, use of a set of trade facilitation measures for a single year limits the interpretation of the coefficients as elasticities. The possibility cannot be excluded that greater bilateral trade will lead to higher values of trade facilitation measures rather than to the reverse relationship that was postulated in the estimation. Port efficiency, customs environment, and e-business usage may improve with a country's import flows, and if this endogeneity is present the estimated coefficients for these variables would be biased upward.

A logical approach to the endogeneity problem when time-series data for the explanatory variable of interest are unavailable is to employ instrumental variables for the trade facilitation variables so that the error term does not correlate with the trade facilitation measures. This approach requires instrumental variables that are exogenous to the trade facilitation measures and trade flow. But such instruments are difficult to find, and their power is uncertain. Moreover, the endogeneity problem remains if instruments that best account for the state of trade facilitation are likely to be dependent on trade flows. The use of instruments is consequently not an effective solution to endogeneity. Time series

for the raw inputs to trade facilitation indicators may become available in the future, which should mitigate the endogeneity problem.

IV. Potential Benefits from Trade Facilitation: Simulation Results

This section examines various scenarios of improved trade facilitation and tariff reduction, focusing on improved port efficiency, customs environment, e-business usage, and regulatory harmonization. The objective is to inform policymakers about specific trade facilitation initiatives with the greatest potential to increase trade and economic well-being.

Simulation Design

The simulations using the gravity model and trade facilitation indicators provide three perspectives on trade facilitation in APEC. First, the simulations present the implications of different trade facilitation initiatives for intra-APEC trade as a whole. Second, the simulations permit examination of an individual APEC member's exports to other APEC members (bilateral and total). Finally, the simulations can provide a proxy for the costs to businesses and consumers in an individual APEC country when its trade facilitation indicators are lower than APEC best practice.

The simulation methodology of applying a common percentage improvement to each trade facilitation indicator implies that even an economy that is already using best practice will also have to improve. Instead, an approach is used that acknowledges the differential potential for improvement revealed by table 1, to better inform policy decisions on the kind of trade facilitation initiative that might yield the greatest improvements. To that end the goal is to identify improvements that bring below-average members halfway to the APEC average.[5] The focus is on below-average performers on the grounds that donor attention and capacity-building efforts should be extended to members of this group, which because of their lower scores will have to make greater efforts. The goal of halfway to average recognizes that it is not realistic to presume a scenario in which all APEC members achieve best practice as measured by the APEC member with the highest score on a particular measure of trade facilitation. Not only does the best-practice economy differ by trade facilitation measures, but the range between lowest value and highest value varies significantly, being greatest for e-business usage and customs environment.

Thus the countries for which an improvement in trade facilitation is simulated will differ by trade facilitation indicator. However, because trade facilita-

5. The simulation is a one-time shot. Thus the problem arises that improvements in the below-average APEC members will change the target average. A simulation exercise that considered sequential rounds of reforms using this strategy would have to take into account the endogeneity of the target levels of trade facilitation reforms.

tion links exporters and importers, all economies enjoy an increase in intra-APEC trade even when only some have an improvement in their trade facilitation indicator. Consider this example for Chile and New Zealand. Chile is below average in port efficiency, and the scenario for improvement in that indicator will bring Chile halfway to the APEC average. But Chile is above average for customs environment, so no improvement is postulated for Chile in the scenario for that indicator. New Zealand has above-average trade facilitation indicators for all except e-business usage. Thus only in the scenario of improved e-business will the trade facilitation indicator for New Zealand be improved. However, because Chile and New Zealand trade with each other in APEC, when Chile improves its ports, New Zealand gains. When New Zealand improves its e-business usage, Chile gains.

Simulation Results

For port logistics, customs environment, and e-business usage, the simulation is designed to bring below-APEC-average members halfway to the initial APEC average. For regulatory environment, for which research suggests that standards harmonization increases trade (Moenius 2000; Hertel and others 2001), the simulation brings the above-average members halfway down to the APEC average, as a proxy for how relaxing regulatory barriers increases trade, and the below-average members halfway up to the APEC average, as a proxy for how standards harmonization increases trade.

Together, the simulations yield an increase in intra-APEC trade of approximately $250 billion, or 21 percent of total intra-APEC manufactures trade (table 4). Some $117 billion of the total gain (a 10 percent increase in trade) comes from improvements in port efficiency and $22 billion from improvements in the customs environment. Another $116 billion might come from improvements behind the border in regulatory harmonization and e-business usage.

The large increase in intra-APEC trade derived from improved port efficiency is due partly to the large coefficient on the relationship between trade and port logistics (4.2; see table 2 model I) and partly to the broad room for improvement in countries such as China and Mexico, which are very large intra-APEC traders. Many APEC countries would exhibit double-digit increases in dollar value exports to the APEC region from the measures, with the greatest gains going to large APEC exporters, such as the United States, Japan, and the Republic of Korea (Wilson and others 2003). These scenarios suggest that the attention devoted by policymakers to improvements in port efficiency is warranted. However, the range from best practice to worst practice is smaller for port logistics than for other trade facilitation indicators, suggesting that there are countries in which port efficiency is not the principal bottleneck to trade.

Each APEC member has a unique trade pattern with other members. From an exporting country's perspective, export gains will depend on which APEC countries it trades with and how much improvement its trading partners achieve under a particular trade facilitation scenario. From an importing country's

TABLE 4. Overview of Simulation: Halfway to APEC Average

Trade facilitation measure	Goal	Change in trade flow: Amount ($ billion)	Change in trade flow: Share of total trade (%)
Border measures			
Port efficiency	Bring below-average members up to the APEC average	116.89	9.7
Customs environment	Bring below-average members up to the APEC average	21.63	1.8
Behind-the-border measures			
E-business	Bring below-average members up to the APEC average	27.69	2.3
Regulatory environment	Regulatory harmonization: Bring above average members down to the APEC average, and below-average members up to the APEC average	88.15	7.3
Total		254.36	21.0

Source: Authors' computations based on survey data for trade facilitation indicators, COMTRADE for trade flows, UNCTAD TRAINS for tariffs, and World Bank *World Development Indicators* for GNP.

perspective efficiency gains (measured as increased imports) depend only on the country's own trade facilitation efforts. Wilson and others (2003) simulate trade gains for individual APEC members from these two perspectives.

Because of countries' dependencies on their own trade facilitation indicators and their own trading patterns, trade facilitation measures that generate the greatest gains for an individual APEC member might not be the same as trade facilitation measures that generate the greatest gains for APEC as a whole. For example, Thailand's port efficiency indicator is near the APEC average. A small improvement (which would still cost resources) in the APEC average would increase Thailand's imports by some $4.4 billion. But Thailand's customs environment and e-business usage are much further away from the APEC average. An improvement halfway to the APEC average in customs environment would increase Thailand's imports by $2.4 billion. If the cost of improving customs is much less than the cost of improving port efficiency, then the net gain might be greater from focusing policy efforts on customs than on port efficiency. Even greater gains would result from an improvement halfway to the APEC average in e-business usage—Thailand's imports would increase $7.9 billion, nearly 50 percent more than they would from the two border measures taken together. Therefore, a Thai policymaker might want to consider reforms that enable greater e-business usage. This example shows that selecting the best target for policy effort requires careful attention not only to the estimated coefficient of trade with respect to individual trade facilitation indicators but also to where an economy ranks in the range of APEC economies.

Tariff Reductions or Trade Facilitation?

The regression results also enable comparison of the potential trade gains from improvements in trade facilitation and from tariff reductions. The estimated coefficients point to tradeoffs between the two. Reducing tariffs to 0 is used as the benchmark for evaluating what equiproportionate improvement in each trade facilitation indicator would generate the same amount of gain in total intra-APEC exports. When all members make equiproportionate improvements in trade facilitation indicators, the total gain is 0.55 percent for port efficiency and 5.46 percent for customs environment. When only below-APEC-average members make equiproportionate improvements in the trade facilitation indicator,[6] the gain is 0.83 percent for port efficiency and 27.7 percent for customs environment.

An average reduction of 6.5 percent in the applied ad valorem tariff is needed to reduce to 0 all tariffs on manufactures in all APEC members. The gain in trade flows from this reform would be $27.8 billion. To achieve the same increase through trade facilitation measures the port efficiency indicator would have to be improved by 0.55 percent if all members are included or by 0.83 percent if only below-APEC-average members are included, the customs environment indicator would have to be improved by 5.5 percent for all APEC members or by 27.7 percent for below-average members, and the e-business indicator by 3.7 percent for all members or by 13.2 percent for below-average members. Thus the required improvements in trade facilitation indicators, especially for port efficiency, are relatively small compared with the required tariff reductions to generate similar gains in trade. This implies that trade facilitation can be a good policy alternative if tariff reduction is not feasible.[7]

Scope of the Analysis and Extension

The scope of the analysis was limited to elicit information useful to the policy target. The analysis has focused on improvement in the trade facilitation measures of importing countries. But the estimates from importers' improvement in trade facilitation account for only partial gains in trade flows. The simulation analysis also needs to be performed for exporters to obtain the total gains in trade flows.

The simulations reported herein focus on the relationship between trade facilitation and trade flows. In a public policy dimension, however, information on the cost of investment in trade facilitation is also indispensable for a country

6. A condition is imposed in the second analysis that the value of a trade facilitation indicator of below-average members will not exceed the APEC average after the improvement.

7. This simulation returns to the tradition of an equiproportionate change for each APEC member. As noted, this equiproportionate increase masks significant differences among the member economies in their trade facilitation indicators and also does not exploit these differences to generate greater gains from one indicator over the others.

government to make socially desirable decisions. Although the analysis indicates that improvement in port efficiency has the greatest positive impact on trade over all the APEC members, this may not be the most cost-effective option for an individual economy. The direct costs of improving port infrastructure may be greater than the direct costs of improving the customs environment, for example (although indirect costs of organization change could be higher in customs). In any case, cross-country data and analysis of the cost of investment and reform in each area of trade facilitation would make possible research that complements the findings here to better inform policymaking.[8]

V. Conclusion

The key innovation in the research approach reported here centers on considering a variety of indicators of trade facilitation and of pragmatic simulations suited to policymaking. Collectively, the country-specific trade facilitation indicators embrace the multiple approaches to trade facilitation reflected in modern international commerce. The simulation analysis also considers the importance of focusing on best practices and achieving benchmarks tied to what is known from experience in best practices in trade facilitation. Considered completely separately from any model estimation of their effect on trade, this set of indicators helps policymakers judge where their economy stands relative to their peers on each of these measures. In the context of quantifying the benefits of trade facilitation efforts, this multiple-indicator approach and realistic simulation design, along with decomposition of the impact of the various indicators on trade, may enable more targeted decisionmaking by policymakers.

The simulation approach offers several perspectives on the potential benefits of improvements in trade facilitation. It permits analysis of the implications for intra-APEC trade as a whole. It also allows examination of an individual member's exports to other APEC members and use of the results as a proxy for the costs to an APEC member whose trade facilitation indicators are below best practice. This three-sided analysis can be a particularly valuable input when considering alternative pilot projects for individual APEC members. Of course, the resource costs of alternative policy reforms must be considered to gauge the net gain.

In sum, using this set of indicators and modeling approach offers policymakers more information about what type of trade facilitation efforts might provide the largest gains in terms of increasing trade flows. Whereas it remains true that a comprehensive effort yields the greatest increase in trade, examination of different kinds of trade facilitation and of disaggregated trade flows could be useful for targeting policy efforts and launching pilot projects in capacity building.

8. For a start on the analysis of costs versus benefit, see the case studies in Wilson and others (2002).

Appendix. Data Sources

- World Economic Forum (2000), *Global Competitiveness Report 2000*. All survey data are from the World Economic Forum's Executive Opinion Survey of senior business leaders in 4,022 firms in different countries.
- IMD (2000) Lausanne, *World Competitiveness Yearbook 2000*. The yearbook uses a 115-question survey sent to executives in top and middle management of firms in 49 countries. The sample size of each country is proportional to its GDP, and firms "normally have an international dimension." The firms are selected to be a cross-section of manufacturing, service, and primary industries. There were 3,532 responses to the survey in 2000.
- Transparency International (2001), *The Global Corruption Report*. Transparency International is the only international nongovernmental organization devoted to studying and fighting corruption. Through 80 independent chapters around the world it monitors government compliance, corruption levels, and the transparency of regulations.
- Clark and others (2002) provides data on port efficiency for maritime transport.

The various raw data series were chosen for their relevance to the four concepts of trade facilitation.

- Port efficiency for each APEC member *J* is the average of three indexed inputs:
  - Port Efficiency Index (1 = worst and 7 = best; Clark and others 2002).
  - "Port facilities and inland waterways are extensive and efficient" (1 = strongly disagree and 7 = strongly agree; World Economic Forum 2000).
  - "Air transport is extensive and efficient" (1 = strongly disagree and 7 = strongly agree; World Economic Forum 2000).
- Customs environment for each APEC member *J* is the average of five indexed inputs:
  - "Irregular, additional payments connected with import and export permits, business licenses, exchange controls, tax assessments, police protection, or loan applications are very rare" (1 = strongly disagree and 7 = strongly agree; World Economic Forum 2000).
  - "Import fees are high" (1 = strongly disagree and 7 = strongly agree; World Economic Forum 2000).
  - "Hidden import barriers other than published tariffs and quotas are: 1 = an important problem and 7 = not an important problem" (World Economic Forum 2000).
  - "Bribery and corruption exist in the economy" (1 = agree and 10 = disagree, IMD Lausanne 2000).
  - Corruption Perceptions Index (Transparency International 2001).
- Regulatory environment for each APEC member *J* is constructed as the average of four indexed inputs (World Economic Forum 2000):
  - "Environmental regulations in your country are 1 = confusing and frequently changing and 7 = transparent and stable."

- "Regulatory standards (product, energy, safety, environmental standards) are among the world's most stringent" (1 = strongly disagree and 7 = strongly agree).
- "Compliance with international environmental agreements is a high priority in your country's government" (1 = strongly agree and 7 = strongly disagree).[9]
- "Environmental regulation in your country is: 1 = not enforced or enforced erratically and 7 = enforced consistently and fairly."

• E-business for each APEC member *J* (World Economic Forum 2000):
- "Percentage of companies that use the Internet for e-commerce."

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9. For indexing, this index value is reversed to make it consistent with the other indexes.

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